МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

ДЗ «ПІВДЕННОУКРАЇНСЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ІМЕНІ К. Д. Ушинського»

Кафедра західних і східних мов та методики їх навчання

Юмрукуз А. А.

Англомовна медична термінологія

Навчальний посібник

Одеса, 2022

Рекомендовано Вченою радою ДЗ «Південноукраїнський національний педагогічний університет ім. К. Д. Ушинського» (протокол № __від ____ 2022 р.)

А. А. Юмрукуз

Англомовна медична термінологія: навчальний посібник. Одеса : Магістр, 2022. 201 с.

Рецензенти: кандидат філологічних наук, доцент Петров О. О.
кандидат педагогічних наук, доцент Першина Л. В.

Методичні рекомендації розроблено для здобувачів вищої освіти 1-го року навчання другого освітнього рівня «Магістр» спеціальності 222 Медицина. Вони мають на меті допомогти здобувачам освіти засвоїти відому їм термінологію англійською мовою.

ЗМІСТ

Передмова

Глобалізація сучасної системи охорони здоров’я, розвиток так званого медичного туризму, спричинюють нові виклики для фахівців відповідної галузі. Необхідність комунікації в міжнародному форматі (під час виступів на конференціях, проведенні спільних заходів, консультувань і т. ін.) вимагає від спеціаліста в галузі медицини знань англомовної медичної термінології. Тому метою даного посібника було допомогти здобувачам освіти за спеціальністю 222 Медицина освоїти англомовну медичну термінологію та закріпити знання під час виконання вправ.

Посібник складається з семи розділів, присвячених опису анатомії та розладів всіх систем організму людини, секції тестів для самоперевірки та секції текстів для додаткового читання.

Кожний розділ містить автентичний текст, що вводить нові лексичні одиниці з теми, комплекс завдань для запам’ятовування нових слів у контексті, а також текст, що вводить лексичні одиниць, які стосуються розладів відповідної системи організму людини.

Тести наприкінці посібника спрямовані допомогти здобувачам освіти перевірити свої знання вивчених термінологічних одиниць.

Посібник розрахований на студентів медичних спеціальностей, а також всіх, хто цікавиться розширенням лексичної компетенції у медичній галузі.

Unit 1. SKELETAL SYSTEM

Text 1.
Skeletal System Anatomy

1. Read the text.

The skeletal system in an adult body is made up of 206 individual bones. These bones are arranged into two major divisions: the ***axial skeleton*** and the ***appendicular skeleton***. The axial skeleton runs along the body's midline axis and is made up of 80 bones in the following regions:

- Skull
- Hyoid
- Auditory ossicles
- Ribs
- Sternum
- Vertebral column

The appendicular skeleton is made up of 126 bones in the following regions:

- Upper limbs
- Lower limbs
- Pelvic girdle
- Pectoral (shoulder) girdle

Skull

The ***skull*** is composed of 22 bones that are fused together except for the mandible. These 21 fused bones are separate in children to allow the skull and brain to grow, but fuse to give added strength and protection as an adult. The ***mandible*** remains as a movable jaw bone and forms the only movable joint in the skull with the ***temporal bone***.

The bones of the superior portion of the skull are known as the ***cranium*** and protect the brain from damage. The bones of the inferior and anterior portion of the skull are known as facial bones and support the eyes, nose, and mouth.

Hyoid and Auditory Ossicles

The ***hyoid*** is a small, U-shaped bone found just inferior to the mandible. The hyoid is the only bone in the body that does not form a joint with any other bone – it is a floating bone. The hyoid's function is to help hold the ***trachea*** open and to form a bony connection for the ***tongue muscles***.

The ***malleus, incus***, and ***stapes*** – known collectively as the ***auditory ossicles –*** are the smallest bones in the body. Found in a small cavity inside of the temporal bone, they serve to transmit and amplify sound from the eardrum to the inner ear.

Vertebrae

Twenty-six vertebrae form the ***vertebral column*** of the human body. They are named by region:

Cervical (neck) – 7 vertebrae

Thoracic (chest) – 12 vertebrae

Lumbar (lower back) – 5 vertebrae

Sacrum - 1 vertebra

Coccyx (tailbone) – 1 vertebra

With the exception of the singular sacrum and coccyx, each vertebra is named for the first letter of its region and its position along the superior-inferior axis. For example, the most superior thoracic vertebra is called T1 and the most inferior is called T12.

Ribs and Sternum

The sternum, or breastbone, is a thin, knife-shaped bone located along the midline of the anterior side of the ***thoracic region of the skeleton***. The sternum connects to the ribs by thin bands of cartilage called the ***costal cartilage***.

There are 12 pairs of ribs that together with the sternum form the ribcage of the thoracic region. The first seven ribs are known as "***true ribs***" because they connect the thoracic vertebrae

directly to the sternum through their own band of costal cartilage. Ribs 8, 9, and 10 all connect to the sternum through cartilage that is connected to the cartilage of the seventh rib, so we consider these to be "***false ribs***." Ribs 11 and 12 are also false ribs, but are also considered to be "***floating ribs***" because they do not have any cartilage attachment to the sternum at all.

Pectoral Girdle and Upper Limb

The pectoral girdle connects the ***upper limb (arm) bones*** to the axial skeleton and consists of the left and right clavicles and left and right scapulae.

The ***humerus*** is the bone of the upper arm. It forms the ball and socket ***joint of the shoulder*** with the scapula and forms the ***elbow joint*** with the lower arm bones. The radius and ulna are the two bones of the forearm. The ulna is on the medial side of the forearm and forms a hinge joint with the humerus at the elbow. The radius allows the forearm and hand to turn over at the wrist joint.

The lower arm bones form the wrist joint with the ***carpals***, a group of eight small bones that give added flexibility to the wrist. The carpals are connected to the five metacarpals that form the ***bones of the hand*** and connect to each of the fingers. Each finger has three bones known as phalanges, except for the thumb, which only has two phalanges.

Pelvic Girdle and Lower Limb

Formed by the left and right hip bones, the pelvic girdle connects the ***lower limb (leg) bones*** to the axial skeleton.

The ***femur*** is the largest bone in the body and the only bone of the thigh (femoral) region. The femur forms the ball and socket ***hip joint*** with the hip bone and forms the ***knee joint*** with the tibia and patella. Commonly called the kneecap, the ***patella*** is special because it is one of the few bones that are not present at birth. The patella forms in early childhood to support the knee for walking and crawling.

The ***tibia*** and ***fibula*** are the bones of the lower leg. The tibia is much larger than the fibula and bears almost all of the body's weight. The fibula is mainly a muscle attachment point and is used to help maintain balance. The tibia and fibula form the ankle joint with the talus, one of the seven tarsal bones in the ***foot***.

The ***tarsals*** are a group of seven small bones that form the posterior end of the foot and heel. The tarsals form joints with the five long metatarsals of the foot. Then each of the metatarsals forms a joint with one of the set of phalanges in the toes. Each toe has three phalanges, except for the big toe, which only has two phalanges.

Microscopic Structure of Bones

The skeleton makes up about 30-40% of an adult's body mass. The skeleton's mass is made up of nonliving bone matrix and many tiny bone cells. Roughly half of the bone matrix's mass is water, while the other half is collagen protein and solid crystals of calcium carbonate and calcium phosphate.

Living bone cells are found on the edges of bones and in small cavities inside of the bone matrix. Although these cells make up very little of the total bone mass, they have several very important roles in the functions of the skeletal system. The bone cells allow bones to:

- Grow and develop
- Be repaired following an injury or daily wear
- Be broken down to release their stored minerals

Types of Bones

All of the bones of the body can be broken down into five types: long, short, flat, irregular, and sesamoid.

Long. Long bones are longer than they are wide and are the major bones of the limbs. Long bones grow more than the other classes of bone throughout childhood and so are responsible for the bulk of our height as adults. A hollow ***medullary cavity*** is found in the center of long bones and serves as a storage area for bone marrow. Examples of long bones include the femur, tibia, fibula, ***metatarsals***, and ***phalanges***.

Short. Short bones are about as long as they are wide and are often cubed or round in shape. The ***carpal bones*** of the wrist and the tarsal bones of the foot are examples of short bones.

Flat. Flat bones vary greatly in size and shape, but have the common feature of being very thin in one direction. Because they are thin, flat bones do not have a medullary cavity like the

long bones. The frontal, ***parietal***, and ***occipital bones*** of the cranium – along with the ribs and hip bones – are all examples of flat bones.

Irregular. Irregular bones have a shape that does not fit the pattern of the long, short, or flat bones. The ***vertebrae***, ***sacrum***, and ***coccyx*** of the spine – as well as the ***sphenoid, ethmoid***, and ***zygomatic bones*** of the skull – are all irregular bones.

Sesamoid. The sesamoid bones are formed after birth inside of tendons that run across joints. Sesamoid bones grow to protect the tendon from stresses and strains at the joint and can help to give a mechanical advantage to muscles pulling on the tendon. The patella and the ***pisiform bone*** of the carpals are the only sesamoid bones that are counted as part of the 206 bones of the body. Other sesamoid bones can form in the joints of the hands and feet, but are not present in all people.

Parts of Bones

The long bones of the body contain many distinct regions due to the way in which they develop. At birth, each long bone is made of three individual bones separated by hyaline cartilage. Each end bone is called an ***epiphysis*** (epi = on; physis = to grow) while the middle bone is called a ***diaphysis*** (dia = passing through). The epiphyses and diaphysis grow towards one another and eventually fuse into one bone. The region of growth and eventual fusion in between the epiphysis and diaphysis is called the ***metaphysis*** (meta = after). Once the long bone parts have fused together, the only hyaline cartilage left in the bone is found as ***articular cartilage*** on the ends of the bone that form joints with other bones. The articular cartilage acts as a shock absorber and gliding surface between the bones to facilitate movement at the joint.

Looking at a bone in cross section, there are several distinct layered regions that make up a bone. The outside of a bone is covered in a thin layer of dense irregular connective tissue called the ***periosteum***. The periosteum contains many strong collagen fibers that are used to firmly anchor tendons and muscles to the bone for movement. Stem cells and osteoblast cells in the periosteum are involved in the growth and repair of the outside of the bone due to stress and injury. Blood vessels present in the periosteum provide energy to the cells on the surface of the bone and penetrate into the bone itself to nourish the cells inside of the bone. The periosteum

also contains nervous tissue and many nerve endings to give bone its sensitivity to pain when injured.

Deep to the periosteum is the compact bone that makes up the hard, mineralized portion of the bone. ***Compact bone*** is made of a matrix of hard mineral salts reinforced with tough collagen fibers. Many tiny cells called osteocytes live in small spaces in the matrix and help to maintain the strength and integrity of the compact bone.

Deep to the compact bone layer is a region of ***spongy bone*** where the bone tissue grows in thin columns called ***trabeculae*** with spaces for ***red bone marrow*** in between. The trabeculae grow in a specific pattern to resist outside stresses with the least amount of mass possible, keeping bones light but strong. Long bones have a spongy bone on their ends but have a hollow ***medullary cavity*** in the middle of the diaphysis. The medullary cavity contains red bone marrow during childhood, eventually turning into yellow bone marrow after puberty.

Articulations

An ***articulation***, or joint, is a point of contact between bones, between a bone and cartilage, or between a bone and a tooth. ***Synovial*** joints are the most common type of articulation and feature a small gap between the bones. This gap allows a free range of motion and space for synovial fluid to lubricate the joint. ***Fibrous joints*** exist where bones are very tightly joined and offer little to no movement between the bones. Fibrous joints also hold ***teeth*** in their bony sockets. Finally, ***cartilaginous joints*** are formed where bone meets cartilage or where there is a layer of cartilage between two bones. These joints provide a small amount of flexibility in the joint due to the gel-like consistency of cartilage.

Skeletal System Physiology

Support and Protection

The skeletal system's primary function is to form a solid framework that supports and protects the body's organs and anchors the skeletal muscles. The bones of the ***axial skeleton*** act as a hard shell to protect the internal organs – such as the brain and the heart – from damage caused by external forces. The bones of the ***appendicular skeleton*** provide support and flexibility at the joints and anchor the muscles that move the limbs.

Movement

The bones of the skeletal system act as attachment points for the skeletal muscles of the body. Almost every skeletal muscle works by pulling two or more bones either closer together or further apart. ***Joint***s act as pivot points for the movement of the bones. The regions of each bone where muscles attach to the bone grow larger and stronger to support the additional force of the muscle. In addition, the overall mass and thickness of a bone increase when it is under a lot of stress from lifting weights or supporting body weight.

Hematopoiesis

Red bone marrow produces red and white blood cells in a process known as hematopoiesis. Red bone marrow is found in the hollow space inside of bones known as the ***medullary cavity***. Children tend to have more red bone marrow compared to their body size than adults do, due to their body's constant growth and development. The amount of red bone marrow drops off at the end of puberty, replaced by ***yellow bone marrow***.

Storage

The skeletal system stores many different types of essential substances to facilitate growth and repair of the body. The skeletal system's cell matrix acts as our ***calcium bank*** by storing and releasing calcium ions into the blood as needed. Proper levels of calcium ions in the blood are essential to the proper function of the nervous and muscular systems. Bone cells also release osteocalcin, a hormone that helps regulate blood sugar and fat deposition. The yellow bone marrow inside of our hollow long bones is used to store energy in the form of lipids. Finally, red bone marrow stores some iron in the form of the molecule ferritin and uses this iron to form hemoglobin in red blood cells.

Growth and Development

The skeleton begins to form early in fetal development as a flexible skeleton made of hyaline cartilage and dense ***irregular fibrous connective tissue***. These tissues act as a soft, growing framework and placeholder for the bony skeleton that will replace them. As development progresses, blood vessels begin to grow into the soft fetal skeleton, bringing stem cells and nutrients for bone growth. ***Osseous tissue*** slowly replaces the cartilage and fibrous

tissue in a process called ***calcification.*** The calcified areas spread out from their blood vessels replacing the old tissues until they reach the border of another bony area. At birth, the skeleton of a newborn has more than 300 bones; as a person ages, these bones grow together and fuse into larger bones, leaving adults with only 206 bones.

Flat bones follow the process of ***intramembranous ossification*** where the young bones grow from a primary ossification center in fibrous membranes and leave a small region of fibrous tissue in between each other. In the skull these soft spots are known as fontanels, and give the skull flexibility and room for the bones to grow. Bone slowly replaces the fontanels until the individual bones of the skull fuse together to form a rigid adult skull.

Long bones follow the process of ***endochondral ossification*** where the diaphysis grows inside of cartilage from a ***primary ossification center*** until it forms most of the bone. The epiphyses then grow from ***secondary ossification centers*** on the ends of the bone. A small band of hyaline cartilage remains in between the bones as a growth plate. As we grow through childhood, the growth plates grow under the influence of growth and sex hormones, slowly separating the bones. At the same time the bones grow larger by growing back into the growth plates. This process continues until the end of puberty, when the growth plate stops growing and the bones fuse permanently into a single bone. The vast difference in height and limb length between birth and adulthood are mainly the result of endochondral ossification in the long bones.

2. Answer the following questions.

1. How many bones are there in the body?
2. What are the two major divisions of bones?
3. How many bones are there in the skull?
4. Where is a medullar cavity located?
5. Which ribs are true ribs and which ones are false?
6. What is the patella?
7. What are the sesamoid bones?

8. What is the region of growth and eventual fusion in between the epiphysis and diaphysis called?

9. What are the types of ossification?

10. What is the function of the osseous tissue?

3. Match these words with their definitions.

a. articular cartilage	*j. the articular capsule*
b. skull	*k. the pelvis*
c. epiphysis	*l. coccyx*
d. zygomatic bone	*m. navicular bone*
e. medullary cavity	*n. false ribs*
f. musculoskeletal health issues	*o. the anterior longitudinal ligament*
g. femur	*p. lesser trochanter*
h. cuboid bone	*q. the skull*
i. clavicles	*r. a sesamoid bone*

1. include conditions that affect joints, such as osteoarthritis, rheumatoid arthritis, psoriatic arthritis, gout, ankylosing spondylitis; bones, such as osteoporosis, osteopenia and associated fragility fractures, traumatic fractures; muscles, such as sarcopenia.

2. a bone with no covering membrane of periosteum.

3. the rounded portions at the ends of a bone separated from the metaphysis by the physis.

4. a thigh bone, is the proximal bone of the hindlimb in tetrapod vertebrates.

5. the hollow part of bone that contains bone marrow.

6. a resilient and smooth elastic tissue, rubber-like padding that covers and protects the ends of long bones at the joints and nerves, and is a structural component of the rib cage, the ear, the nose, the bronchial tubes, the intervertebral discs, and many other body components. It is not as hard and rigid as bone, but it is much stiffer and much less flexible than muscle.

7. a paired irregular bone which articulates with the maxilla, the temporal bone, the sphenoid bone and the frontal bone.

8. protects the all-important brain and supports the other soft tissues of the head.

9. consists of strong, dense fibers, located inside the bodies of the vertebrae.

10. is the lower, medial part of a construction, or neck, just below the head of the femur.

11. located in the lower torso, it is a sturdy ring of bones that protects the delicate organs of the abdominopelvic cavity while anchoring the powerful muscles of the hip, thigh, and abdomen.

12. surrounds the joints between the cartilages of the true ribs and the sternum (breastbone).

13. is both the smallest and the most inferior bone in the spinal column.

14. are a pair of long bones that connect the scapula to the sternum.

15. are the remaining five pairs of ribs (the other seven are called true ribs) in which their cartilages do not reach the sternum directly.

16. is one of the seven bones that make up the tarsus, or ankle bones.

17. is one of the seven tarsal, or ankle, bones. This bone, along with the other tarsal bones, forms a group called the tarsus.

4. Fill in the gaps with the words from the box.

the deltoid ligament	*shoulder joint*	*the talus*	*pisometacarpal ligament*		
hamate bone	*humerus*	*ulna*	*sternum*	*metacarpal bones*	*ilium*

1. ……is a ligamentous structure that is triangular in shape and attaches the medial malleolus of the tibia to the navicular, calcaneus, and talus (anteriorly and posteriorly) bones of the tarsus.

2. ……is a tarsal bone and is arranged with a group, called the tarsus, so that it can move freely where it joins the tibia and fibula (lower leg bones).

3. The……, commonly known as the breastbone, is a long, narrow flat bone that serves as the keystone of the rib cage and stabilizes the thoracic skeleton.

4. The most flexible joint in the entire human body, our…… is formed by the union of the humerus, the scapula (or shoulder blade), and the clavicle (or collarbone).

5. The…….. is the largest and most superior of the three bones that join to form the hipbone, or os coxa.

6. The…… is the both the largest bone in the arm and the only bone in the upper arm.

7. The …… is the longer, larger and more medial of the lower arm bones.

8. The ……. is located in the wrist, and can be identified by its wedged shape.

9. The ……. are five long cylindrical bones in the body of the hand.

10. The ……. is a palmar ligament and is a strong, fibrous band.

5. Translate the following sentences into English.

1. Пизометакарпальна зв’язка з’єднує пізоподібну кістку з основою п’ятої п’ясткової кістки. Є продовженням сухожилля ліктьового згинача зап’ястя.

2. Плечова кістка - це довга кістка, яка складається з діафіза і двох кінцівок (епіфіза). Це найдовша кістка верхньої кінцівки.

3. Комплекс медіальних колатеральних зв’язок гомілковостопного суглоба має загальну назву дельтовидної зв’язки. Він прикріплює медіальну кісточку до кількох кісток плесна.

4. Кістки зап'ястя відомі як зап'ястові кістки. Гачкоподібна кістка – це зап’ясткова кістка клиноподібної форми.

5. Кісткова тканина — тверда, міцна тканина, яка утворює кістки. Вона в основному складається з фосфату кальцію і містить клітини остеобластів, остеоцитів і остеокластів, які створюють, підтримують і розсмоктують кісткову тканину.

Text 2.
Common Bone and Joint Disorders

6. Read the text.

Common Bone Disorders

Osteoporosis

This common disease occurs when bones become weak due to changes in bone mineral density and mass, causing a higher risk for fractures. Osteoporosis is known as a ***"silent" disease*** as there are no obvious symptoms until a bone actually breaks. These fractures can occur anywhere, but typically in the hip, spine, and wrist. Although anyone can develop this disease, osteoporosis is ***more prevalent in*** older women. Aside from aging, additional risk factors include being of ***small stature***, family history, certain medications, and having ***low bone density***.

Fracture

A fracture is a break in a bone which occurs when it is put under sudden or very strong pressure or force. This covers falls, a direct impact on the body, and sports-related injuries.

People at high risk of getting fractures are the elderly, individuals with osteoporosis and endocrine or intestinal disorders, and those taking ***corticosteroids.*** There are several types of fractures but are usually classified as closed or open, and incomplete or complete.

Closed/Open fractures

A closed or simple fracture is when the broken bone does not break the skin. Conversely, an open or compound fracture happens when the ends of a fractured bone tear through the skin. Open fractures that expose the bone and other tissues put the injured at greater risk of infection.

Incomplete/Complete fractures

Incomplete fractures are when the bone ***cracks*** without breaking completely, keeping it in one piece. Complete fractures, meanwhile, happen when the bone is snapped or crushed into two or more pieces.

Both types have a slew of variations, depending on how the bone breaks and its condition after ***breakage.***

Scoliosis

Scoliosis is an abnormal curvature of the spine resulting in an S or C shape. The disorder often occurs in a child's growth spurt before puberty, with cases usually diagnosed in the first seven years. In around 80% of scoliosis cases, no ***identifiable causes*** are found, though it may happen due to birth defects, neurological abnormalities, and genetic conditions.

Symptoms of scoliosis depend on the severity of the condition, including having one shoulder blade higher or more protrusive than the other, uneven hips, a ***rotating spine***, breathing problems, and back pain.

Paget's disease

Paget's disease is ***a chronic disorder*** that affects the way that bones break down and regrow. This results in excessive breakdown and regrowth, leading to bones that are bigger and softer than usual. Paget's disease may also cause bones to grow ***misshapen*** and more ***prone to fracturing***.

Symptoms of Paget's disease rarely manifest, and when they do, they can be similar to that of arthritis. These include pain in ***the affected area***, headaches and hearing loss (if the disorder affects the skull), pressure on the nerves (if the skull or spine is affected), damage to the cartilage in the joints, increased head size, ***limb bowing***, and ***spine curvature.***

Common Joint Disorders

Osteoarthritis

One of the most common joint disorders, osteoarthritis arises when the cartilage between two joints is ***worn down***. This causes the bones in the joint to rub together, causing swelling and stiffness in the area.

Symptoms typically occur way into adulthood, with the average person over 60 displaying some of the symptoms. ***Risk factors*** for this disorder include age, weight, frequency and intensity of joint activity, sports that directly affect the joint, and family history.

Rheumatoid arthritis

Rheumatoid arthritis is an ***autoimmune and inflammatory disease*** that causes the body's immune system to attack healthy cells mistakenly, leading to inflammation or painful swelling in the affected area. It can attack multiple joints at once, usually the hands, wrists, and knees, and damage the joint tissue, leading to chronic pain, lack of balance or instability, and deformities.

Signs of rheumatoid arthritis include pain and ***stiffness*** in multiple joints, as well as ***tenderness*** and ***swelling***. These will occur symmetrically on both sides of the body, like in both wrists or both knees. Other symptoms are weight loss, ***fever, fatigue***, and weakness.

While the primary cause of the disorder is unknown, factors like age, gender, genetics, exposure to smoking at a young age, and obesity have been linked to an increased risk of ***contracting*** it.

Gout

Gout is a common form of ***inflammatory arthritis*** marked by intense pain and caused by too much uric acid in the body. Uric acid crystals build up in the joints and surrounding tissues in the body. This disorder typically affects one joint at a time, usually

the one connecting the big toe. Other commonly afflicted joints are the lesser toe joints, ankles, and knees.

Symptoms like intense pain, swelling, redness, and heat are known to get worse ("flares") or disappear ("remission") entirely. ***Repeated instances*** of gout may lead to ***gouty arthritis***, a severe form of arthritis.

Increased risk factors include gender, obesity, certain health conditions, use of certain medications like diuretics, an increased intake of alcohol and high-fructose food and drink, and a purine-rich diet.

Bursitis

This disorder is characterized by the ***inflammation of the bursa***, the small fluid-filled sac that serves as a cushion between the bone and other moving parts like muscles, tendons, joints, or skin. The bursa may turn red and increase in fluid content, leading to painful swelling.

Bursitis is caused by overuse or an increased activity level involving the joint. ***Trauma*** or a complication from rheumatoid arthritis, gout, or infection may also be a culprit, although there are cases of bursitis where no cause can be determined.

Symptoms include pain and tenderness when pressing around the joint, stiffness and aches when moving the afflicted joint, and swelling, warmth, or redness over the joint itself.

Treatment and Prevention

Treating various bone and joint diseases will depend on their nature. Fractures will need emergency medical attention, and if the ***injury*** is severe, it may require surgery. Other disorders may require surgery as well, or medication for less severe or chronic afflictions. Bracing, ortho visits, physical medical rehabilitation, and lifestyle and behavioral changes are also recommended.

In most cases, living a healthier lifestyle is the best one can do to prevent the onset of these conditions. Eating a well-balanced diet, ***engaging in regular exercise***, and getting

the recommended doses of vitamins and minerals can go a long way in strengthening and maintaining one's bones and joints.

Bones and joints let people move and go about their daily lives, making it vital to keep them in good health. Some of the most common bone and joint diseases are avoidable or can be minimized through healthy lifestyle and ***early detection***.

7. Match some of the words and word combinations in the text with their Ukrainian equivalents below.

1. хірургічне втручання – …….
2. ускладнення ревматоїдного артриту – …….
3. запалення сумки –…….
4. подагричний артрит – ……
5. заразитися – ……
6. ушкоджена ділянка – ……
7. встановлені випадки – ……...
8. тріщина – ……
9. більш поширений серед – …….
10.травма – …….
11. рання діагностика – ……

8. Match the following bone and joint disorders with their description.

1.It is an infection of bone. Symptoms may include pain in a specific bone with overlying redness, fever, and weakness. The long bones of the arms and legs are most commonly involved in children e.g. the femur and humerus, while the feet, spine, and hips are most commonly involved in adults. The cause is usually a bacterial infection, but rarely can be a fungal infection. It may occur by spread from the blood or from surrounding tissue. Risks for developing osteomyelitis include diabetes, intravenous drug use, prior removal of the spleen, and trauma to the area. Diagnosis is typically suspected based

on symptoms and basic laboratory tests as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR).This is because plain radiographs are unremarkable in the first few days following acute infection. Diagnosis is further confirmed by blood tests, medical imaging, or bone biopsy.

2. It is a disease that weakens bones and can cause them to break more easily. It is a disorder of decreased mineralization, which results in bone breaking down faster than it can re-form. It is a condition that occurs in adults. In children, inadequate concentrations of vitamin D may cause rickets. It develops most commonly due to a vitamin D deficiency (often from not getting enough sunlight), or less frequently, due to a digestive or kidney disorder. Vitamin D is essential for calcium absorption and for maintaining bone health. These disorders can interfere with the body's ability to absorb vitamins. There are also rare genetic conditions that can cause this disease. The most common symptoms of this disorder are pain in the bones and hips, bone fractures, and muscle weakness. Patients can also have difficulty walking.

3. This disorder is a type of arthritis that attacks the spine and, in some people, the joints of the arms and legs. It can also involve the skin, intestines and eyes. The main symptom in most patients is low back pain. Symptoms of this disease vary between patients but may include: longstanding low back pain, back stiffness, back pain and stiffness are typically worse at night and improve with exercise, fatigue, painful swelling of joints, sausage-like appearance of fingers or toes, heel pain, skin and nail changes of psoriasis.

9. Prepare the description of two bone or joint disorders. Make the class guess what they are.

Text 1.
Muscular System Anatomy

1. Read the text.

Muscle Types

There are three types of muscle tissue: ***visceral, cardiac***, and ***skeletal***.

Visceral Muscle

Visceral muscle is found inside of organs like the stomach, intestines, and blood vessels. The weakest of all muscle tissues, visceral muscle makes organs contract to move substances through the organ. Because visceral muscle is controlled by the unconscious part of the brain, it is known as ***involuntary muscle*** – it cannot be directly controlled by the conscious mind. The term "smooth muscle" is often used to describe visceral muscle because it has a very smooth, uniform appearance when viewed under a microscope. This smooth appearance starkly contrasts with the banded appearance of cardiac and skeletal muscles.

Cardiac Muscle

Found only in the heart, cardiac muscle is responsible for pumping blood throughout the body. Cardiac muscle tissue cannot be controlled consciously, so it is an involuntary muscle. While hormones and signals from the brain adjust the ***rate of contraction***, cardiac muscle stimulates itself to contract. The natural pacemaker of the heart is made of cardiac muscle tissue that stimulates other cardiac muscle cells to contract. Because of its self-stimulation, cardiac muscle is considered to be autorhythmic or intrinsically controlled.

The cells of cardiac muscle tissue are striated – that is, they appear to have light and dark stripes when viewed under a light microscope. The arrangement of protein fibers inside of the cells causes these light and dark bands. Striations indicate that a muscle cell is very strong, unlike visceral muscles.

The cells of cardiac muscle are branched X or Y shaped cells tightly connected together by special junctions called ***intercalated disks***. Intercalated disks are made up of fingerlike

projections from two neighboring cells that interlock and provide a strong bond between the cells. The branched structure and intercalated disks allow the muscle cells to resist high blood pressures and the strain of pumping blood throughout a lifetime. These features also help to spread electrochemical signals quickly from cell to cell so that the heart can beat as a unit.

Skeletal Muscle

Skeletal muscle is the only ***voluntary muscle tissue*** in the human body – it is controlled consciously. Every physical action that a person consciously performs (e.g. speaking, walking, or writing) requires skeletal muscle. The function of skeletal muscle is to contract to move parts of the body closer to the bone that the muscle is attached to. Most skeletal muscles are attached to two bones across a joint, so the muscle serves to move parts of those bones closer to each other.

Skeletal muscle cells form when many smaller ***progenitor cells*** lump themselves together to form long, straight, multinucleated fibers. Striated just like cardiac muscle, these skeletal muscle fibers are very strong. Skeletal muscle derives its name from the fact that these muscles always connect to the skeleton in at least one place.

Gross Anatomy of a Skeletal Muscle

Most skeletal muscles are attached to two bones through ***tendons***. Tendons are tough bands of dense regular connective tissue whose strong ***collagen fibers*** firmly attach muscles to bones. Tendons are under extreme stress when muscles pull on them, so they are very strong and are woven into the coverings of both muscles and bones.

Muscles move by shortening their length, pulling on tendons, and moving bones closer to each other. One of the bones is pulled towards the other bone, which remains stationary. The place on the stationary bone that is connected via tendons to the muscle is called the ***origin***. The place on the moving bone that is connected to the muscle via tendons is called the ***insertion***. The ***belly*** of the muscle is the fleshy part of the muscle in between the tendons that does the actual contraction.

Names of Skeletal Muscles

Skeletal muscles are named based on many different factors, including their location, origin and insertion, number of origins, shape, size, direction, and function.

Location. Many muscles derive their names from their anatomical region. The rectus abdominis and transverse abdominis, for example, are found in the ***abdominal region***. Some muscles, like the ***tibialis anterior***, are named after the part of the bone (the anterior portion of the ***tibia***) that they are attached to. Other muscles use a hybrid of these two, like the ***brachioradialis***, which is named after a region (brachial) and a bone (***radius***).

Origin and Insertion. Some muscles are named based upon their connection to a stationary bone (origin) and a moving bone (insertion). These muscles become very easy to identify once you know the names of the bones that they are attached to. Examples of this type of muscle include the ***sternocleidomastoid*** (connecting the ***sternum*** and ***clavicle*** to the mastoid process of the skull) and the occipitofrontalis (connecting the ***occipital bone*** to the ***frontal bone***).

Number of Origins. Some muscles connect to more than one bone or to more than one place on a bone, and therefore have more than one origin. A muscle with two origins is called a ***biceps.*** A muscle with three origins is a ***triceps*** muscle. Finally, a muscle with four origins is a ***quadriceps*** muscle.

Shape, Size, and Direction. We also classify muscles by their shapes. For example, the ***deltoids*** have a delta or triangular shape. The ***serratus*** muscles feature a serrated or saw-like shape. The ***rhomboid*** major is a rhombus or diamond shape. The size of the muscle can be used to distinguish between two muscles found in the same region. The gluteal region contains three muscles differentiated by size – the gluteus maximus (large), gluteus medius (medium), and gluteus minimus (smallest). Finally, the direction in which the muscle fibers run can be used to identify a muscle. In the abdominal region, there are several sets of wide, flat muscles. The muscles whose fibers run straight up and down are the ***rectus abdominis***, the ones running transversely (left to right) are the transverse abdominis, and the ones running at an angle are the ***obliques***.

Function. Muscles are sometimes classified by the type of function that they perform. Most of the muscles of the forearms are named based on their function because they are located in the same region and have similar shapes and sizes. For example, the flexor group of the forearm flexes the wrist and the fingers. The ***supinator*** is a muscle that supinates the wrist by rolling it

over to face palm up. In the leg, there are muscles called ***adductors*** whose role is to adduct (pull together) the legs.

Groups Action in Skeletal Muscle

Skeletal muscles rarely work by themselves to achieve movements in the body. More often they work in groups to produce precise movements. The muscle that produces any particular movement of the body is known as an agonist or prime mover. The agonist always pairs with an antagonist muscle that produces the opposite effect on the same bones. For example, the ***biceps brachii muscle*** flexes the arm at the elbow. As the antagonist for this motion, the ***triceps brachii muscle*** extends the arm at the elbow. When the triceps is extending the arm, the biceps would be considered the antagonist.

In addition to the agonist/antagonist pairing, other muscles work to support the movements of the agonist. ***Synergists*** are muscles that help to stabilize a movement and reduce extraneous movements. They are usually found in regions near the agonist and often connect to the same bones. Because skeletal muscles move the insertion closer to the immobile origin, fixator muscles assist in movement by holding the origin stable. If you lift something heavy with your arms, fixators in the trunk region hold your body upright and immobile so that you maintain your balance while lifting.

Skeletal Muscle Histology

Skeletal muscle fibers differ dramatically from other tissues of the body due to their highly specialized functions. Many of the ***organelles*** that make up muscle fibers are unique to this type of cell.

The ***sarcolemma*** is the cell membrane of muscle fibers. The sarcolemma acts as a conductor for electrochemical signals that stimulate muscle cells. Connected to the sarcolemma are ***transverse tubules (T-tubules)*** that help carry these electrochemical signals into the middle of the muscle fiber. The ***sarcoplasmic reticulum*** serves as a storage facility for calcium ions (Ca2+) that are vital to muscle contraction. ***Mitochondria***, the "power houses" of the cell, are abundant in muscle cells to break down sugars and provide energy in the form of ATP to active muscles. Most of the muscle fiber's structure is made up of ***myofibrils***, which are the contractile

structures of the cell. Myofibrils are made up of many proteins fibers arranged into repeating subunits called sarcomeres. The ***sarcomere*** is the functional unit of muscle fibers.

Sarcomere Structure

Sarcomeres are made of two types of protein fibers: ***thick filaments*** and ***thin filaments***.

Thick filaments. Thick filaments are made of many bonded units of the protein myosin. ***Myosin*** is the protein that causes muscles to contract.

Thin filaments. Thin filaments are made of three proteins:

Actin. Actin forms a helical structure that makes up the bulk of the thin filament mass. Actin contains myosin-binding sites that allow myosin to connect to and move actin during muscle contraction.

Tropomyosin. Tropomyosin is a long protein fiber that wraps around actin and covers the myosin binding sites on actin.

Troponin. Bound very tightly to tropomyosin, troponin moves tropomyosin away from myosin binding sites during muscle contraction.

Muscular System Physiology

Function of Muscle Tissue

The main function of the muscular system is movement. Muscles are the only tissue in the body that has the ability to contract and therefore move the other parts of the body.

Related to the function of movement is the muscular system's second function: the maintenance of posture and body position. Muscles often contract to hold the body still or in a particular position rather than to cause movement. The muscles responsible for the body's posture have the greatest endurance of all muscles in the body – they hold up the body throughout the day without becoming tired.

Another function related to movement is the movement of substances inside the body. The cardiac and visceral muscles are primarily responsible for transporting substances like blood or food from one part of the body to another.

The final function of muscle tissue is the generation of body heat. As a result of the high ***metabolic rate*** of contracting muscle, our muscular system produces a great deal of waste heat.

Many small muscle contractions within the body produce our natural body heat. When we exert ourselves more than normal, the extra muscle contractions lead to a rise in body temperature and eventually to sweating.

Skeletal Muscles as Levers

Skeletal muscles work together with bones and joints to form lever systems. The muscle acts as the ***effort force***; the joint acts as the ***fulcrum***; the bone that the muscle moves acts as the ***lever***; and the object being moved acts as the ***load***.

There are three classes of levers, but the vast majority of the levers in the body are third class levers. A third class lever is a system in which the fulcrum is at the end of the lever and the effort is between the fulcrum and the load at the other end of the lever. The third class levers in the body serve to increase the distance moved by the load compared to the distance that the muscle contracts.

The tradeoff for this increase in distance is that the force required to move the load must be greater than the mass of the load. For example, the biceps brachia of the arm pulls on the radius of the forearm, causing flexion at the ***elbow joint*** in a third class lever system. A very slight change in the length of the biceps causes a much larger movement of the forearm and hand, but the force applied by the biceps must be higher than the load moved by the muscle.

Motor Units

Nerve cells called ***motor neurons*** control the skeletal muscles. Each motor neuron controls several muscle cells in a group known as a motor unit. When a motor neuron receives a signal from the brain, it stimulates all of the muscles cells in its motor unit at the same time.

The size of motor units varies throughout the body, depending on the function of a muscle. Muscles that perform fine movements – like those of the eyes or fingers – have very few muscle fibers in each motor unit to improve the precision of the brain's control over these structures. Muscles that need a lot of strength to perform their function – like leg or arm muscles – have many muscle cells in each motor unit. One of the ways that the body can control the strength of each muscle is by determining how many motor units to activate for a given function. This

explains why the same muscles that are used to pick up a pencil are also used to pick up a bowling ball.

Contraction Cycle

Muscles contract when stimulated by signals from their motor neurons. Motor neurons contact muscle cells at a point called the ***Neuromuscular Junction (NMJ).*** Motor neurons release neurotransmitter chemicals at the NMJ that bond to a special part of the sarcolemma known as the ***motor end plate***. The motor end plate contains many ***ion channels*** that open in response to neurotransmitters and allow positive ions to enter the muscle fiber. The positive ions form an electrochemical gradient to form inside of the cell, which spreads throughout the sarcolemma and the T-tubules by opening even more ion channels.

When the positive ions reach the sarcoplasmic reticulum, Ca2+ ions are released and allowed to flow into the myofibrils. Ca2+ ions bind to troponin, which causes the troponin molecule to change shape and move nearby molecules of ***tropomyosin***. Tropomyosin is moved away from myosin binding sites on actin molecules, allowing actin and myosin to bind together. ATP molecules power myosin proteins in the thick filaments to bend and pull on actin molecules in the thin filaments. ***Myosin*** proteins act like oars on a boat, pulling the thin filaments closer to the center of a sarcomere. As the thin filaments are pulled together, the sarcomere shortens and contracts. ***Myofibrils*** of muscle fibers are made of many sarcomeres in a row, so that when all of the sarcomeres contract, the muscle cells shortens with a great force relative to its size.

Muscles continue contraction as long as they are stimulated by a neurotransmitter. When a motor neuron stops the release of the neurotransmitter, the process of contraction reverses itself. Calcium returns to the sarcoplasmic reticulum; troponin and tropomyosin return to their resting positions; and actin and myosin are prevented from binding. Sarcomeres return to their elongated resting state once the force of myosin pulling on actin has stopped.

Certain conditions or disorders, such as ***myoclonus***, can affect the normal contraction of muscles.

Types of Muscle Contraction

The strength of a muscle's contraction can be controlled by two factors: the number of motor units involved in contraction and the amount of stimulus from the nervous system. A single nerve impulse of a motor neuron will cause a motor unit to contract briefly before relaxing. This small contraction is known as ***a twitch contraction***. If the motor neuron provides several signals within a short period of time, the strength and duration of the muscle contraction increases. This phenomenon is known as ***temporal summation***. If the motor neuron provides many nerve impulses in rapid succession, the muscle may enter the state of ***tetanus, or complete and lasting contraction.*** A muscle will remain in tetanus until the nerve signal rate slows or until the muscle becomes too fatigued to maintain the tetanus.

Not all muscle contractions produce movement. ***Isometric contractions*** are light contractions that increase the tension in the muscle without exerting enough force to move a body part. When people tense their bodies due to stress, they are performing an isometric contraction. Holding an object still and maintaining posture are also the result of isometric contractions. A contraction that does produce movement is an ***isotonic contraction***. Isotonic contractions are required to develop muscle mass through weight lifting.

Muscle tone is a natural condition in which a skeletal muscle stays partially contracted at all times. Muscle tone provides a slight tension on the muscle to prevent damage to the muscle and joints from sudden movements, and also helps to maintain the body's posture. All muscles maintain some amount of muscle tone at all times, unless the muscle has been disconnected from the central nervous system due to nerve damage.

Functional Types of Skeletal Muscle Fibers

Skeletal muscle fibers can be divided into two types based on how they produce and use energy: Type I and Type II.

Type I fibers are very slow and deliberate in their contractions. They are very resistant to fatigue because they use aerobic respiration to produce energy from sugar. We find Type I fibers in muscles throughout the body for stamina and posture. Near the ***spine*** and neck regions, very high concentrations of Type I fibers hold the body up throughout the day.

Type II fibers are broken down into two subgroups: Type II A and Type II B.

Type II A fibers are faster and stronger than Type I fibers, but do not have as much endurance. Type II A fibers are found throughout the body, but especially in the legs where they work to support your body throughout a long day of walking and standing.

Type II B fibers are even faster and stronger than Type II A, but have even less endurance. Type II B fibers are also much lighter in color than Type I and Type II A due to their lack of myoglobin, an oxygen-storing pigment. We find Type II B fibers throughout the body, but particularly in the upper body where they give speed and strength to the arms and chest at the ***expense of stamina***.

Muscle Metabolism and Fatigue

Muscles get their energy from different sources depending on the situation that the muscle is working in. Muscles use ***aerobic respiration*** when we call on them to produce a low to moderate level of force. Aerobic respiration requires oxygen to produce about 36-38 ATP molecules from a molecule of glucose. Aerobic respiration is very efficient, and can continue as long as a muscle receives adequate amounts of oxygen and glucose to keep contracting. When we use muscles to produce a high level of force, they become so tightly contracted that oxygen carrying blood cannot enter the muscle. This condition causes the muscle to create energy using ***lactic acid fermentation***, a form of anaerobic respiration. Anaerobic respiration is much less efficient than aerobic respiration – only 2 ATP are produced for each molecule of glucose. Muscles quickly tire as they burn through their energy reserves under anaerobic respiration.

To keep muscles working for a longer period of time, muscle fibers contain several important energy molecules. ***Myoglobin,*** a red pigment found in muscles, contains iron and stores oxygen in a manner similar to hemoglobin in the blood. The oxygen from myoglobin allows muscles to continue aerobic respiration in the absence of oxygen. Another chemical that helps to keep muscles working is creatine phosphate. Muscles use energy in the form of ATP, converting ATP to ADP to release its energy. ***Creatine phosphate*** donates its phosphate group to ADP to turn it back into ATP in order to provide extra energy to the muscle. Finally, muscle fibers contain energy-storing ***glycogen***, a large macromolecule made of many linked glucoses. Active muscles break glucoses off of glycogen molecules to provide an internal fuel supply.

When muscles run out of energy during either aerobic or anaerobic respiration, the muscle quickly tires and loses its ability to contract. This condition is known as muscle fatigue. A fatigued muscle contains very little or no oxygen, glucose or ATP, but instead has many waste products from respiration, like ***lactic acid*** and ADP. The body must take in extra oxygen after exertion to replace the oxygen that was stored in myoglobin in the muscle fiber as well as to power the aerobic respiration that will rebuild the energy supplies inside of the cell. ***Oxygen debt*** (or ***recovery oxygen uptake***) is the name for the extra oxygen that the body must take in to restore the muscle cells to their resting state. This explains why you feel out of breath for a few minutes after a strenuous activity – your body is trying to restore itself to its normal state.

2. Answer the following questions.

1. What is the smooth muscle?
2. What is cardiac muscle responsible for?
3. How do skeletal muscle cells form?
4. What is the muscle with two origins called?
5. How are muscles classified according to their shape?
6. How are muscles classified according to their function?
7. What is the sarcolemma?
8. What are the functions of muscular system?
9. What are motor neurons?
10. What are the types of muscular contraction?

3. Match the terms with their definitions.

a. elbow joint

b. rectus abdominis

c. tibialis anterior

d. sternocleidomastoid

e. occipital bone

f. deltoids

g. supinator

1. is a muscle in humans that originates along the upper two-thirds of the lateral (outside) surface of the tibia and inserts into the medial cuneiform and first metatarsal bones of the foot. It acts to dorsiflex and invert the foot.
2. also known as the “abdominal muscle” or simply the “abs”, is a paired muscle running vertically on each side of the anterior wall of the human abdomen, as well as that of some other mammals.
3. a complex hinge joint formed between the distal end of the humerus in the upper arm and the proximal ends of the ulna and radius in the forearm.
4. is a broad muscle in the posterior compartment of the forearm, curved around the upper third of the radius. Its function is to supinate the forearm.
5. is a cranial dermal bone and the main bone of the occiput (back and lower part of the skull). It is trapezoidal in shape and curved on itself like a shallow dish.
6. is the muscle forming the rounded contour of the human shoulder. It is also known as the ‘common shoulder muscle’, particularly in other animals such as the domestic cat.
7. is one of the largest and most superficial cervical muscles. The primary actions of the muscle are rotation of the head to the opposite side and flexion of the neck.

4. Find mistakes in the following sentences.

1. Found only in the heart, cardiac muscle is responsible for pumping blood throughout the brain.
2. The function of skeletal muscle is to loosen to move parts of the body closer to the bone that the muscle is attached to.
3. Most skeletal muscles are attached to two bones through joints.
4. Skeletal muscles are named based on many different factors, including their location, origin and insertion, number of origins, colour, size, direction, and function.

5. The muscles whose fibers run straight up and down are the deltoids, the ones running transversely (left to right) are the transverse abdominis, and the ones running at an angle are the obliques.

6. The main function of the muscular system is streightening.

7. When a motor neuron receives a signal from the brain, it stimulates all of the muscles cells in its motor unit at different times.

5. Fill in the gaps in the text with the words from the box.

actin	*isometric*	*myosin*	*posture*	*fiber*	*isotonic*
yielding	*concentric*		*cross-bridge cycling*		*eccentric*
overcoming		*voluntary*	*sarcomere*		*involuntary*

Types of Muscle Contraction

A muscle fiber generates tension through (1) _____ and (2) _____ cross-bridge cycling. While under tension, the muscle may lengthen, shorten, or remain the same. Although the term contraction implies shortening, when referring to the muscular system, it means the generation of tension within a muscle (3) _____. Several types of muscle contractions occur and are defined by the changes in the length of the muscle during contraction.

(4) _____ contractions maintain constant tension in the muscle as the muscle changes length. They can be of two types.

A (5) _____ contraction is a type of muscle contraction in which the muscles shorten while generating force, overcoming resistance. For example, when lifting a heavy weight, a concentric contraction of the biceps would cause the arm to bend at the elbow, lifting the weight towards the shoulder. (6) _____ occurs, shortening the sarcomere, muscle fiber, and muscle.

An (7) _____ contraction results in the elongation of a muscle while the muscle is still generating force; in effect, resistance is greater than force generated. They

can be of both types. For example, a (8) _____ contraction would be the controlled lowering of the heavy weight raised during the above concentric contraction. An (9) _____ contraction may occur when a weight is too great for a muscle to bear and so it is slowly lowered while under tension. Cross-bridge cycling occurs even though the sarcomere, muscle fiber, and muscle are lengthening, controlling the extension of the muscle.

In contrast to isotonic contractions, (10) _____ contractions generate force without changing the length of the muscle, common in the muscles of the hand and forearm responsible for grip. Using the above example, the muscle contraction required to grip but not move a heavy object prior to lifting would be isometric. These contractions are frequently used to maintain (11) _____ .

Isometric contractions are sometimes described as the following two types.

A (12) _____ contraction occurs when a muscle contraction is opposed by resistance. For example, when holding a heavy weight steady, neither raising nor lowering it.

An (13) _____ contraction occurs when a muscle contraction is opposed by an immovable object, such as the contraction generated in the muscles when pushing against a wall.

In both instances, cross-bridge cycling is maintaining tension in the muscle; the (14) _____, muscle fibers, and muscle are not changing length.

6. Translate the following sentences into English.

1. Саркомер є основною скорочувальною одиницею м'язового волокна в скелетних м'язах. Кожен саркомер складається з білкових волокон (міофіламентів), які включають переважно товсті волокна, які називаються міозином, і тонкі волокна, які називаються актином. Пучки міофіламентів називаються міофібрилами.

2. Груднинно-ключично-соскоподібний м’яз є найбільш поверхневим і найбільшим м’язом передньої частини шиї. Він також відомий як SCM або стерномоскоподібний або грудинний м'яз.

3. Рухові нейрони - це клітини головного та спинного мозку, які дозволяють нам рухатися, говорити, ковтати та дихати, надсилаючи команди з мозку до м’язів, які виконують ці функції. Їх нервові волокна найдовші в тілі, один аксон може простягатися від основи спинного мозку аж до пальців ніг.

Text 2.
Muscular System Disorders

7. Read the following text.

Primary Muscle Diseases

Primary muscle diseases are caused by abnormalities of the muscles. A muscle disease is considered primary if it occurs on its own, not because of any other associated diseases. Some conditions can occur as primary diseases or as secondary diseases.

Myositis is an inflammation of muscles and their associated tissues, including blood vessels. ***Polymyositis*** (PM) is a rare type of myositis. PM is mostly seen in people over age 20, more often females. PM is marked by muscle inflammation and weakness. A person with this condition may experience falls and problems getting up from falls. Other symptoms include chronic ***dry cough,*** and/or ***difficulty swallowing***.

Dermatomyositis (DM) is a rare inflammatory muscle disease. It can affect people of any age or sex, though it's more often seen in women. Common symptoms of DM include: a distinctive rash, muscle weakness, inflamed, painful muscles. Like other inflammatory myopathies, the cause is unknown. There is no cure, but the condition can be managed with medications and other therapies.

Muscular dystrophy (MD) is a group of inherited myopathies. These conditions all cause muscle loss and weakness. Some types of MD appear in infancy or childhood. Others may not appear until middle age or even later. Symptoms are specific to the type of MD. They can vary based on the muscle groups and people they affect. All forms of MD grow worse with time. Most people lose their ability to walk. There is no cure for MD, but symptoms can be treated. Treatment can also prevent complications. Treatments include: ***medications***, ***physical therapy, speech therapy, orthopedic devices***, such as ***canes*** or ***walkers***.

Myasthenia gravis (MG) is an autoimmune neuromuscular disease. Neuromuscular diseases are caused by problems with how the nerves and muscles work together. In people with MG, the immune system mistakenly attacks the receptors that make it possible for nerve cells and muscles to communicate. This interferes with nerve signals to the muscles, causing muscle weakness. MG is the most common chronic autoimmune neuromuscular disorder. It affects 20 out of every 100,000 people. The primary symptom of MG is ***weakness in the voluntary skeletal muscles***. There is no cure for MG, but treatment can control the activity of the immune system.

Amyotrophic lateral sclerosis (ALS) is also called ***Lou Gehrig's disease***. This group of rare neurological diseases affects the nerve cells in the brain and spinal cord. ALS affects the muscles responsible for voluntary movement. Most cases are diagnosed in people ages 40 to 70. There is no cure for ALS and symptoms get worse with time. Treatment can help control symptoms and prevent complications. Typical life expectancy, though, is only a few years after diagnosis. Treatments for ALS include: medication, speech therapy, physical therapy. In severe cases, patients may need ***nutritional*** and ***breathing support***.

Rhabdomyolysis is a disease that causes the breakdown of skeletal muscle. This breakdown causes myoglobin release in the bloodstream. Myoglobin is a protein that stores oxygen in the muscles. Too much myoglobin in the blood can lead to kidney

damage. Treatment depends on the severity of symptoms and the presence of complications. Kidney damage from rhabdomyolysis may not be reversible.

Cardiomyopathy, also called ***heart muscle disease***, is a disease that affects cardiac muscle. In cardiomyopathy, the heart becomes abnormally enlarged, thickened, and/or stiff. This makes it harder for the heart muscle to pump blood efficiently. Eventually, this may lead to heart failure. Blood and fluids may back up into the lungs and other parts of the body. Cardiomyopathy can also cause abnormal heart rhythms and heart valve problems.

Sarcopenia, also called ***geriatric muscle disease***, is common in older adults. Other types of muscle diseases are less common in older adults. Sarcopenia risk in older adults ages 65 to 70 is around 14%. This risk is 53% in those over age 80. Sarcopenia causes loss of muscle mass and strength. For some people, muscle weakness appears suddenly. For others, it comes on slowly over many years. Sarcopenia can be diagnosed a number of ways, including: ***physical exam, medical history***, ***blood tests*** to look for inflammation, genetic disease, low hormone levels, or low vitamin D levels, ***imaging***, such as ***magnetic resonance imaging (MRI), electrical activity testing, muscle biopsy***.

Secondary Muscle Diseases

Sometimes, muscle diseases appear as a result of other more serious health conditions. They may appear with many different diseases, including: infectious diseases, endocrine disorders, or diseases of the glands, metabolic disorders, such as diabetes, immunological conditions, such as HIV/AIDS, vascular diseases, conditions of the blood vessels.

Primary muscle diseases that can also be secondary to another health condition include: rhabdomyolysis, myopathy, myositis, myasthenia gravis, sarcopenia. Some secondary muscle diseases may even affect the respiratory muscles. Secondary conditions may affect one single muscle, a group of muscles, or an entire system of muscles. They may be permanent or temporary. A person may experience mild symptoms or severe ones.

Secondary muscle diseases are diagnosed the same way as primary conditions. Treatment involves managing the underlying cause and treating the secondary condition.

Muscular System Disease Symptoms

One of the first signs of muscle problems is muscle weakness. This means the muscle lacks strength and cannot do its job. Many different diseases can cause muscles to become weak.

Muscle pain that improves with home therapies is usually nothing to worry about. Pain from severe injuries or a serious illness that affects the whole body often requires medical care. Seek immediate medical attention if you have any of the following symptoms: muscle pain with breathing issues, ***dizziness***, muscle weakness, ***high fever***, ***stiff neck***.

People with muscle disease may also experience ***muscle spasms, cramping***, or ***twitching***.

Other symptoms of muscle diseases include: ***muscle wasting*** or ***muscle loss***, problems with movement and balance, ***numbness***, ***tingling***, or painful sensations, ***double vision***, ***droopy eyelids***, ***dysphagia***, problems with swallowing, breathing troubles, especially ***dyspnea***, which is a shortness of breath.

Diagnosis of Muscle Diseases

Muscle diseases are often diagnosed with ***electromyography*** (EMG). An EMG measures electrical activity in the muscles. This can help identify neuromuscular abnormalities. EMG can diagnose a number of problems, including: muscle disorders, nerve and motor problems, degenerative diseases, or diseases that get worse over time. During an EMG test, a thin needle called an electrode is inserted into the skin and into muscle tissue. Once the needle is in place, the patient is asked to contract or relax muscles. The electrode detects electrical activity.

A nerve conduction velocity test may be done with an EMG. This test measures the speed of the electrical impulses moving through your nerves. This can help determine if the cause of symptoms is muscle disease or a nerve disorder.

7. Match some of the words and word combinations in the text with their Ukrainian equivalents below.

проблеми з диханням – …….

оніміння – ……...

опущені повіки – ……

посмикування – ……..

магнітно-резонансна томографія (МРТ) – ……...

рабдоміоліз – ……..

ходунки – ……

8. Match the following bone and joint disorders with their description.

1. This disorder is a chronic autoimmune, neuromuscular disease that causes weakness in the skeletal muscles that worsens after periods of activity and improves after periods of rest. These muscles are responsible for functions involving breathing and moving parts of the body, including the arms and legs. Available treatments can control symptoms and often allow people to have a relatively high quality of life. Most individuals with the condition have a normal life expectancy.

2. It is a progressive nervous system disease that affects nerve cells in the brain and spinal cord, causing loss of muscle control. The disorder often begins with muscle twitching and weakness in a limb, or slurred speech. Eventually, it affects control of the muscles needed to move, speak, eat and breathe. There is no cure for this fatal disease.

3. It refers to a clinical disorder of the skeletal muscles. Abnormalities of muscle cell structure and metabolism lead to various patterns of weakness and dysfunction. In some cases, the pathology extends to involve cardiac muscle fibers, resulting in a hypertrophic or dilated cardiomyopathy. Disruption of the structural integrity and metabolic processes

of muscle cells can result from genetic abnormalities, toxins, inflammation, infection, and hormonal and electrolyte imbalances. These disorders may be divided into two main categories: inherited and acquired.

9. Prepare the description of two bone or joint disorders. Make the class guess what they are.

Text 1.
Cardiovascular System Anatomy

1. Read the text.

Cardiovascular System Anatomy

The Heart

The ***heart*** is a muscular pumping organ located medial to the lungs along the body's midline in the thoracic region. The bottom tip of the heart, known as its ***apex***, is turned to the left, so that about 2/3 of the heart is located on the body's left side with the other 1/3 on right. The top of the heart, known as ***the heart's base***, connects to the great blood vessels of the body: the ***aorta, vena cava, pulmonary trunk,*** and ***pulmonary veins***.

Circulatory Loops

There are 2 primary circulatory loops in the human body: the ***pulmonary circulation loop*** and the ***systemic circulation loop***.

Pulmonary circulation transports ***deoxygenated blood*** from the right side of the heart to the lungs, where the blood picks up oxygen and returns to the left side of the heart. The pumping chambers of the heart that support the pulmonary circulation loop are the right atrium and right ventricle.

Systemic circulation carries highly oxygenated blood from the left side of the heart to all of the tissues of the body (with the exception of the heart and lungs). Systemic circulation removes wastes from body tissues and returns deoxygenated blood to the right side of the heart. The ***left atrium*** and ***left ventricle of the heart*** are the pumping chambers for the systemic circulation loop.

Blood Vessels

Blood vessels are the body's highways that allow blood to flow quickly and efficiently from the heart to every region of the body and back again. The size of blood vessels corresponds with the amount of blood that passes through the vessel. All blood vessels contain a hollow area

called the ***lumen*** through which blood is able to flow. Around the lumen is the wall of the vessel, which may be thin in the case of capillaries or very thick in the case of arteries.

All blood vessels are lined with a thin layer of simple squamous epithelium known as the ***endothelium*** that keeps blood cells inside of the blood vessels and prevents clots from forming. The endothelium lines the entire circulatory system, all the way to the interior of the heart, where it is called the ***endocardium.***

There are three major types of blood vessels: ***arteries, capillaries*** and ***veins***. Blood vessels are often named after either the region of the body through which they carry blood or for nearby structures. For example, the ***brachiocephalic artery*** carries blood into the brachial (arm) and cephalic (head) regions. One of its branches, the subclavian artery, runs under the clavicle; hence the name subclavian. The subclavian artery runs into the axillary region where it becomes known as the axillary artery.

Arteries and Arterioles

Arteries are blood vessels that carry blood away from the heart. Blood carried by arteries is usually highly oxygenated, having just left the lungs on its way to the body's tissues. The pulmonary trunk and arteries of the pulmonary circulation loop provide an exception to this rule – these arteries carry deoxygenated blood from the heart to the lungs to be oxygenated.

Arteries face high levels of blood pressure as they carry blood being pushed from the heart under great force. To withstand this pressure, the walls of the arteries are thicker, more elastic, and more muscular than those of other vessels. The largest arteries of the body contain a high percentage of elastic tissue that allows them to stretch and accommodate the pressure of the heart.

Smaller arteries are more muscular in the structure of their walls. The smooth muscles of the arterial walls of these smaller arteries contract or expand to regulate the flow of blood through their lumen. In this way, the body controls how much blood flows to different parts of the body under varying circumstances. The regulation of blood flow also affects blood pressure, as smaller arteries give blood less area to flow through and therefore increases the pressure of the blood on arterial walls.

Arterioles are narrower arteries that branch off from the ends of arteries and carry blood to capillaries. They face much lower blood pressures than arteries due to their greater number, decreased blood volume, and distance from the direct pressure of the heart. Thus arteriole walls are much thinner than those of arteries. Arterioles, like arteries, are able to use smooth muscle to control their aperture and regulate blood flow and blood pressure.

Capillaries

Capillaries are the smallest and thinnest of the blood vessels in the body and also the most common. They can be found running throughout almost every tissue of the body and border the edges of the body's avascular tissues. ***Capillaries*** connect to arterioles on one end and ***venules*** on the other.

Capillaries carry blood very close to the cells of the tissues of the body in order to exchange gases, nutrients, and waste products. The walls of capillaries consist of only a thin layer of endothelium so that there is the minimum amount of structure possible between the blood and the tissues. The ***endothelium*** acts as a filter to keep blood cells inside of the vessels while allowing liquids, dissolved gases, and other chemicals to diffuse along their concentration gradients into or out of tissues.

Precapillary sphincters are bands of smooth muscle found at the arteriole ends of capillaries. These sphincters regulate blood flow into the capillaries. Since there is a limited supply of blood, and not all tissues have the same energy and oxygen requirements, the precapillary sphincters reduce blood flow to inactive tissues and allow free flow into active tissues.

Veins and Venules

Veins are the large return vessels of the body and act as the blood return counterparts of arteries. Because the arteries, arterioles, and capillaries absorb most of the force of the heart's contractions, veins and venules are subjected to very low blood pressures. This lack of pressure allows the walls of veins to be much thinner, less elastic, and less muscular than the walls of arteries.

Veins rely on gravity, inertia, and the force of skeletal muscle contractions to help push blood back to the heart. To facilitate the movement of blood, some veins contain many one-way valves that prevent blood from flowing away from the heart. As skeletal muscles in the body contract, they squeeze nearby veins and push blood through valves closer to the heart.

When the muscle relaxes, the valve traps the blood until another contraction pushes the blood closer to the heart. Venules are similar to arterioles as they are small vessels that connect capillaries, but unlike arterioles, venules connect to veins instead of arteries. Venules pick up blood from many capillaries and deposit it into larger veins for transport back to the heart.

Coronary Circulation

The heart has its own set of blood vessels that provide the ***myocardium*** with the oxygen and nutrients necessary to pump blood throughout the body. The left and right coronary arteries branch off from the aorta and provide blood to the left and right sides of the heart. ***The coronary sinus*** is a vein on the posterior side of the heart that returns deoxygenated blood from the myocardium to the vena cava.

Hepatic Portal Circulation

The veins of the stomach and intestines perform a unique function: instead of carrying blood directly back to the heart, they carry blood to the liver through the ***hepatic portal vein***. Blood leaving the digestive organs is rich in nutrients and other chemicals absorbed from food. The liver removes toxins, stores sugars, and processes the products of digestion before they reach the other body tissues. Blood from the liver then returns to the heart through the inferior vena cava.

Blood

The average human body contains about 4 to 5 liters of blood. As a liquid connective tissue, it transports many substances through the body and helps to maintain homeostasis of nutrients, wastes, and gases. Blood is made up of ***red blood cells, white blood cells, platelets,*** and ***liquid plasma***.

Red Blood Cells

Red blood cells, also known as erythrocytes, are by far the most common type of blood cell and make up about 45% of blood volume. ***Erythrocytes*** are produced inside of ***red bone marrow*** from stem cells at the astonishing rate of about 2 million cells every second. The shape of erythrocytes is biconcave – disks with a concave curve on both sides of the disk so that the center of an erythrocyte is its thinnest part. The unique shape of erythrocytes gives these cells a high surface area to volume ratio and allows them to fold to fit into thin capillaries. Immature erythrocytes have a nucleus that is ejected from the cell when it reaches maturity to provide it with its unique shape and flexibility. The lack of a nucleus means that red blood cells contain no DNA and are not able to repair themselves once damaged.

Erythrocytes transport oxygen in the blood through the red pigment hemoglobin. Hemoglobin contains iron and proteins joined to greatly increase the oxygen carrying capacity of erythrocytes. The high surface area to volume ratio of erythrocytes allows oxygen to be easily transferred into the cell in the lungs and out of the cell in the capillaries of the systemic tissues.

White Blood Cells

White blood cells, also known as leukocytes, make up a very small percentage of the total number of cells in the bloodstream, but have important functions in the body's immune system. There are two major classes of white blood cells: ***granular leukocytes*** and ***agranular leukocytes***.

Granular Leukocytes: The three types of granular leukocytes are neutrophils, eosinophils, and basophils. Each type of granular leukocyte is classified by the presence of chemical-filled vesicles in their ***cytoplasm*** that give them their function. ***Neutrophils*** contain ***digestive enzymes*** that neutralize bacteria that invade the body. ***Eosinophils*** contain digestive enzymes specialized for digesting viruses that have been bound to by antibodies in the blood. ***Basophils*** release histamine to intensify allergic reactions and help protect the body from parasites.

Agranular Leukocytes: The two major classes of agranular leukocytes are ***lymphocytes*** and ***monocytes***. Lymphocytes include T cells and natural killer cells that fight off viral infections and B cells that produce antibodies against infections by pathogens. Monocytes develop into

cells called macrophages that engulf and ingest pathogens and the dead cells from wounds or infections.

Platelets

Also known as ***thrombocytes***, platelets are small cell fragments responsible for the clotting of blood and the formation of scabs. Platelets form in the red bone marrow from large megakaryocyte cells that periodically rupture and release thousands of pieces of membrane that become the platelets. Platelets do not contain a nucleus and only survive in the body for up to a week before macrophages capture and digest them.

Plasma

Plasma is the non-cellular or liquid portion of the blood that makes up about 55% of the blood's volume. Plasma is a mixture of water, proteins, and dissolved substances. Around 90% of plasma is made of water, although the exact percentage varies depending upon the hydration levels of the individual. The proteins within plasma include ***antibodies*** and ***albumins***. Antibodies are part of the immune system and bind to antigens on the surface of pathogens that infect the body. Albumins help maintain the body's osmotic balance by providing an isotonic solution for the cells of the body. Many different substances can be found dissolved in the plasma, including glucose, oxygen, carbon dioxide, electrolytes, nutrients, and cellular waste products. The plasma functions as a transportation medium for these substances as they move throughout the body.

Cardiovascular System Physiology

Functions of the Cardiovascular System

The cardiovascular system has three major functions: transportation of materials, protection from pathogens, and regulation of the body's homeostasis.

Transportation: The cardiovascular system transports blood to almost all of the body's tissues. The blood delivers essential nutrients and oxygen and removes wastes and carbon dioxide to be processed or removed from the body. Hormones are transported throughout the body via the blood's liquid plasma.

Protection: The cardiovascular system protects the body through its white blood cells. White blood cells clean up cellular debris and fight pathogens that have entered the body. Platelets and red blood cells form scabs to seal wounds and prevent pathogens from entering the body and liquids from leaking out. Blood also carries antibodies that provide specific immunity to pathogens that the body has previously been exposed to or has been vaccinated against.

Regulation: The cardiovascular system is instrumental in the body's ability to maintain homeostatic control of several internal conditions. Blood vessels help maintain a stable body temperature by controlling the blood flow to the surface of the skin. Blood vessels near the skin's surface open during times of overheating to allow hot blood to dump its heat into the body's surroundings. In the case of hypothermia, these blood vessels constrict to keep blood flowing only to vital organs in the body's core. Blood also helps balance the body's pH due to the presence of bicarbonate ions, which act as a buffer solution. Finally, the albumins in blood plasma help to balance the osmotic concentration of the body's cells by maintaining an isotonic environment.

Many serious conditions and diseases can cause our cardiovascular system to stop working properly. Quite often, we don't do enough about them proactively, resulting in emergencies. Also, explore how ***DNA health testing*** can allow you to begin important conversations with your doctor about genetic risks for disorders involving clotting, hemophilia, hemochromatosis (a common hereditary disorder causing iron to accumulate in the heart) and glucose-6-phosphate dehydrogenase (which affects about 1 in 10 African American men).

The Circulatory Pump

The heart is a ***four-chambered "double pump***," where each side (left and right) operates as a separate pump. The left and right sides of the heart are separated by a muscular wall of tissue known as the septum of the heart. The right side of the heart receives deoxygenated blood from the systemic veins and pumps it to the lungs for oxygenation. The left side of the heart receives oxygenated blood from the lungs and pumps it through the systemic arteries to the tissues of the body. Each ***heartbeat*** results in the simultaneous pumping of both sides of the heart, making the heart a very efficient pump.

Regulation of Blood Pressure

Several functions of the cardiovascular system can control blood pressure. Certain hormones along with autonomic nerve signals from the brain affect the rate and strength of heart contractions. Greater contractile force and heart rate lead to an increase in blood pressure. Blood vessels can also affect blood pressure. ***Vasoconstriction*** decreases the diameter of an artery by contracting the smooth muscle in the arterial wall. The sympathetic (fight or flight) division of the autonomic nervous system causes vasoconstriction, which leads to increases in blood pressure and decreases in blood flow in the constricted region. Vasodilation is the expansion of an artery as the smooth muscle in the arterial wall relaxes after the fight-or-flight response wears off or under the effect of certain hormones or chemicals in the blood. The volume of blood in the body also affects blood pressure. A higher volume of blood in the body raises blood pressure by increasing the amount of blood pumped by each heartbeat. Thicker, more ***viscous blood*** from clotting disorders can also raise blood pressure.

Hemostasis

Hemostasis, or the clotting of blood and formation of scabs, is managed by the platelets of the blood. Platelets normally remain inactive in the blood until they reach damaged tissue or leak out of the blood vessels through a wound. Once active, platelets change into a spiny ball shape and become very sticky in order to latch on to damaged tissues. Platelets next release chemical clotting factors and begin to produce the protein fibrin to act as structure for the blood clot. Platelets also begin sticking together to form a platelet plug. The platelet plug will serve as a temporary seal to keep blood in the vessel and foreign material out of the vessel until the cells of the blood vessel can repair the damage to the vessel wall.

1. Answer the following questions.

1. What is the heart’s base?
2. What is the difference between pulmanory and systemic circulations?
3. What is the lumen?
4. Where is the endocardium?

5. What is the function of the coronary sinus?

6. What is the other name of the red blood cells?

7. What are the two major classes of white blood cells?

8. What are the functions of the cardiovascular system?

9. How many chambers are there in the heart?

10. What is hemostasis managed by?

2. Fill in the blanks with the appropriate words from the box.

pulmonary circulation	cardiovascular system		the coronary sinus
red bone marrow	proteins	leukocytes	lymphocytes

1. _____ transports deoxygenated blood from the right side of the heart to the lungs, where the blood picks up oxygen and returns to the left side of the heart.

2. _____is a vein on the posterior side of the heart that returns deoxygenated blood from the myocardium to the vena cava.

3. Erythrocytes are produced inside of _____from stem cells at the astonishing rate of about 2 million cells every second.

4. The _____ within plasma include antibodies and albumins.

5. The _____ protects the body through its white blood cells.

6. _____ include T cells and natural killer cells that fight off viral infections and B cells that produce antibodies against infections by pathogens.

7. White blood cells, also known as_____, make up a very small percentage of the total number of cells in the bloodstream, but have important functions in the body's immune system.

3. Translate the following sentences into English.

1. Плазма – це неклітинна або рідка складова крові, яка становить близько 55% об'єму крові.

2. Серце являє собою чотирикамерний «подвійний насос», де кожна сторона (ліва і права) працює як окремий насос.

3. Кровоносні судини допомагають підтримувати стабільну температуру тіла, контролюючи приплив крові до поверхні шкіри.

4. Серцево-судинна система транспортує кров практично до всіх тканин організму.

5. Вени шлунка і кишечника виконують унікальну функцію: замість того, щоб нести кров безпосередньо до серця, вони переносять кров до печінки через ворітну вену печінки.

6. Вінцевий синус - це вена на задній стороні серця, яка повертає знекиснену кров з міокарда в порожнисту вену.

7. Прекапілярні сфінктери - це смуги гладкої мускулатури, що знаходяться на кінцях капілярів артеріол.

4. Fill in the blanks with the appropriate words from the box.

erythrocytes

aorta

albumin

hepatic portal vein (HPV)

agranular leukocytes

1) _____, a type of protein that is soluble in water and in water half saturated with a salt such as ammonium sulfate.

2) Both lymphocytes and monocytes are _____.

3) The portal vein or _____is a blood vessel that carries blood from the gastrointestinal tract, gallbladder, pancreas and spleen to the liver.

4) _____ are anucleate, biconcave cells, filled with hemoglobin, that transport oxygen and carbon dioxide between the lungs and tissues.

5) The _____ is the largest artery in the body.

Text 2.
Cardiovascular Disorders

5. Read the following text.

What Are Cardiovascular Diseases?

Cardiovascular diseases are conditions that affect the structures or function of your heart, such as:

- Abnormal heart rhythms, or arrhythmias
- Aorta disease and Marfan syndrome
- Congenital heart disease
- Coronary artery disease (narrowing of the arteries)
- Deep vein thrombosis and pulmonary embolism
- Heart attack
- Heart failure
- Heart muscle disease (cardiomyopathy)
- Heart valve disease
- Pericardial disease
- Peripheral vascular disease
- Rheumatic heart disease
- Stroke
- Vascular disease (blood vessel disease)

Cardiovascular disease is the leading cause of death in the U.S. It's important to learn about your heart to help prevent it. If you have it, you can live a healthier, more active life by learning about your disease and taking care of yourself.

Types of cardiovascular disease can have various causes, so it's important to know the difference.

Abnormal Heart Rhythms

The heart is an amazing organ. It beats in a steady, even rhythm, about 60 to 100 times each minute. That's about 100,000 times each day. Sometimes your heart gets out of rhythm. Your doctor calls an irregular or abnormal heartbeat an arrhythmia. An arrhythmia (also called a dysrhythmia) can bring on an uneven heartbeat or a heartbeat that is either too slow or too fast.

Aorta Disease and Marfan Syndrome

The aorta is the large artery that leaves your heart and brings oxygen-rich blood to the rest of your body. These two conditions can cause the aorta to widen or tear. This raises the chance of things like:

Atherosclerosis (hardened arteries)

High blood pressure

Connective tissue disorders that can weaken your blood vessel walls, such as scleroderma, osteogenesis imperfecta, Ehlers-Danlos syndrome, and polycystic kidney disease

Injury

If you have aorta disease, you'll need a team of specialists and surgeons to take part in your treatment.

Cardiomyopathies

This is the term for diseases of the heart muscle. They're sometimes simply called enlarged heart. People with these conditions have hearts that are unusually big, thick, or stiff. Their hearts can't pump blood as well as they should. Without treatment, cardiomyopathies get worse. They can lead to heart failure and abnormal heart rhythms.

Cardiomyopathy may sometimes run in families, but it can also be caused by high blood pressure, diabetes, obesity, metabolic diseases, or infections.

Congenital Heart Disease

This is a problem in one or more parts of the heart or blood vessels. It happens before birth.

About 8 out of every 1,000 children get it. They may have symptoms at birth, but some people with it don't have symptoms until childhood or even adulthood.

In most cases, we don't know why it happens. Genes may play a role, or it can happen if a baby is exposed to viral infections, alcohol, or drugs before it's born.

Coronary Artery Disease

You may hear this called CAD. It's when plaque builds up and hardens the arteries that give your heart vital oxygen and nutrients. That hardening is also called atherosclerosis.

Deep Vein Thrombosis and Pulmonary Embolism

Blood clots can form in your deep veins, usually in your legs. This is deep vein thrombosis (DVT). They can break loose and travel through your bloodstream to your lungs, where they can block blood flow. This condition is called pulmonary embolism. It's life threatening and needs immediate medical attention.

You might be at higher risk of DVT because of your genes or family history. Other things that can increase risk include sitting for a long time, like in a car or on a plane; long-term bed rest; pregnancy; and using birth control pills or hormone replacement.

Heart Failure

This term can be scary. It doesn't mean your heart has "failed," or stopped working. It means your heart doesn't pump as strongly as it should. This will cause your body to hold in salt and water, which will give you swelling and shortness of breath.

Heart failure is a major health problem in the United States, affecting more than 6.5 million people. It is the leading cause of hospitalization in people older than 65.

The number of people diagnosed with heart failure is projected to rise 46% by 2030, according to the American Heart Association.

Heart Valve Disease

Your valves sit at the exit of each of your four heart chambers. They keep blood flowing through your heart.

Sometimes, there are problems with these valves. Examples of heart valve problems include:

Aortic stenosis. Your aortic valve narrows. It slows blood flow from your heart to the rest of your body.

Mitral valve insufficiency. Your mitral valve doesn't close tightly enough. This causes blood to leak backward, leading to fluid backup in the lungs.

Mitral valve prolapse. The valve between your left upper and left lower chambers doesn't close right.

Pericarditis

This condition is rare and means the lining surrounding your heart is inflamed. An infection often causes this.

Rheumatic Heart Disease

This happens when rheumatic fever, an inflammatory disease that's most common in children, damages your heart valves.

Rheumatic fever starts with untreated strep throat and can affect many parts of your child's body. If your doctor thinks your child may have had rheumatic fever, they'll do a physical exam and give tests including X-rays and EKGs to look for heart damage.

Stroke

Strokes happen when something slows or blocks blood flow to your brain. Your brain can't get the oxygen and nutrients it needs, and brain cells start to die. When blood can't get to the part of your brain that controls a certain function, your body doesn't work like it should.

A stroke can happen because of a blocked artery or a leaking or burst blood vessel. It needs immediate treatment to limit brain damage and other complications.

Stroke is the leading cause of disability and one of the top causes of death in the United States.

Other Vascular Diseases

Your circulatory system is made up of the vessels that carry blood to every part of your body.

Vascular disease includes any condition that affects your circulatory system. These include diseases of the arteries that go to your legs (peripheral vascular disease) and slow blood flow to your brain, causing strokes.

Cardiovascular Disease Treatments

Treatments for cardiovascular diseases can differ by the type of condition. Yours may include:

Changing parts of your lifestyle like your diet, exercise, and alcohol and tobacco use

Medications, including ones that treat risk factors like blood pressure or cholesterol or to break up clots

Medical procedures like having a balloon or stent placed in your blood vessel, heart valve surgery, or coronary artery bypass graft surgery.

6. Find the English equivalents to the following words in the text.

недостатність мітрального клапана …….

кардіоміопатії ……

склеродермія ……..

полікістоз нирок …….

інсульт ……

нерівномірне серцебиття ……...

клапани ……...

7. Try to state the medical conditions described below.

1. It occurs when the heart's aortic valve narrows. The valve doesn't open fully, which reduces or blocks blood flow from your heart into the main artery to your body (aorta) and to the rest of your body. Your treatment depends on the severity of your condition.

2. Chest pain is the most common symptom of this medical condition. It usually feels sharp or stabbing. However, some people have dull, achy or pressure-like chest pain. The pain usually occurs behind the breastbone or in the left side of your chest. It may spread to your left shoulder and neck. It often gets worse when you cough, lie down or take a deep breath. Sitting up and leaning forward makes you feel better. Other signs and symptoms of this disease may include: Abdominal or leg swelling, Cough, Fatigue or general feeling of weakness or being sick, Low-grade fever, Pounding or racing heartbeat (heart palpitations), Shortness of breath when lying down.

3. It is the most common form of valvular heart disease, occurs when the mitral valve does not close properly, allowing blood to flow backwards into the heart. As a result, the heart cannot pump efficiently, causing symptoms like fatigue and shortness of breath. You may need heart surgery to repair or replace the valve for severe leakage or regurgitation. Left untreated, severe mitral valve regurgitation can cause heart failure or heart rhythm problems (arrhythmias). Even people without symptoms may need to be evaluated by a cardiologist and surgeon trained in mitral valve disease to determine whether early intervention may be beneficial.

8. Prepare the description of two cardiovascular disorders. Make the class guess what they are.

Text 1.
Digestive and Endocrine Systems Anatomy

1. Read the text.

Digestive System Anatomy

Mouth

Food begins its journey through the digestive system in the mouth, also known as the oral cavity. Inside the mouth are many accessory organs that aid in the digestion of food – ***the tongue***, ***teeth***, and ***salivary glands***. Teeth chop food into small pieces, which are moistened by saliva before the tongue and other muscles push the food into the ***pharynx***.

Teeth. The teeth are 32 small, hard organs found along the anterior and lateral edges of the mouth. Each tooth is made of a bone-like substance called dentin and covered in a layer of ***enamel*** – the hardest substance in the body. Teeth are living organs and contain blood vessels and nerves under the dentin in a soft region known as the pulp. The teeth are designed for cutting and grinding food into smaller pieces.

Tongue. The tongue is located on the inferior portion of the mouth just posterior and medial to the teeth. It is a small organ made up of several pairs of muscles covered in a thin, bumpy, skin-like layer. The outside of the tongue contains many rough ***papillae*** for gripping food as it is moved by the tongue's muscles. ***The taste buds*** on the surface of the tongue detect taste molecules in food and connect to nerves in the tongue to send taste information to the brain. The tongue also helps to push food toward the posterior part of the mouth for swallowing.

Salivary Glands. Surrounding the mouth are 3 sets of salivary glands. The salivary glands are accessory organs that produce a watery secretion known as ***saliva***. Saliva helps to moisten food and begins the digestion of carbohydrates. The body also uses saliva to lubricate food as it passes through the mouth, pharynx, and ***esophagus.***

Pharynx

The pharynx, or throat, is a funnel-shaped tube connected to the posterior end of the mouth. The pharynx is responsible for the passing of masses of chewed food from the mouth to the esophagus. The pharynx also plays an important role in the respiratory system, as air from the nasal cavity passes through the pharynx on its way to the larynx and eventually the lungs. Because the pharynx serves two different functions, it contains a flap of tissue known as the ***epiglottis*** that acts as a switch to route food to the esophagus and air to the ***larynx***.

Esophagus

The esophagus is a muscular tube connecting the pharynx to the stomach that is part of the upper gastrointestinal tract. It carries swallowed masses of chewed food along its length. At the inferior end of the esophagus is a muscular ring called the ***lower esophageal sphincter*** or ***cardiac sphincter***. The function of this sphincter is to close of the end of the esophagus and trap food in the stomach.

Stomach

The stomach is a muscular sac that is located on the left side of the abdominal cavity, just inferior to the ***diaphragm***. In an average person, the stomach is about the size of their two fists placed next to each other. This major organ acts as a storage tank for food so that the body has time to digest large meals properly. The stomach also contains ***hydrochloric acid*** and ***digestive enzymes*** that continue the digestion of food that began in the mouth.

Small Intestine

The small intestine is a long, thin tube about 1 inch in diameter and about 10 feet long that is part of the ***lower gastrointestinal tract***. It is located just inferior to the stomach and takes up most of the space in the ***abdominal cavity***. The entire small intestine is coiled like a hose and the inside surface is full of many ridges and folds. These folds are used to maximize the digestion of food and absorption of nutrients. By the time food leaves the small intestine, around 90% of all nutrients have been extracted from the food that entered it.

Liver and Gallbladder

The ***liver*** is a roughly triangular accessory organ of the digestive system located to the right of the stomach, just inferior to the diaphragm and superior to the small intestine. The liver weighs about 3 pounds and is the second largest organ in the body.

The liver has many different functions in the body, but the main function of the liver in digestion is the production of bile and its secretion into the small intestine. The ***gallbladder*** is a small, pear-shaped organ located just posterior to the liver. The gallbladder is used to store and recycle excess bile from the small intestine so that it can be reused for the digestion of subsequent meals.

Pancreas

The pancreas is a large gland located just inferior and posterior to the stomach. It is about 6 inches long and shaped like short, lumpy snake with its "head" connected to the ***duodenum*** and its "tail" pointing to the left wall of the abdominal cavity. The pancreas secretes digestive enzymes into the small intestine to complete the chemical digestion of foods.

Large Intestine

The large intestine is a long, thick tube about 2.5 inches in diameter and about 5 feet long. It is located just inferior to the stomach and wraps around the superior and lateral border of the ***small intestine***. The large intestine absorbs water and contains many symbiotic bacteria that aid in the breaking down of wastes to extract some small amounts of nutrients. Feces in the large intestine exit the body through the ***anal canal***.

Digestive System Physiology

The digestive system is responsible for taking whole foods and turning them into energy and nutrients to allow the body to function, grow, and repair itself. The six primary processes of the digestive system include:

- ingestion of food
- ***secretion of fluids*** and digestive enzymes
- mixing and movement of food and wastes through the body
- digestion of food into smaller pieces

- ***absorption of nutrients***
- ***excretion of wastes***

Ingestion

The first function of the digestive system is ingestion, or the intake of food. The mouth is responsible for this function, as it is the orifice through which all food enters the body. The mouth and stomach are also responsible for the storage of food as it is waiting to be digested. This storage capacity allows the body to eat only a few times each day and to ingest more food than it can process at one time.

Secretion

In the course of a day, the digestive system secretes around 7 liters of fluids. These fluids include saliva, ***mucus***, hydrochloric acid, enzymes, and ***bile***. Saliva moistens dry food and contains salivary amylase, a digestive enzyme that begins the digestion of carbohydrates. Mucus serves as a protective barrier and lubricant inside of the GI tract. Hydrochloric acid helps to digest food chemically and protects the body by killing bacteria present in our food. Enzymes are like tiny biochemical machines that disassemble large macromolecules like proteins, carbohydrates, and lipids into their smaller components. Finally, bile is used to emulsify large masses of lipids into tiny globules for easy digestion.

Mixing and Movement

The digestive system uses 3 main processes to move and mix food:

Swallowing. Swallowing is the process of using smooth and skeletal muscles in the mouth, tongue, and pharynx to push food out of the mouth, through the pharynx, and into the esophagus.

Peristalsis. Peristalsis is a muscular wave that travels the length of the GI tract, moving partially digested food a short distance down the tract. It takes many waves of peristalsis for food to travel from the esophagus, through the stomach and intestines, and reach the end of the GI tract.

Segmentation. Segmentation occurs only in the small intestine as short segments of intestine contract like hands squeezing a toothpaste tube. Segmentation helps to increase the absorption of nutrients by mixing food and increasing its contact with the walls of the intestine.

Digestion

Digestion is the process of turning large pieces of food into its component chemicals. Mechanical digestion is the physical breakdown of large pieces of food into smaller pieces. This mode of digestion begins with the chewing of food by the teeth and is continued through the muscular mixing of food by the stomach and intestines. ***Bile*** produced by the liver is also used to mechanically break fats into smaller globules. While food is being mechanically digested it is also being chemically digested as larger and more complex molecules are being broken down into smaller molecules that are easier to absorb. Chemical digestion begins in the mouth with salivary amylase in saliva splitting complex carbohydrates into simple carbohydrates. The enzymes and acid in the stomach continue chemical digestion, but the bulk of chemical digestion takes place in the small intestine thanks to the action of the pancreas. The ***pancreas*** secretes an incredibly strong digestive cocktail known as pancreatic juice, which is capable of digesting lipids, carbohydrates, proteins and nucleic acids. By the time food has left the duodenum, it has been reduced to its chemical building blocks – fatty acids, amino acids, monosaccharides, and nucleotides.

Absorption

Once food has been reduced to its building blocks, it is ready for the body to absorb. Absorption begins in the stomach with simple molecules like water and alcohol being absorbed directly into the bloodstream. Most absorption takes place in the walls of the small intestine, which are densely folded to maximize the surface area in contact with digested food. Small blood and ***lymphatic vessels*** in the intestinal wall pick up the molecules and carry them to the rest of the body. The large intestine is also involved in the absorption of water and vitamins B and K before feces leave the body.

Excretion

The final function of the digestive system is the excretion of waste in a process known as defecation. ***Defecation*** removes indigestible substances from the body so that they do not accumulate inside the gut. The timing of defecation is controlled voluntarily by the conscious part of the brain, but must be accomplished on a regular basis to prevent a backup of indigestible materials.

Anatomy of the Endocrine System

Hypothalamus

The ***hypothalamus*** is a part of the ***brain*** located superior and anterior to the brain stem and inferior to the ***thalamus***. It serves many different functions in the **n*ervous system***, and is also responsible for the direct control of the endocrine system through the pituitary gland. The hypothalamus contains special cells called neurosecretory cells – ***neurons*** that secrete hormones:

Thyrotropin-releasing hormone (TRH)

Growth hormone-releasing hormone (GHRH)

Growth hormone-inhibiting hormone (GHIH)

Gonadotropin-releasing hormone (GnRH)

Corticotropin-releasing hormone (CRH)

Oxytocin

Antidiuretic hormone (ADH)

All of the releasing and inhibiting hormones affect the function of the anterior pituitary gland. TRH stimulates the anterior pituitary gland to release thyroid-stimulating hormone. GHRH and GHIH work to regulate the release of growth hormone – GHRH stimulates growth hormone release, GHIH inhibits its release. GnRH stimulates the release of follicle stimulating hormone and luteinizing hormone while CRH stimulates the release of adrenocorticotropic hormone. The last two hormones – oxytocin and antidiuretic hormone – are produced by the hypothalamus and transported to the posterior pituitary, where they are stored and later released.

Pituitary Gland

The ***pituitary gland***, also known as the ***hypophysis***, is a small pea-sized lump of tissue connected to the inferior portion of the hypothalamus of the brain. Many blood vessels surround the pituitary gland to carry the hormones it releases throughout the body. Situated in a small depression in *the* ***sphenoid bone*** called ***the sella turcica***, the pituitary gland is actually made of 2 completely separate structures: the posterior and anterior pituitary glands.

Posterior Pituitary

The posterior pituitary gland is actually not glandular tissue at all, but nervous tissue instead. The posterior pituitary is a small extension of the hypothalamus through which the axons of some of the neurosecretory cells of the hypothalamus extend. These neurosecretory cells create 2 hormones in the hypothalamus that are stored and released by the posterior pituitary:

Oxytocin triggers uterine contractions during childbirth and the release of milk during breastfeeding.

Antidiuretic hormone (ADH) prevents water loss in the body by increasing the re-uptake of water in the kidneys and reducing blood flow to sweat glands.

Anterior Pituitary

The anterior pituitary gland is the true glandular part of the pituitary gland. The function of the anterior pituitary gland is controlled by the releasing and inhibiting hormones of the hypothalamus. The anterior pituitary produces 6 important hormones:

Thyroid stimulating hormone (TSH), as its name suggests, is a tropic hormone responsible for the stimulation of the thyroid gland.

Adrenocorticotropic hormone (ACTH) stimulates the adrenal cortex, the outer part of the adrenal gland, to produce its hormones.

Follicle stimulating hormone (FSH) stimulates the follicle cells of the gonads to produce gametes – ova in females and sperm in males.

Luteinizing hormone (LH) stimulates the gonads to produce the sex hormones – ***estrogens*** in females and ***testosterone*** in males.

Human growth hormone (HGH) affects many target cells throughout the body by stimulating their growth, repair, and reproduction.

Prolactin (PRL) has many effects on the body, chief of which is that it stimulates the ***mammary glands*** of the breast to produce milk.

Pineal Gland

The ***pineal gland*** is a small pinecone-shaped mass of glandular tissue found just posterior to the thalamus of the brain. The pineal gland produces the hormone *melatonin* that helps to regulate the human sleep-wake cycle known as the ***circadian rhythm***. The activity of the pineal gland is inhibited by stimulation from the ***photoreceptors of the retina.*** This light sensitivity causes melatonin to be produced only in low light or darkness. Increased melatonin production causes humans to feel drowsy at nighttime when the pineal gland is active.

Thyroid Gland

The ***thyroid gland*** is a butterfly-shaped gland located at the base of the neck and wrapped around the lateral sides of the trachea. The thyroid gland produces 3 major hormones:

Calcitonin

Triiodothyronine (T3)

Thyroxine (T4)

Calcitonin is released when calcium ion levels in the blood rise above a certain set point. Calcitonin functions to reduce the concentration of calcium ions in the blood by aiding the absorption of calcium into the matrix of bones. The hormones T3 and T4 work together to regulate the body's metabolic rate. Increased levels of T3 and T4 lead to increased cellular activity and energy usage in the body.

Parathyroid Glands

The ***parathyroid glands*** are 4 small masses of glandular tissue found on the posterior side of the thyroid gland. The parathyroid glands produce the hormone ***parathyroid hormone (PTH)***, which is involved in calcium ion homeostasis. PTH is released from the parathyroid glands when calcium ion levels in the blood drop below a set point. PTH stimulates the osteoclasts to break down the calcium containing bone matrix to release free calcium ions into the bloodstream. PTH also triggers the kidneys to return calcium ions filtered out of the blood back to the bloodstream so that it is conserved.

Adrenal Glands

The ***adrenal glands*** are a pair of roughly triangular glands found immediately superior to the kidneys. The adrenal glands are each made of 2 distinct layers, each with their own unique functions: the ***outer adrenal cortex*** and ***inner adrenal medulla***.

Adrenal cortex

The adrenal cortex produces many cortical hormones in 3 classes: glucocorticoids, mineralocorticoids, and androgens.

Glucocorticoids have many diverse functions, including the breakdown of proteins and lipids to produce glucose. Glucocorticoids also function to reduce inflammation and immune response.

Mineralocorticoids, as their name suggests, are a group of hormones that help to regulate the concentration of mineral ions in the body.

Androgens, such as testosterone, are produced at low levels in the adrenal cortex to regulate the growth and activity of cells that are receptive to male hormones. In adult males, the amount of androgens produced by the testes is many times greater than the amount produced by the adrenal cortex, leading to the appearance of male secondary sex characteristics.

Adrenal medulla

The adrenal medulla produces the hormones epinephrine and norepinephrine under stimulation by the sympathetic division of the autonomic nervous system. Both of these hormones help to increase the flow of blood to the brain and muscles to improve the "fight-or-flight" response to stress. These hormones also work to increase heart rate, breathing rate, and blood pressure while decreasing the flow of blood to and function of organs that are not involved in responding to emergencies.

Pancreas

The ***pancreas*** is a large gland located in the abdominal cavity just inferior and posterior to the **stomach**. The pancreas is considered to be a ***heterocrine gland*** as it contains both ***endocrine and exocrine tissue***. The endocrine cells of the pancreas make up just about 1% of the total mass of the pancreas and are found in small groups throughout the pancreas called ***islets***

of Langerhans. Within these islets are 2 types of cells – alpha and beta cells. The alpha cells produce the hormone glucagon, which is responsible for raising blood glucose levels. ***Glucagon*** triggers muscle and liver cells to break down the polysaccharide glycogen to release glucose into the bloodstream. The beta cells produce the hormone insulin, which is responsible for lowering blood glucose levels after a meal. Insulin triggers the absorption of glucose from the blood into cells, where it is added to glycogen molecules for storage.

Gonads

The gonads – ***ovaries*** in females and ***testes*** in males – are responsible for producing the sex hormones of the body. These sex hormones determine the secondary sex characteristics of adult females and adult males.

Testes: The testes are a pair of ellipsoid organs found in the scrotum of males that produce the androgen testosterone in males after the start of puberty. Testosterone has effects on many parts of the body, including the muscles, bones, sex organs, and hair follicles. This hormone causes growth and increases in strength of the bones and muscles, including the accelerated growth of long bones during adolescence. During puberty, testosterone controls the growth and development of the sex organs and body hair of males, including pubic, chest, and facial hair. In men who have inherited genes for baldness testosterone triggers the onset of androgenic alopecia, commonly known as male pattern baldness.

Ovaries: The **ovaries** are a pair of almond-shaped glands located in the pelvic body cavity lateral and superior to the uterus in females. The ovaries produce the female sex hormones progesterone and estrogens. Progesterone is most active in females during ovulation and pregnancy where it maintains appropriate conditions in the human body to support a developing fetus. Estrogens are a group of related hormones that function as the primary female sex hormones. The release of estrogen during puberty triggers the development of female secondary sex characteristics such as uterine development, breast development, and the growth of pubic hair. Estrogen also triggers the increased growth of bones during adolescence that lead to adult height and proportions.

Thymus

The **thymus** is a soft, triangular-shaped organ found in the chest posterior to the sternum. The thymus produces hormones called ***thymosins*** that help to train and develop T-lymphocytes during fetal development and childhood. The T-lymphocytes produced in the thymus go on to protect the body from pathogens throughout a person's entire life. The thymus becomes inactive during puberty and is slowly replaced by adipose tissue throughout a person's life.

Other Hormone Producing Organs

In addition to the glands of the endocrine system, many other non-glandular organs and tissues in the body produce hormones as well.

Heart: The cardiac muscle tissue of the **heart** is capable of producing ***the hormone atrial natriuretic peptide (ANP)*** in response to ***high blood pressure*** levels. ANP works to reduce blood pressure by triggering vasodilation to provide more space for the blood to travel through. ANP also reduces blood volume and pressure by causing water and salt to be excreted out of the blood by the kidneys.

Kidneys: The kidneys produce the hormone ***erythropoietin (EPO)*** in response to low levels of oxygen in the blood. EPO released by the kidneys travels to the red bone marrow where it stimulates an increased production of red blood cells. The number of red blood cells increases the oxygen carrying capacity of the blood, eventually ending the production of EPO.

Digestive System: The hormones ***cholecystokinin (CCK), secretin,*** and ***gastrin*** are all produced by the organs of the gastrointestinal tract. CCK, secretin, and gastrin all help to regulate the secretion of pancreatic juice, bile, and gastric juice in response to the presence of food in the stomach. CCK is also instrumental in the sensation of satiety or "fullness" after eating a meal.

Adipose: ***Adipose tissue*** produces the hormone ***leptin*** that is involved in the management of appetite and energy usage by the body. Leptin is produced at levels relative to the amount of adipose tissue in the body, allowing the brain to monitor the body's energy storage condition. When the body contains a sufficient level of adipose for energy storage, the level of leptin in the blood tells the brain that the body is not starving and may work normally. If the level of adipose or leptin decreases below a certain threshold, the body enters starvation mode and attempts to conserve energy through increased hunger and food intake and decreased energy usage. Adipose

tissue also produces very low levels of estrogens in both men and women. In obese people the large volume of adipose tissue may lead to abnormal estrogen levels.

Placenta: In pregnant women, the ***placenta*** produces several hormones that help to maintain pregnancy. Progesterone is produced to relax the uterus, protect the fetus from the mother's immune system, and prevent premature delivery of the fetus. ***Human chorionic gonadotropin (HCG)*** assists progesterone by signaling the ovaries to maintain the production of estrogen and progesterone throughout pregnancy.

Local Hormones: ***Prostaglandins*** and l***eukotrienes*** are produced by every tissue in the body (except for blood tissue) in response to damaging stimuli. These two hormones mainly affect the cells that are local to the source of damage, leaving the rest of the body free to function normally.

Prostaglandins cause swelling, inflammation, increased pain sensitivity, and increased local body temperature to help block damaged regions of the body from infection or further damage. They act as the body's natural bandages to keep pathogens out and swell around damaged joints like a natural cast to limit movement.

Leukotrienes help the body heal after prostaglandins have taken effect by reducing inflammation while helping white blood cells to move into the region to clean up pathogens and damaged tissues.

Physiology of the Endocrine System

Endocrine System vs. Nervous System Function

The endocrine system works alongside of the nervous system to form the control systems of the body. The nervous system provides a very fast and narrowly targeted system to turn on specific glands and muscles throughout the body. The endocrine system, on the other hand, is much slower acting, but has very widespread, long lasting, and powerful effects. Hormones are distributed by glands through the bloodstream to the entire body, affecting any cell with a receptor for a particular hormone. Most hormones affect cells in several organs or throughout the entire body, leading to many diverse and powerful responses.

Hormone Properties

Once hormones have been produced by glands, they are distributed through the body via the bloodstream. As hormones travel through the body, they pass through cells or along the plasma membranes of cells until they encounter a receptor for that particular hormone. Hormones can only affect target cells that have the appropriate receptors. This property of hormones is known as specificity. Hormone specificity explains how each hormone can have specific effects in widespread parts of the body.

Many hormones produced by the endocrine system are classified as tropic hormones. A tropic hormone is a hormone that is able to trigger the release of another hormone in another gland. Tropic hormones provide a pathway of control for hormone production as well as a way for glands to be controlled in distant regions of the body. Many of the hormones produced by the pituitary gland, such as TSH, ACTH, and FSH are tropic hormones.

Hormonal Regulation

The levels of hormones in the body can be regulated by several factors. The nervous system can control hormone levels through the action of the hypothalamus and its releasing and inhibiting hormones. For example, TRH produced by the hypothalamus stimulates the anterior pituitary to produce TSH. Tropic hormones provide another level of control for the release of hormones. For example, TSH is a tropic hormone that stimulates the thyroid gland to produce T3 and T4. Nutrition can also control the levels of hormones in the body. For example, the thyroid hormones T3 and T4 require 3 or 4 iodine atoms, respectively, to be produced. In people lacking iodine in their diet, they will fail to produce sufficient levels of thyroid hormones to maintain a healthy metabolic rate. Finally, the number of receptors present in cells can be varied by cells in response to hormones. Cells that are exposed to high levels of hormones for extended periods of time can begin to reduce the number of receptors that they produce, leading to reduced hormonal control of the cell.

Classes of Hormones

Hormones are classified into 2 categories depending on their chemical make-up and solubility: ***water-soluble*** and ***lipid-soluble*** hormones. Each of these classes of hormones has specific mechanisms for their function that dictate how they affect their target cells.

Water-soluble hormones: Water-soluble hormones include the peptide and amino-acid hormones such as insulin, epinephrine, HGH, and oxytocin. As their name indicates, these hormones are soluble in water. Water-soluble hormones are unable to pass through the phospholipid bilayer of the plasma membrane and are therefore dependent upon receptor molecules on the surface of cells. When a water-soluble hormone binds to a receptor molecule on the surface of a cell, it triggers a reaction inside of the cell. This reaction may change a factor inside of the cell such as the permeability of the membrane or the activation of another molecule. A common reaction is to cause molecules of ***cyclic adenosine monophosphate*** (cAMP) to be synthesized from ***adenosine triphosphate (ATP)*** present in the cell. cAMP acts as a second messenger within the cell where it binds to a second receptor to change the function of the cell's physiology.

Lipid-soluble hormones: ***Lipid-soluble hormones*** include the steroid hormones such as testosterone, estrogens, glucocorticoids, and mineralocorticoids. Because they are soluble in lipids, these hormones are able to pass directly through the phospholipid bilayer of the plasma membrane and bind directly to receptors inside the cell nucleus. Lipid-soluble hormones are able to directly control the function of a cell from these receptors, often triggering the transcription of particular genes in the DNA to produce "messenger RNAs (mRNAs)" that are used to make proteins that affect the cell's growth and function.

1. Answer the following questions.

1. What is the calcitonin?
2. What is the function of sulivary glands?
3. Which hormones does the thyroid gland produce?
4. What is gallbladder used for?
5. What do the six primary processes of the digestive system include?
6. What does the hypothalamus contain?
7. What are the classes of hormones?
8. What are the prostaglandins and leukotrienes produced by?

9. What is the thymus?

10. What are the testes?

2. Fill in the blanks with the appropriate words from the box.

epiglottis	*parathyroid glands*	*larynx*	*ovaries*	*epinephrine gastrin*

1. Because the pharynx serves two different functions, it contains a flap of tissue known as the _____that acts as a switch to route food to the esophagus and air to the _____.

2. The _____ produce the hormone parathyroid hormone (PTH), which is involved in calcium ion homeostasis.

3. CCK, secretin, and _____ all help to regulate the secretion of pancreatic juice, bile, and gastric juice in response to the presence of food in the stomach.

4. The _____ are a pair of almond-shaped glands located in the pelvic body cavity lateral and superior to the uterus in females.

5. Water-soluble hormones include the peptide and amino-acid hormones such as insulin, _____, HGH, and oxytocin.

3. Translate the following sentences into English.

1. Зуби є живими органами і містять кровоносні судини та нерви під дентином у м’якій області, відомій як пульпа.

2. На той час, коли їжа виходить з дванадцятипалої кишки, вона трансформується на хімічні будівельні блоки — жирні кислоти, амінокислоти, моносахариди та нуклеотиди.

3. Нервова система створює дуже швидку і вузько націлену систему для роботи певних залоз і м’язів по всьому тілу.

4. Тимус виробляє гормони тимозини, які допомагають розвивати Т-лімфоцити під час внутрішньоутробного розвитку і дитинства.

5. Простагландини викликають набряк, запалення, підвищену чутливість до болю та підвищення місцевої температури тіла, щоб допомогти заблокувати пошкоджені ділянки тіла від інфекції або подальшого пошкодження.

6. Ліпідорозчинні гормони включають стероїдні гормони, такі як тестостерон, естрогени, глюкокортикоїди та мінералокортикоїди.

7. Тропний гормон - це гормон, який здатний викликати виділення іншого гормону в іншій залозі.

4. Fill in the blanks with the appropriate words below.

large intestine

thymus

pancreas

Adipose tissue

pituitary gland

1. _____, or simply body fat, or simply fat is a loose connective tissue composed mostly of adipocytes.

2. The _____- is a soft, triangular-shaped organ found in the chest posterior to the sternum.

3. The _____, also known as the hypophysis, is a small pea-sized lump of tissue connected to the inferior portion of the hypothalamus of the brain.

4. The_____-, also known as the large bowel, is the last part of the gastrointestinal tract and of the digestive system in vertebrates.

5. The _____ is an organ of the digestive system and endocrine system of vertebrates.

Text 2. 1

Causes of Endocrine Disorders

Endocrine disorders are typically grouped into two categories:

Endocrine disease that results when a gland produces too much or too little of an endocrine hormone, called a hormone imbalance.

Endocrine disease due to the development of lesions (such as nodules or tumors) in the endocrine system, which may or may not affect hormone levels.

The endocrine's feedback system helps control the balance of hormones in the bloodstream. If your body has too much or too little of a certain hormone, the feedback system signals the proper gland or glands to correct the problem. A ***hormone imbalance*** may occur if this feedback system has trouble keeping the right level of hormones in the bloodstream, or if your body doesn't clear them out of the bloodstream properly.

Increased or decreased levels of endocrine hormone may be caused by:

- A problem with the endocrine feedback system
- Disease
- Failure of a gland to stimulate another gland to release hormones (for example, a problem with the hypothalamus can disrupt hormone production in the pituitary gland).
- A genetic disorder, such as ***multiple endocrine neoplasia*** (MEN) or congenital ***hypothyroidism.***
- Infection
- Injury to an endocrine gland
- ***Tumor*** of an endocrine gland

Most ***endocrine tumors*** and ***nodules (lumps)*** are noncancerous. They usually do not spread to other parts of the body. However, a tumor or nodule on the gland may interfere with the gland's hormone production.

Types of Endocrine Disorders

There are many different types of endocrine disorders. ***Diabetes*** is the most common endocrine disorder diagnosed in the U.S.

Other endocrine disorders include:

Adrenal insufficiency. The adrenal gland releases too little of the hormone cortisol and sometimes, aldosterone. Symptoms include ***fatigue, stomach upset***, ***dehydration***, and ***skin*** changes. ***Addison's disease*** is a type of adrenal insufficiency.

Cushing's disease. Overproduction of a pituitary gland hormone leads to an overactive adrenal gland. A similar condition called ***Cushing's syndrome*** may occur in people, particularly children, who take high doses of corticosteroid ***medications***.

Gigantism (acromegaly) and other growth hormone problems. If the pituitary gland produces too much growth hormone, a child's bones and body parts may grow abnormally fast. If growth hormone levels are too low, a child can stop growing in height.

Hyperthyroidism. The thyroid gland produces too much thyroid hormone, leading to weight loss, fast heart rate, ***sweating***, and nervousness. The most common cause for an ***overactive thyroid*** is an ***autoimmune disorder*** called Grave's disease.

Hypothyroidism. The thyroid gland does not produce enough thyroid hormone, leading to ***fatigue, constipation, dry skin***, and depression. The underactive gland can cause slowed development in children. Some types of ***hypothyroidism*** are present at birth.

Hypopituitarism. The pituitary gland releases little or no hormones. It may be caused by a number of different diseases. Women with this condition may stop getting their periods.

Multiple endocrine neoplasia I and II (MEN I and MEN II). These rare, genetic conditions are passed down through families. They cause tumors of the parathyroid, adrenal, and thyroid glands, leading to overproduction of hormones.

Polycystic ovary syndrome (PCOS). Overproduction of androgens interfere with the development of eggs and their release from the female ovaries. PCOS is a leading cause of infertility.

Precocious puberty. Abnormally early puberty that occurs when glands tell the body to release sex hormones too soon in life.

Testing for Endocrine Disorders

If you have an endocrine disorder, your doctor may refer you to a specialist called an endocrinologist. An endocrinologist is specially trained in problems with the endocrine system.

The symptoms of an endocrine disorder vary widely and depend on the specific gland involved. However, most people with endocrine disease complain of ***fatigue*** and weakness.

Blood and urine tests to check your hormone levels can help your doctors determine if you have an endocrine disorder. Imaging tests may be done to help locate or pinpoint a nodule or tumor.

Treatment of endocrine disorders can be complicated, as a change in one hormone level can throw off another. Your doctor or specialist may order routine blood work to check for problems or to determine if your medication or treatment plan needs to be adjusted.

Text 2. 2

Common Digestive Conditions From Top to Bottom

1. Gastroesophageal Reflux Disease (GERD)

When stomach acid backs up into your esophagus – a condition called ***acid reflux*** – you may feel a burning pain in the middle of your chest. It often occurs after meals or at night, says Neville Bamji, MD, a clinical instructor of medicine at the Icahn School of Medicine at Mount Sinai and a gastroenterologist with New York Gastroenterology Associates.

While it's common for people to experience acid reflux and ***heartburn*** once in a while, having symptoms that affect your daily life or occur at least twice each week could be a ***sign of GERD***, a chronic digestive disease that affects 20 percent of Americans,

according to the ***National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK).*** If you experience persistent heartburn, ***bad breath***, tooth erosion, nausea, pain in your chest or upper part of your abdomen, or have trouble swallowing or breathing, see your doctor.

Most people find relief by avoiding the foods and beverages that trigger their symptoms and/or taking over-the-counter ***antacids*** or other medication that reduces stomach acid production and inflammation of the esophagus. In addition, ***lifestyle changes*** like elevating the head of the bed, not lying down after a meal, avoiding tight-fitting clothing, and ***quitting smoking*** can also help. However, some cases of ***GERD*** require stronger ***treatment***, such as medication or surgery.

2. Gallstones

Gallstones are hard deposits that form in your ***gallbladder*** — a small, pear-shaped sac that stores and secretes bile for digestion. Nearly one million Americans are found to have gallstones every year, according to the ***American Gastroenterological Association.*** Gallstones can form when there's too much cholesterol or waste in your bile, or if your gallbladder doesn't empty properly.

When gallstones block the ducts leading from your gallbladder to your intestines, they can cause ***sharp pain*** in your upper-right abdomen. Medication sometimes dissolves gallstones, but if that doesn't work, the next step is ***surgery to remove the gallbladder***.

3. Celiac Disease

An estimated 1 in 133 Americans – about 1 percent of the population – has ***celiac disease, according to Beyond Celiac*** (formerly the National Foundation for Celiac Awareness). The group also estimates that more than 80 percent of ***people with celiac disease*** don't know they have it or have been misdiagnosed with a different condition.

Celiac disease is a serious sensitivity to ***gluten,*** which is a protein found in wheat, rye, and barley. Eat gluten, and your immune system goes on the attack: It damages your villi, the fingerlike protrusions in your small intestines that help you absorb nutrients from the foods you eat. In children, symptoms may include ***abdominal pain and bloating,***

diarrhea, constipation, vomiting, and weight loss. Symptoms in adults can also include ***anemia,*** fatigue, bone loss, depression, and seizures.

Yet some people may not have any symptoms. The only ***treatment for celiac disease*** is to completely avoid eating gluten. Common alternatives to gluten include brown rice, ***quinoa***, lentils, soy flour, corn flour, and amaranth.

4. Crohn's Disease

Crohn's disease is part of a group of digestive conditions called ***inflammatory bowel disease (IBD).*** Crohn's can affect any part of the GI tract but most commonly affects the terminal ileum, which connects the end of the small bowel and the beginning of the colon. As many as 780,000 Americans may be affected by Crohn's, according to the ***Crohn's & Colitis Foundation (CCFA)***.

Doctors aren't sure what causes the disease, but it's thought that genetics and family history may play a part. The most common ***Crohn's symptoms*** are abdominal pain, diarrhea, ***rectal bleeding***, weight loss, and fever. "Treatment depends on the symptoms and can include topical pain relievers, ***immunosuppressants***, and surgery," Dr. Bamji says. Avoiding ***trigger foods*** like dairy products, carbonated beverages, alcohol, coffee, raw fruit and vegetables, red meat, and foods that are fatty, fried, spicy, or gas-producing can also help prevent flares.

5. Ulcerative Colitis

Ulcerative colitis is another inflammatory bowel disease that may affect as many as 907,000 Americans, according to the ***CCFA***. The ***symptoms of ulcerative colitis*** are very similar to those of ***Crohn's***, but the part of the digestive tract affected is solely the large intestine, also known as the colon.

If your immune system mistakes food or other materials for invaders, ***sores or ulcers*** develop in the colon's lining. If you experience frequent and urgent bowel movements, pain with diarrhea, blood in your stool, or ***abdominal cramps***, visit your doctor.

Medication can suppress the inflammation, and eliminating foods that cause discomfort may help as well. In severe cases, ***treatment for ulcerative colitis*** may involve surgery to remove the colon.

6. Irritable Bowel Syndrome

Is your digestive tract irritable? Do you have stomach pain or discomfort at least three times a month for several months? It could be ***irritable bowel syndrome (IBS)***, another common digestive condition.

About 10 to 15 percent of people worldwide suffer from IBS, and of that percentage, up to 45 million ***people with IBS*** live in the United States, according to the ***International Foundation for Functional Gastrointestinal Disorders. Signs of IBS*** can vary widely from having hard, dry stools one day to loose, watery stools on another. Bloating is also a ***symptom of IBS***.

7. Hemorrhoids

Bright red blood in the toilet bowl when you move your bowels could be a ***sign of hemorrhoids***, which is a very common condition. In fact, 75 percent of Americans over age 45 have hemorrhoids, according to the ***NIDDK***.

Hemorrhoids are an inflammation of the blood vessels at the end of your digestive tract that can be painful and itchy. Causes include ***chronic constipation***, diarrhea, straining during bowel movements, and a lack of ***fiber in your diet***.

Treat hemorrhoids by eating more fiber, drinking more water, and exercising. Over-the-counter creams and suppositories may provide temporary relief of ***hemorrhoid symptoms.*** See your doctor if at-home treatments don't help; sometimes a ***hemorrhoidectomy*** is needed to remove hemorrhoids surgically.

8. Diverticulitis

Small pouches called ***diverticula*** can form anywhere there are weak spots in the lining of your digestive system, but they are most commonly found in the colon. If you have diverticula but no symptoms, the condition is called ***diverticulosis***, which is quite common among older adults and rarely causes problems. By age 50, about half of people

have diverticulosis, according to the American Gastroenterological Association. But in about 5 percent of people, the pouches become inflamed or infected, a condition called ***diverticulitis.*** Symptoms include fever, chills, nausea, and abdominal pain. Obesity is a major ***risk factor for diverticulitis***.

Mild ***diverticulitis*** is treated with antibiotics and a clear liquid diet so your colon can heal. A low-fiber diet could be the ***cause of diverticulitis***, so your doctor may direct you to eat a diet ***high in fiber*** — whole grains, legumes, vegetables — as part of your treatment.

If you have severe attacks that recur frequently, you may need surgery to remove the diseased part of your colon.

9. Anal Fissure

Anal fissures are tiny, oval-shaped tears in the lining of the very end of your digestive tract called your anus. The symptoms are similar to those of hemorrhoids, such as bleeding and pain after moving your bowels. Straining and hard bowel movements can cause fissures, but so can soft stools and diarrhea.

A ***high-fiber diet*** that makes your stool well formed and bulky is often the best treatment for this common digestive condition. Medication to relax the anal sphincter muscles, as well as topical anesthetics and sitz baths, can ***relieve pain***; however, chronic fissures may require surgery of the anal sphincter muscle.

5. Translate into English

пухлина ендокринної залози ……

синдром полікістозних яєчників ……..

хвороба Кушинга ……...

гормональний дисбаланс ……..

ендокринний розлад …….

дивертикуліт ……..

дієта з високим вмістом клітковини …….

виразковий коліт ……

6. Try to state the medical conditions described below.

1. A noncancerous (benign) tumor of the pituitary gland, located at the base of the brain, produces an excess amount of ACTH , which in turn stimulates the adrenal glands to make more cortisol.

2. It occurs when small, bulging pouches (diverticula) develop in your digestive tract. When one or more of these pouches become inflamed or infected, the condition takes place. Diverticula are small, bulging pouches that can form in the lining of your digestive system.

3. It is the most common type of endocrine cancer, diagnosed in about 64,000 people each year. In most cases, it's a very treatable form of cancer. Endocrine cancer can also affect the pancreas, which is an organ in the belly.

7. Prepare the description of two endocrine and digestive disorders. Make the class guess what they are.

Text 1.

Immune and Lymphatic, Nervous Systems Anatomy

1. Read the text.

Immune and Lymphatic System Anatomy

Red Bone Marrow and Leukocytes

Red bone marrow is a highly vascular tissue found in the spaces between ***trabeculae of spongy bone***. It is mostly found in the ends of long bones and in the flat bones of the body. ***Red bone marrow*** is a hematopoietic tissue containing many stem cells that produce blood cells. All of the leukocytes, or white blood cells, of the immune system are produced by red bone marrow. Leukocytes can be further broken down into 2 groups based upon the type of stem cells that produces them: myeloid stem cells and lymphoid stem cells.

Myeloid Stem Cells

Myeloid stem cells produce monocytes and the granular leukocytes – ***eosinophils, basophils,*** and ***neutrophils***.

Monocytes are agranular leukocytes that can form 2 types of cells: macrophages and dendritic cells.

Macrophages. Monocytes respond slowly to infection and once present at the site of infection, develop into macrophages. Macrophages are ***phagocytes*** able to consume pathogens, destroyed cells, and ***debris*** by ***phagocytosis***. As such, they have a role in both preventing infection as well as cleaning up the aftermath of an infection.

Dendritic cells. Monocytes also develop into dendritic cells in healthy tissues of the skin and mucous membranes. Dendritic cells are responsible for the detection of pathogenic antigens which are used to activate T cells and B cells.

Granular Leukocytes include the following:

Eosinophils. Eosinophils are granular leukocytes that reduce allergic inflammation and help the body fight off parasites.

Basophils. Basophils are granular leukocytes that trigger inflammation by releasing the chemicals heparin and histamine. Basophils are active in producing inflammation during allergic reactions and parasitic infections.

Neutrophils. Neutrophils are granular leukocytes that act as the first responders to the site of an infection. Neutrophils use chemotaxis to detect chemicals produced by infectious agents and quickly move to the site of infection. Once there, neutrophils ingest the pathogens via phagocytosis and release chemicals to trap and kill the pathogens.

Lymphoid Stem Cells

Lymphoid stem cells produce T lymphocytes and B lymphocytes.

T lymphocytes. T lymphocytes, also commonly known as T cells, are cells involved in fighting specific pathogens in the body. T cells may act as helpers of other immune cells or attack pathogens directly. After an infection, memory T cells persist in the body to provide a faster reaction to ***subsequent infection*** by pathogens expressing the same ***antigen.***

B lymphocytes. B lymphocytes, also commonly known as B cells, are also cells involved in fighting specific pathogens in the body. Once B cells have been activated by contact with a pathogen, they form plasma cells that produce antibodies. Antibodies then neutralize the pathogens until other immune cells can destroy them. After an infection, memory B cells persist in the body to quickly produce antibodies to subsequent infection by pathogens expressing the same antigen.

Natural killer cells. Natural killer cells, also known as NK cells, are lymphocytes that are able to respond to a wide range of pathogens and cancerous cells. NK cells travel within the blood and are found in the lymph nodes, spleen, and red bone marrow where they fight most types of infection.

Lymph Capillaries

As blood passes through the tissues of the body, it enters thin-walled capillaries to facilitate diffusion of nutrients, gases, and wastes. Blood plasma also diffuses through the thin

capillary walls and penetrates into the spaces between the cells of the tissues. Some of this plasma diffuses back into the blood of the capillaries, but a considerable portion becomes embedded in the tissues as ***interstitial fluid***. To prevent the accumulation of excess fluids, small dead-end vessels called lymphatic capillaries extend into the tissues to absorb fluids and return them to circulation.

Lymph

The interstitial fluid picked up by lymphatic capillaries is known as lymph. Lymph very closely resembles the plasma found in the veins: it is a mixture of about 90% water and 10% solutes such as proteins, cellular waste products, dissolved gases, and hormones. Lymph may also contain bacterial cells that are picked up from diseased tissues and the white blood cells that fight these pathogens. In late-stage cancer patients, lymph often contains cancerous cells that have metastasized from tumors and may form new tumors within the lymphatic system. A special type of lymph, known as chyle, is produced in the digestive system as lymph absorbs triglycerides from the intestinal villi. Due to the presence of triglycerides, chyle has a milky white coloration to it.

Lymphatic Vessels

Lymphatic capillaries merge together into larger lymphatic vessels to carry lymph through the body. The structure of lymphatic vessels closely resembles that of veins: they both have thin walls and many check valves due to their shared function of carrying fluids under low pressure. Lymph is transported through lymphatic vessels by the skeletal muscle pump – contractions of skeletal muscles constrict the vessels to push the fluid forward. ***Check valves*** prevent the fluid from flowing back toward the lymphatic capillaries.

Lymph Nodes

Lymph nodes are small, kidney-shaped organs of the lymphatic system. There are several hundred lymph nodes found mostly throughout the thorax and abdomen of the body with the highest concentrations in the axillary (armpit) and inguinal (groin) regions. The outside of each lymph node is made of a dense ***fibrous connective tissue capsule***. Inside the capsule, the lymph node is filled with ***reticular tissue*** containing many lymphocytes and macrophages. The lymph

nodes function as filters of lymph that enters from several afferent lymph vessels. The reticular fibers of the lymph node act as a net to catch any debris or cells that are present in the lymph. Macrophages and lymphocytes attack and kill any microbes caught in the reticular fibers. Efferent lymph vessels then carry the filtered lymph out of the lymph node and towards the lymphatic ducts.

Lymphatic Ducts

All of the lymphatic vessels of the body carry lymph toward the 2 lymphatic ducts: the ***thoracic duct*** and the ***right lymphatic ducts***. These ducts serve to return lymph back to the venous blood supply so that it can be circulated as plasma.

Thoracic duct. The thoracic duct connects the lymphatic vessels of the legs , abdomen, left arm, and the left side of the head, neck, and thorax to the left brachiocephalic vein.

Right lymphatic duct. The right lymphatic duct connects the lymphatic vessels of the right arm and the right side of the head, neck, and thorax to the right brachiocephalic vein.

Lymphatic Nodules

Outside of the system of lymphatic vessels and lymph nodes, there are masses of non-encapsulated lymphatic tissue known as lymphatic nodules. The lymphatic nodules are associated with the mucous membranes of the body, where they work to protect the body from pathogens entering the body through open body cavities.

Tonsils. There are 5 tonsils in the body – 2 ***lingual,*** 2 ***palatine***, and 1 ***pharyngeal. The lingual tonsils*** are located at the posterior root of the tongue near the pharynx. ***The palatine tonsils*** are in the posterior region of the mouth near the pharynx. ***The pharyngeal pharynx***, also known as the adenoid, is found in the nasopharynx at the posterior end of the nasal cavity. The tonsils contain many T and B cells to protect the body from inhaled or ingested substances. The tonsils often become inflamed in response to an infection.

Peyer's patches. Peyer's patches are small masses of lymphatic tissue found in the ileum of the small intestine. Peyer's patches contain T and B cells that monitor the contents of the intestinal lumen for pathogens. Once the antigens of a pathogen are detected, the T and B cells spread and prepare the body to fight a possible infection.

Spleen. The spleen is a flattened, oval-shaped organ located in the upper left quadrant of the abdomen lateral to the stomach. The spleen is made up of a dense fibrous connective tissue capsule filled with regions known as ***red and white pulp***. Red pulp, which makes up most of the spleen's mass, is so named because it contains many sinuses that filter the blood. Red pulp contains reticular tissues whose fibers filter worn out or damaged red blood cells from the blood. Macrophages in the red pulp digest and recycle the hemoglobin of the captured red blood cells. The red pulp also stores many platelets to be released in response to blood loss. White pulp is found within the red pulp surrounding the arterioles of the spleen. It is made of lymphatic tissue and contains many T cells, B cells, and macrophages to fight off infections.

Thymus. The thymus is a small, triangular organ found just posterior to the sternum and anterior to the heart. The thymus is mostly made of glandular epithelium and hematopoietic connective tissues. The thymus produces and trains T cells during fetal development and childhood. T cells formed in the thymus and red bone marrow mature, develop, and reproduce in the thymus throughout childhood. The vast majority of T cells do not survive their training in the thymus and are destroyed by macrophages. The surviving T cells spread throughout the body to the other lymphatic tissues to fight infections. By the time a person reaches puberty, the immune system is mature and the role of the thymus is diminished. After puberty, the inactive thymus is slowly replaced by adipose tissue.

Immune and Lymphatic System Physiology

Lymph Circulation

One of the primary functions of the lymphatic system is the movement of interstitial fluid from the tissues to the circulatory system. Like the veins of the circulatory system, lymphatic capillaries and vessels move lymph with very little pressure to help with circulation. To help move lymph towards the lymphatic ducts, there is a series of many one-way check valves found throughout the lymphatic vessels. These check valves allow lymph to move toward the lymphatic ducts and close when lymph attempts to flow away from the ducts. In the limbs, skeletal muscle contraction squeezes the walls of ***lymphatic vessels*** to push lymph through the valves and towards the thorax. In the trunk, the diaphragm pushes down into the abdomen during

inhalation. This increased abdominal pressure pushes lymph into the less pressurized thorax. The pressure gradient reverses during exhalation, but the check valves prevent lymph from being pushed backwards.

Transport of Fatty Acids

Another major function of the lymphatic system is the transportation of fatty acids from the digestive system. The digestive system breaks large macromolecules of carbohydrates, proteins, and lipids into smaller nutrients that can be absorbed through ***the villi of the intestinal wall***. Most of these nutrients are absorbed directly into the bloodstream, but most fatty acids, the building blocks of fats, are absorbed through the lymphatic system.

In the villi of the small intestine are lymphatic capillaries called ***lacteals.*** Lacteals are able to absorb fatty acids from the intestinal epithelium and transport them along with lymph. The fatty acids turn the lymph into a white, milky substance called ***chyle***. Chyle is transported through lymphatic vessels to the thoracic duct where it enters the bloodstream and travels to the liver to be metabolized.

Types of Immunity

The body employs many different types of immunity to protect itself from infection from a seemingly endless supply of pathogens. These defenses may be external and prevent pathogens from entering the body. Conversely, internal defenses fight pathogens that have already entered the body. Among the internal defenses, some are specific to only one pathogen or may be innate and defend against many pathogens. Some of these specific defenses can be acquired to preemptively prevent an infection before a pathogen enters the body.

The body has many innate ways to defend itself against a broad spectrum of pathogens. These defenses may be external or internal defenses.

External defenses include the following:

The coverings and linings of the body constantly prevent infections before they begin by barring pathogens from entering the body. Epidermal cells are constantly growing, dying, and shedding to provide a renewed physical barrier to pathogens.

Secretions like ***sebum, cerumen, mucus, tears***, and ***saliva*** are used to trap, move, and sometimes even kill bacteria that settle on or in the body. Stomach acid acts as a chemical barrier to kill microbes found on food entering the body. Urine and acidic vaginal secretions also help to kill and remove pathogens that attempt to enter the body.

The flora of naturally occurring ***beneficial bacteria*** that live on and in our bodies provide a layer of protection from harmful microbes that would seek to colonize our bodies for themselves.

Internal defenses include fever, inflammation, natural killer cells, and phagocytes. Let's explore internal defenses in greater detail.

Fever

In response to an infection, the body may start a fever by raising its internal temperature out of its normal homeostatic range. Fevers help to speed up the body's response system to an infection while at the same time slowing the reproduction of the pathogen.

Inflammation

The body may also start an inflammation in a region of the body to stop the spread of the infection. Inflammations are the result of a localized vasodilation that allows extra blood to flow into the infected region. The extra blood flow speeds the arrival of ***leukocytes*** to fight the infection. The enlarged blood vessel allows fluid and cells to leak out of the blood vessel to cause swelling and the movement of leukocytes into the tissue to fight the infection.

Natural Killer Cells

Natural killer (NK) cells are special lymphocytes that are able to recognize and kill ***virus-infected cells*** and ***tumor cells.*** NK cells check the surface markers on the surface of the body's cells, looking for cells that are lacking the correct number of markers due to disease. The NK cells then kill these cells before they can spread infection or cancer.

Phagocytes

The term *phagocyte* means "eating cell" and refers to a group of cell types including ***neutrophils*** and ***macrophages***. A phagocyte engulfs pathogens with its cell membrane before

using digestive enzymes to kill and dissolve the cell into its chemical parts. Phagocytes are able to recognize and consume many different types of cells, including dead or damaged body cells.

Cell-mediated Specific Immunity

When a pathogen infects the body, it often encounters macrophages and dendritic cells of the innate immune system. These cells can become ***antigen-presenting cells (APCs)*** by consuming and processing pathogenic antigens. The APCs travel into the lymphatic system carrying these antigens to be presented to the T cells and B cells of the specific immune system.

Inactive T cells are found in lymphatic tissue awaiting infection by a pathogen. Certain T cells have antigen receptors that recognize the pathogen but do not reproduce until they are triggered by an APC. The activated T cell begins reproducing very quickly to form an army of active T cells that spread through the body and fight the pathogen. ***Cytotoxic T cells*** directly attach to and kill pathogens and virus-infected cells using powerful toxins. Helper T cells assist in the immune response by stimulating the response of B cells and macrophages.

After an infection has been fought off, memory T cells remain in the lymphatic tissue waiting for a new infection by cells presenting the same antigen. The response by memory T cells to the antigen is much faster than that of the inactive T cells that fought the first infection. The increase in T cell reaction speed leads to immunity – the reintroduction of the same pathogen is fought off so quickly that there are few or no symptoms. This immunity may last for years or even an entire lifetime.

Antibody-mediated Specific Immunity

During an infection, the APCs that travel to the lymphatic system to stimulate T cells also stimulate B cells. B cells are lymphocytes that are found in lymphatic tissues of the body that produce antibodies to fight pathogens (instead of traveling through the body themselves). Once a B cell has been contacted by an APC, it processes the antigen to produce an MHC-antigen complex. Helper T cells present in the lymphatic system bind to the MHC-antigen complex to stimulate the B cell to become active. The active B cell begins to reproduce and produce 2 types of cells: plasma cells and memory B cells.

Plasma cells become antibody factories producing thousands of antibodies.

Memory B cells reside in the lymphatic system where they help to provide immunity by preparing for later infection by the same antigen-presenting pathogen.

Antibodies are proteins that are specific to and bind to a particular antigen on a cell or virus. Once antibodies have latched on to a cell or virus, they make it harder for their target to move, reproduce, and infect cells. Antibodies also make it easier and more appealing for phagocytes to consume the pathogen.

Acquired Immunity

Under most circumstances, immunity is developed throughout a lifetime by the accumulation of memory T and B cells after an infection. There are a few ways that immunity can be acquired without exposure to a pathogen. Immunization is the process of introducing antigens from a virus or bacterium to the body so that memory T and B cells are produced to prevent an actual infection. Most immunizations involve the injection of bacteria or viruses that have been inactivated or weakened. Newborn infants can also acquire some temporary immunity from infection thanks to antibodies that are passed on from their mother. Some antibodies are able to cross the placenta from the mother's blood and enter the infant's bloodstream. Other antibodies are passed through breast milk to protect the infant.

Text 2.

Nervous System Anatomy

Nervous Tissue

The majority of the nervous system is tissue made up of two classes of cells: neurons and neuroglia.

Neurons

Neurons, also known as ***nerve cells***, communicate within the body by transmitting electrochemical signals. Neurons look quite different from other cells in the body due to the many long cellular processes that extend from their central cell body. The cell body is the roughly round part of a neuron that contains the nucleus, mitochondria, and most of the cellular organelles. Small tree-like structures called ***dendrites*** extend from the cell body to pick up stimuli from the

environment, other neurons, or sensory receptor cells. Long transmitting processes called ***axons*** extend from the cell body to send signals onward to other neurons or effector cells in the body.

There are 3 basic classes of neurons: ***afferent neurons, efferent neurons,*** and ***interneurons***.

Afferent neurons. Also known as sensory neurons, afferent neurons transmit sensory signals to the central nervous system from receptors in the body.

Efferent neurons. Also known as motor neurons, efferent neurons transmit signals from the central nervous system to effectors in the body such as muscles and glands.

Interneurons. Interneurons form complex networks within the central nervous system to integrate the information received from afferent neurons and to direct the function of the body through efferent neurons.

Neuroglia

Neuroglia, also known as glial cells, act as the "helper" cells of the nervous system. Each neuron in the body is surrounded by anywhere from 6 to 60 ***neuroglia*** that protect, feed, and insulate the neuron. Because neurons are extremely specialized cells that are essential to body function and almost never reproduce, neuroglia are vital to maintaining a functional nervous system.

Brain

The ***brain***, a soft, wrinkled organ that weighs about 3 pounds, is located inside the cranial cavity, where the ***bones of the skull*** surround and protect it. The approximately 100 billion neurons of the brain form the main control center of the body. The brain and spinal cord together form the ***central nervous system (CNS)***, where information is processed and responses originate. The brain, the seat of higher mental functions such as consciousness, memory, planning, and voluntary actions, also controls lower body functions such as the maintenance of respiration, heart rate, blood pressure, and digestion.

Spinal Cord

The ***spinal cord*** is a long, thin mass of bundled neurons that carries information through the vertebral cavity of the spine beginning at the ***medulla oblongata*** of the brain on its superior

end and continuing inferiorly to the lumbar region of the spine. In the lumbar region, the spinal cord separates into a bundle of individual nerves called the ***cauda equina*** (due to its resemblance to a horse's tail) that continues inferiorly to the ***sacrum*** and ***coccyx***. The white matter of the spinal cord functions as the main conduit of nerve signals to the body from the brain. The grey matter of the spinal cord integrates reflexes to stimuli.

Nerves

Nerves are ***bundles of axons*** in the ***peripheral nervous system (PNS)*** that act as information highways to carry signals between the brain and spinal cord and the rest of the body. Each axon is wrapped in a connective tissue sheath called the ***endoneurium***. Individual axons of the nerve are bundled into groups of axons called ***fascicles***, wrapped in a sheath of connective tissue called ***the perineurium***. Finally, many fascicles are wrapped together in another layer of connective tissue called the epineurium to form a whole nerve. The wrapping of nerves with connective tissue helps to protect the axons and to increase the speed of their communication within the body.

Afferent, Efferent, and ***Mixed Nerves***. Some of the nerves in the body are specialized for carrying information in only one direction, similar to a one-way street. Nerves that carry information from sensory receptors to the central nervous system only are called ***afferent nerves***. Other neurons, known as efferent nerves, carry signals only from the central nervous system to effectors such as muscles and glands. Finally, some nerves are mixed nerves that contain both afferent and efferent axons. Mixed nerves function like 2-way streets where afferent axons act as lanes heading toward the central nervous system and efferent axons act as lanes heading away from the central nervous system.

Cranial Nerves. Extending from the inferior side of the brain are 12 pairs of cranial nerves. Each cranial nerve pair is identified by a Roman numeral 1 to 12 based upon its location along the anterior-posterior axis of the brain. Each nerve also has a descriptive name (e.g. olfactory, optic, etc.) that identifies its function or location. ***The cranial nerves*** provide a direct connection to the brain for the special sense organs, muscles of the head, neck, and shoulders, the heart, and the GI tract.

Spinal Nerves. Extending from the left and right sides of the spinal cord are 31 pairs of spinal nerves. The ***spinal nerves*** are mixed nerves that carry both sensory and motor signals between the spinal cord and specific regions of the body. The 31 spinal nerves are split into 5 groups named for the 5 regions of the vertebral column. Thus, there are 8 pairs of cervical nerves, 12 pairs of ***thoracic nerves***, 5 pairs of ***lumbar nerves***, 5 pairs of ***sacral nerves,*** and 1 pair of ***coccygeal nerves***. Each spinal nerve exits from the spinal cord through the intervertebral foramen between a pair of vertebrae or between the ***C1*** vertebra and the ***occipital bone*** of the skull.

Meninges

The meninges are the protective coverings of the central nervous system (CNS). They consist of three layers: ***the dura mater, arachnoid mater, and pia mater.***

Dura mater. The ***dura mater***, which means "tough mother," is the thickest, toughest, and most superficial layer of meninges. Made of dense irregular connective tissue, it contains many tough collagen fibers and blood vessels. Dura mater protects the CNS from external damage, contains the cerebrospinal fluid that surrounds the CNS, and provides blood to the nervous tissue of the CNS.

Arachnoid mater. The ***arachnoid mater***, which means "spider-like mother," is much thinner and more delicate than the dura mater. It lines the inside of the dura mater and contains many thin fibers that connect it to the underlying pia mater. These fibers cross a fluid-filled space called the subarachnoid space between the arachnoid mater and the pia mater.

Pia mater. The pia mater, which means "tender mother," is a thin and delicate layer of tissue that rests on the outside of the brain and spinal cord. Containing many blood vessels that feed the nervous tissue of the CNS, the pia mater penetrates into the valleys of the sulci and fissures of the brain as it covers the entire surface of the CNS.

Cerebrospinal Fluid

The space surrounding the organs of the CNS is filled with a clear fluid known as ***cerebrospinal fluid (CSF)***. CSF is formed from blood plasma by special structures called ***choroid plexuses***. The choroid plexuses contain many capillaries lined with ***epithelial tissue*** that filters blood plasma and allows the filtered fluid to enter the space around the brain.

Newly created CSF flows through the inside of the brain in hollow spaces called ventricles and through a small cavity in the middle of the spinal cord called the central canal. CSF also flows through the subarachnoid space around the outside of the brain and spinal cord. CSF is constantly produced at the choroid plexuses and is reabsorbed into the bloodstream at structures called arachnoid villi.

Cerebrospinal fluid provides several vital functions to the central nervous system:

CSF absorbs shocks between the brain and skull and between the spinal cord and vertebrae. This shock absorption protects the CNS from blows or sudden changes in velocity, such as during a car accident.

The brain and spinal cord float within the CSF, reducing their apparent weight through buoyancy. The brain is a very large but soft organ that requires a high volume of blood to function effectively. The reduced weight in ***cerebrospinal fluid*** allows the blood vessels of the brain to remain open and helps protect the nervous tissue from becoming crushed under its own weight.

CSF helps to maintain ***chemical homeostasis*** within the central nervous system. It contains ions, nutrients, oxygen, and albumins that support the chemical and osmotic balance of nervous tissue. CSF also removes waste products that form as byproducts of cellular metabolism within nervous tissue.

Sense Organs

All of the bodies' many sense organs are components of the nervous system. What are known as the special senses – vision, taste, smell, hearing, and balance – are all detected by specialized organs such as the eyes, ***taste buds***, and ***olfactory epithelium***. Sensory receptors for the general senses like touch, temperature, and pain are found throughout most of the body. All of the sensory receptors of the body are connected to afferent neurons that carry their sensory information to the CNS to be processed and integrated.

Nervous System Physiology

Functions of the Nervous System

The nervous system has 3 main functions: sensory, integration, and motor.

Sensory. The sensory function of the nervous system involves collecting information from sensory receptors that monitor the body's internal and external conditions. These signals are then passed on to the central nervous system (CNS) for further processing by afferent neurons (and nerves).

Integration. The process of integration is the processing of the many sensory signals that are passed into the CNS at any given time. These signals are evaluated, compared, used for decision making, discarded or committed to memory as deemed appropriate. Integration takes place in the gray matter of the brain and spinal cord and is performed by interneurons. Many **interneurons** work together to form complex networks that provide this processing power.

Motor. Once the networks of interneurons in the CNS evaluate sensory information and decide on an action, they stimulate efferent neurons. ***Efferent neurons*** (also called motor neurons) carry signals from the gray matter of the CNS through the nerves of the peripheral nervous system to effector cells. ***The effector*** may be smooth, cardiac, or skeletal muscle tissue or glandular tissue. The effector then releases a hormone or moves a part of the body to respond to the stimulus.

Unfortunately of course, our nervous system doesn't always function as it should. Sometimes this is the result of diseases like ***Alzheimer's*** and ***Parkinson's*** disease.

Divisions of the Nervous System

Central Nervous System

The brain and ***spinal cord*** together form the central nervous system, or CNS. The CNS acts as the control center of the body by providing its processing, memory, and regulation systems. The CNS takes in all of the conscious and subconscious sensory information from the body's sensory receptors to stay aware of the body's internal and external conditions. Using this sensory information, it makes decisions about both conscious and subconscious actions to take to maintain the body's homeostasis and ensure its survival. The CNS is also responsible for the higher functions of the nervous system such as language, creativity, expression, emotions, and personality. The brain is the seat of consciousness and determines who we are as individuals.

Peripheral Nervous System

The peripheral nervous system (PNS) includes all of the parts of the nervous system outside of the brain and spinal cord. These parts include all of the ***cranial and spinal nerves, ganglia,*** and ***sensory receptors.***

Somatic Nervous System

The somatic nervous system (SNS) is a division of the PNS that includes all of the voluntary efferent neurons. The SNS is the only consciously controlled part of the PNS and is responsible for stimulating skeletal muscles in the body.

Autonomic Nervous System

The autonomic nervous system (ANS) is a division of the PNS that includes all of the involuntary efferent neurons. The ANS controls subconscious effectors such as visceral muscle tissue, cardiac muscle tissue, and glandular tissue.

There are 2 divisions of the autonomic nervous system in the body: ***the sympathetic and parasympathetic divisions.***

Sympathetic. The sympathetic division forms the body's "fight or flight" response to stress, danger, excitement, exercise, emotions, and embarrassment. The sympathetic division increases respiration and heart rate, releases adrenaline and other stress hormones, and decreases digestion to cope with these situations.

Parasympathetic. The parasympathetic division forms the body's "rest and digest" response when the body is relaxed, resting, or feeding. The parasympathetic works to undo the work of the sympathetic division after a stressful situation. Among other functions, the parasympathetic division works to decrease respiration and heart rate, increase digestion, and permit the elimination of wastes.

Enteric Nervous System

The enteric nervous system (ENS) is the division of the ANS that is responsible for regulating digestion and the function of the digestive organs. The ENS receives signals from the central nervous system through both the sympathetic and parasympathetic divisions of the autonomic nervous system to help regulate its functions. However, the ENS mostly works independently of the CNS and continues to function without any outside input. For this reason,

the ENS is often called the "brain of the gut" or the body's "second brain." The ENS is an immense system – almost as many neurons exist in the ENS as in the spinal cord.

Action Potentials

Neurons function through the generation and propagation of electrochemical signals known as action potentials (APs). An AP is created by the movement of ***sodium*** and ***potassium ions*** through the membrane of neurons.

Resting Potential. At rest, neurons maintain a concentration of sodium ions outside of the cell and potassium ions inside of the cell. This concentration is maintained by the ***sodium-potassium pump*** of the cell membrane which pumps ***3 sodium ions*** out of the cell for every 2 potassium ions that are pumped into the cell. The ion concentration results in a resting electrical potential of -70 millivolts (mV), which means that the inside of the cell has a negative charge compared to its surroundings.

Threshold Potential. If a stimulus permits enough positive ions to enter a region of the cell to cause it to reach -55 mV, that region of the cell will open its voltage-gated sodium channels and allow sodium ions to diffuse into the cell. -55 mV is the threshold potential for neurons as this is the "trigger" voltage that they must reach to cross the threshold into forming an action potential.

Depolarization. Sodium carries a positive charge that causes the cell to become depolarized (positively charged) compared to its normal negative charge. The voltage for depolarization of all neurons is +30 mV. The depolarization of the cell is the AP that is transmitted by the neuron as a nerve signal. The positive ions spread into neighboring regions of the cell, initiating a new AP in those regions as they reach -55 mV. The AP continues to spread down the cell membrane of the neuron until it reaches the end of an axon.

Repolarization. After the depolarization voltage of +30 mV is reached, voltage-gated potassium ion channels open, allowing positive potassium ions to diffuse out of the cell. The loss of potassium along with the pumping of sodium ions back out of the cell through the sodium-potassium pump restores the cell to the -55 mV resting potential. At this point the neuron is ready to start a new action potential.

Synapses

A synapse is the junction between a neuron and another cell. Synapses may form between 2 neurons or between a neuron and an effector cell. There are two types of synapses found in the body: ***chemical synapses*** and ***electrical synapses***.

Chemical synapses. At the end of ***a neuron's axon*** is an enlarged region of the axon known as ***the axon terminal***. The axon terminal is separated from the next cell by a small gap known as the synaptic cleft. When an AP reaches the axon terminal, it opens ***voltage-gated calcium ion channels***. Calcium ions cause ***vesicles*** containing chemicals known as ***neurotransmitters (NT)*** to release their contents by exocytosis into the synaptic cleft. The NT molecules cross the synaptic cleft and bind to receptor molecules on the cell, forming a synapse with the neuron. These receptor molecules open ion channels that may either stimulate the receptor cell to form a new action potential or may inhibit the cell from forming an action potential when stimulated by another neuron.

Electrical synapses. Electrical synapses are formed when 2 neurons are connected by small holes called ***gap junctions***. The gap junctions allow electric current to pass from one neuron to the other, so that an AP in one cell is passed directly on to the other cell through the synapse.

Myelination

The axons of many neurons are covered by a coating of insulation known as ***myelin*** to increase the speed of nerve conduction throughout the body. Myelin is formed by 2 types of ***glial cells: Schwann cells*** in the PNS and ***oligodendrocytes*** in the CNS. In both cases, the glial cells wrap their plasma membrane around the axon many times to form a thick covering of lipids. The development of these myelin sheaths is known as myelination.

Myelination speeds up the movement of APs in the axon by reducing the number of APs that must form for a signal to reach the end of an axon. The myelination process begins speeding up nerve conduction in fetal development and continues into early adulthood. Myelinated axons appear white due to the presence of lipids and form the white matter of the inner brain and outer spinal cord. White matter is specialized for carrying information quickly through the brain and

spinal cord. The gray matter of the brain and spinal cord are the unmyelinated integration centers where information is processed.

Reflexes

Reflexes are fast, involuntary responses to stimuli. The most well known reflex is the ***patellar reflex***, which is checked when a physicians taps on a patient's knee during a physical examination. Reflexes are integrated in the gray matter of the spinal cord or in the brain stem. Reflexes allow the body to respond to stimuli very quickly by sending responses to effectors before the nerve signals reach the conscious parts of the brain. This explains why people will often pull their hands away from a hot object before they realize they are in pain.

Functions of the Cranial Nerves

Each of the 12 ***cranial nerves*** has a specific function within the nervous system.

The olfactory nerve (I) carries scent information to the brain from the olfactory epithelium in the roof of the nasal cavity.

The optic nerve (II) carries visual information from the eyes to the brain.

Oculomotor, trochlear, and abducens nerves (III, IV, and VI) all work together to allow the brain to control the movement and focus of the eyes. The ***trigeminal nerve*** (V) carries sensations from the face and innervates the muscles of mastication.

The facial nerve (VII) innervates the muscles of the face to make facial expressions and carries taste information from the anterior 2/3 of the tongue.

The vestibulocochlear nerve (VIII) conducts auditory and balance information from the ears to the brain.

The glossopharyngeal nerve (IX) carries taste information from the posterior 1/3 of the tongue and assists in swallowing.

The vagus nerve (X), sometimes called the wandering nerve due to the fact that it innervates many different areas, "wanders" through the head, neck, and torso. It carries information about the condition of the vital organs to the brain, delivers motor signals to control speech and delivers parasympathetic signals to many organs.

The accessory nerve (XI) controls the movements of the shoulders and neck.

The hypoglossal nerve (XII) moves the tongue for speech and swallowing.

Sensory Physiology

All sensory receptors can be classified by their structure and by the type of stimulus that they detect. Structurally, there are 3 classes of sensory receptors: ***free nerve endings, encapsulated nerve endings, and specialized cells***. ***Free nerve endings*** are simply free dendrites at the end of a neuron that extend into a tissue. Pain, heat, and cold are all sensed through free nerve endings. ***An encapsulated nerve*** ending is a free nerve ending wrapped in a round capsule of connective tissue. When the capsule is deformed by touch or pressure, the neuron is stimulated to send signals to the CNS. ***Specialized cells*** detect stimuli from the 5 special senses: vision, hearing, balance, smell, and taste. Each of the special senses has its own unique sensory cells—such as rods and cones in the retina to detect light for the sense of vision.

Functionally, there are 6 major classes of receptors: mechanoreceptors, nociceptors, photoreceptors, chemoreceptors, osmoreceptors, and thermoreceptors.

Mechanoreceptors. Mechanoreceptors are sensitive to mechanical stimuli like touch, pressure, vibration, and blood pressure.

Nociceptors. Nociceptors respond to stimuli such as extreme heat, cold, or tissue damage by sending pain signals to the CNS.

Photoreceptors. Photoreceptors in the retina detect light to provide the sense of vision.

Chemoreceptors. Chemoreceptors detect chemicals in the bloodstream and provide the senses of taste and smell.

Osmoreceptors. Osmoreceptors monitor the osmolarity of the blood to determine the body's hydration levels.

Thermoreceptors. Thermoreceptors detect temperatures inside the body and in its surroundings.

1. Answer the following questions.

1. What is produced by red bone marrow?
2. What types of cells do monocytes form?

3. What do granular leukocytes produce?

4. What are T lymphocytes?

5. What is the difference between Thoracic and Right lymphatic ducts?

6. What is one of the primary functions of the lymphatic system?

7. What do Memory B cells do*?*

8. What are the neurons?

9. What are the three types of neurons?

10. What are meninges?

2. Fill in the blanks with the appropriate words from the box.

myelination *action potentials* *trabeculae of spongy bone* *lymph* *somatic nervous system (SNS)* *spleen* *basophils*

1. The interstitial fluid picked up by lymphatic capillaries is known as _____.

2. _____ speeds up the movement of APs in the axon by reducing the number of APs that must form for a signal to reach the end of an axon.

3. Neurons function through the generation and propagation of electrochemical signals known as _____ .

4. The _____ is a flattened, oval-shaped organ located in the upper left quadrant of the abdomen lateral to the stomach.

5. The _____is a division of the PNS that includes all of the voluntary efferent neurons.

6. _____are granular leukocytes that trigger inflammation by releasing the chemicals heparin and histamine.

7. Red bone marrow is a highly vascular tissue found in the spaces between _____ .

3. Translate the following sentences into English.

1. Червоний кістковий мозок - це кровотворна тканина, що містить багато стовбурових клітин, які виробляють клітини крові.
2. Такі виділення, як шкірне сало, себум, слиз, сльози та слина, використовуються для уловлювання, переміщення, а іноді навіть для знищення бактерій, які осідають на тілі чи в тілі.
3. Після боротьби з інфекцією Т-клітини пам'яті залишаються в лімфатичній тканині, чекаючи нової інфекції клітинами, що представляють той самий антиген.
4. Електричні синапси утворюються, коли 2 нейрони з'єднуються невеликими отворами, які називаються щілинними з'єднаннями.
5. Червона пульпа, яка складає більшу частину маси селезінки, названа так тому, що містить багато пазух, які фільтрують кров.
6. Невеликі деревоподібні структури, які називаються дендритами, простягаються від тіла клітини, щоб уловлювати подразники з навколишнього середовища, інших нейронів або сенсорних рецепторних клітин.
7. Те, що відоме як особливі органи чуття — зір, смак, нюх, слух і рівновагу — виявляються спеціалізованими органами, такими як очі, смакові рецептори та епітелій нюху.

4. Fill in the blanks with the appropriate words below.

Peyer's patches
arachnoid mater
choroid plexus
dendritic cells
an action potential

1. an _____ occurs when the membrane potential of a specific cell location rapidly rises and falls: this depolarization then causes adjacent locations to similarly depolarize.

2. The _____ is one of the three meninges, the protective membranes that cover the brain and spinal cord.

3. _____ are a type of antigen-presenting cell (APC) that form an important role in the adaptive immune system. The main function of dendritic cells is to present antigens and the cells are therefore sometimes referred to as “professional” APCs.

4. _____ are groupings of lymphoid follicles in the mucus membrane that lines your small intestine.

5. The _____-, or plica choroidea, is a plexus of cells that arises from the tela choroidea in each of the ventricles of the brain.

Text 2.1. Lymphatic disease

Lymphatic disease is a class of disorders which directly affect the components of the lymphatic system.

Diseases and disorder

Hodgkin's Disease/Hodgkin's Lymphoma Hodgkin lymphoma. This is a type of cancer of the lymphatic system. It can start almost anywhere in the body. It is believed to be caused by HIV, Epstein-Barr Syndrome, age, and family history. Symptoms include weight gain, fever, swollen lymph nodes, night sweats, itchy skin, fatigue, chest pain, coughing, or trouble swallowing.

Non-Hodgkin's Lymphoma

Lymphoma is usually malignant cancer. It is caused by the body producing too many abnormal white blood cells. It is not the same as Hodgkin's Disease. Symptoms usually include painless, enlarged lymph node or nodes in the neck, weakness, fever, weight loss, and anemia.

Lymphadenitis

Lymphadenitis is an infection of the lymph nodes usually caused by a virus, bacteria or fungi. Symptoms include redness or swelling around the lymph node.

Lymphangitis

Lymphangitis is an inflammation of the lymph vessels. Symptoms usually include swelling, redness, warmth, pain or red streaking around the affected area.

Lymphedema

Lymphedema is the chronic pooling of lymph fluid in the tissue. It usually starts in the feet or lower legs. It's also a side-effect of some surgical procedures.

Lymphocytosis

Lymphocytosis is a high lymphocyte count. It can be caused by an infection, blood cancer, lymphoma, or autoimmune disorders that are accompanied by chronic swelling.

Text 2. Disorders of the nervous system

Disorders of the nervous system may involve the following:

- **Vascular disorders**, such as stroke, transient ischemic attack (TIA), subarachnoid hemorrhage, subdural hemorrhage and hematoma, and extradural hemorrhage
- **Infections**, such as meningitis, encephalitis, polio, and epidural abscess
- **Structural disorders**, such as brain or spinal cord injury, Bell's palsy, cervical spondylosis, carpal tunnel syndrome, brain or spinal cord tumors, peripheral neuropathy, and Guillain-Barré syndrome
- **Functional disorders**, such as headache, epilepsy, dizziness, and neuralgia
- **Degeneration**, such as Parkinson disease, multiple sclerosis, amyotrophic lateral sclerosis (ALS), Huntington chorea, and Alzheimer disease

Signs and symptoms of nervous system disorders

The following are the most common general signs and symptoms of a nervous system disorder. However, each individual may experience symptoms differently. Symptoms may include:

- Persistent or sudden onset of a headache
- A headache that changes or is different
- Loss of feeling or tingling
- Weakness or loss of muscle strength
- Loss of sight or double vision
- Memory loss
- Impaired mental ability
- Lack of coordination
- Muscle rigidity
- Tremors and seizures
- Back pain which radiates to the feet, toes, or other parts of the body
- Muscle wasting and slurred speech
- New language impairment (expression or comprehension)

The symptoms of a nervous system disorder may look like other medical conditions or problems.

Healthcare providers who treat nervous system disorders

The best way to manage nervous system disorders is with the help of a team of healthcare providers. You may not need all members of the team at any given time. But it's good to know who they are and how they can help. Here is a list of some of the healthcare providers that may be involved in treating nervous system disorders:

- **Neurologist.** The medical healthcare providers who diagnose and treat nervous system disorders are called neurologists. Some neurologists treat acute strokes and cerebral aneurysms using endovascular techniques.
- **Neurosurgeon.** Surgeons who operate as a treatment team for nervous system disorders are called neurological surgeons or neurosurgeons.
- **Neuroradiologist and interventional radiologist.** This is a radiologist who specializes in diagnosing nervous system conditions using imaging and in treating nervous system conditions such as cerebral aneurysms, acute strokes, and vertebral fractures. This provider also does biopsies of certain tumors.
- **Psychologist.** Emotional problems such as anxiety, depression, mood swings, and irritability are common in nervous system disorders. Your psychologist can help. Psychologists may do testing to find out how much your disorder is affecting the way you think and feel. Psychologists also do talk therapy (counseling) to help you deal with the emotional effects caused by nervous system disorders.
- **Psychiatrist.** Like your psychologist, this team member deals with emotional and behavior symptoms caused by nervous system disorders. In most cases, talk therapy works best for these problems. But if you need medicines to treat symptoms such as depression or anxiety, this doctor can help.
- **Physiatrist.** Healthcare providers who work with people in the rehab (rehabilitation) process are called physiatrists.
- **Physical therapist.** This is a movement specialist who can help you move and walk well. In physical therapy, you can also work on painful or stiff muscles and joints.
- **Occupational therapist.** This provider helps you learn to handle your day-to-day activities. For example, you might have trouble doing tasks you need to do at work or at home. Your occupational therapist will help you find ways to adjust to any changes in your physical abilities.

- **Speech/language pathologist.** This provider specializes in communication, including cognitive communication. They also diagnose and treat swallowing problems.

5. Translate into English the following words from the text above.

втрата ваги ……..……

побічний ефект …….……..

субдуральний крововилив ……...

раптовий напад головного болю……..

нерозбірливе мовлення …….

терапія бесідою ……..

біопсія певних пухлин …… …….

6. Try to state the medical conditions described below.

1. It is a condition of localized swelling caused by a compromised lymphatic system. The lymphatic system functions as a critical portion of the body's immune system and returns interstitial fluid to the bloodstream. It is most frequently a complication of cancer treatment or parasitic infections, but it can also be seen in a number of genetic disorders. Though incurable and progressive, a number of treatments may improve symptoms. Tissues with lthis disease are at high risk of infection because the lymphatic system has been compromised.

2. It is an infection in one or more lymph nodes. When lymph nodes become infected, it's usually because an infection started somewhere else in your body. It can cause lymph nodes to become enlarged, red, or tender. Treatment may include antibiotics, and medications to control pain and fever.

3. It is a group of movement disorders that appear in early childhood Signs and symptoms vary among people and over time, but include poor coordination, stiff muscles, weak muscles, and tremors. There may be problems with sensation, vision, hearing, and speaking. Often, babies with this disorder do not roll over, sit, crawl or walk as early as other children of their age. Other symptoms include seizures and problems with thinking or reasoning, which each occur in about one-third of people with the disorder. While symptoms may get more noticeable over the first few years of life, underlying problems do not worsen over time.

7. Prepare the description of two endocrine and digestive disorders. Make the class guess what they are.

Text 1.

Anatomy of Respiratory System

1. Read the text.

Nose and Nasal Cavity

The ***nose and nasal cavity*** form the main external opening for the respiratory system and are the first section of the body's airway – the respiratory tract through which air moves. The nose is a structure of the face made of cartilage, bone, muscle, and skin that supports and protects the anterior portion of the nasal cavity. The nasal cavity is a hollow space within the nose and ***skull*** that is lined with ***hairs*** and ***mucus membrane***. The function of the nasal cavity is to warm, moisturize, and filter air entering the body before it reaches the lungs. Hairs and mucus lining the nasal cavity help to trap dust, mold, pollen and other environmental contaminants before they can reach the inner portions of the body. Air exiting the body through the nose returns moisture and heat to the nasal cavity before being exhaled into the environment.

Mouth

The mouth, also known as the *oral cavity*, is the secondary external opening for the respiratory tract. Most normal breathing takes place through the nasal cavity, but the oral cavity can be used to supplement or replace the nasal cavity's functions when needed. Because the pathway of air entering the body from the mouth is shorter than the pathway for air entering from the nose, the mouth does not warm and moisturize the air entering the lungs as well as the nose performs this function. The mouth also lacks the hairs and sticky mucus that filter air passing through the nasal cavity. The one advantage of breathing through the mouth is that its shorter distance and larger diameter allows more air to quickly enter the body.

Pharynx

The pharynx, also known as the throat, is a muscular funnel that extends from the posterior end of the nasal cavity to the superior end of the ***esophagus*** and larynx. The pharynx is divided

into 3 regions: the nasopharynx, oropharynx, and laryngopharynx. The ***nasopharynx*** is the superior region of the pharynx found in the posterior of the nasal cavity. Inhaled air from the nasal cavity passes into the nasopharynx and descends through the oropharynx, located in the posterior of the oral cavity. Air inhaled through the oral cavity enters the pharynx at the ***oropharynx***. The inhaled air then descends into the ***laryngopharynx***, where it is diverted into the opening of the larynx by the epiglottis. The ***epiglottis*** is a flap of elastic cartilage that acts as a switch between the trachea and the esophagus. Because the pharynx is also used to swallow food, the epiglottis ensures that air passes into the trachea by covering the opening to the esophagus. During the process of swallowing, the epiglottis moves to cover the trachea to ensure that food enters the esophagus and to prevent choking.

Larynx

The ***larynx***, also known as the voice box, is a short section of the airway that connects the laryngopharynx and the trachea. The larynx is located in the anterior portion of the neck, just inferior to the ***hyoid bone*** and superior to the trachea. Several cartilage structures make up the larynx and give it its structure. The epiglottis is one of the cartilage pieces of the larynx and serves as the cover of the larynx during swallowing. Inferior to the epiglottis is the ***thyroid cartilage***, which is often referred to as the Adam's apple as it is most commonly enlarged and visible in adult males. The ***thyroid*** holds open the anterior end of the larynx and protects the vocal folds. Inferior to the thyroid cartilage is the ring-shaped cricoid cartilage which holds the larynx open and supports its posterior end. In addition to cartilage, the larynx contains special structures known as vocal folds, which allow the body to produce the sounds of speech and singing. The vocal folds are folds of mucous membrane that vibrate to produce vocal sounds. The tension and vibration speed of the vocal folds can be changed to change the pitch that they produce.

Trachea

The trachea, or windpipe, is a 5-inch long tube made of C-shaped hyaline cartilage rings lined with pseudostratified ciliated columnar epithelium. The trachea connects the larynx to the bronchi and allows air to pass through the neck and into the thorax. The rings of cartilage making up the trachea allow it to remain open to air at all times. The open end of the cartilage rings faces

posteriorly toward the esophagus, allowing the esophagus to expand into the space occupied by the trachea to accommodate masses of food moving through the esophagus.

The main function of the trachea is to provide a clear airway for air to enter and exit the lungs. In addition, the epithelium lining the trachea produces mucus that traps dust and other contaminants and prevents it from reaching the lungs. Cilia on the surface of the epithelial cells move the mucus superiorly toward the pharynx where it can be swallowed and digested in the gastrointestinal tract.

Bronchi and Bronchioles

At the inferior end of the trachea, the airway splits into left and right branches known as the primary bronchi. The left and right bronchi run into each lung before branching off into smaller secondary bronchi. The secondary bronchi carry air into the lobes of the lungs – 2 in the left lung and 3 in the right lung. The secondary bronchi in turn split into many smaller tertiary bronchi within each lobe. The ***tertiary bronchi*** split into many smaller bronchioles that spread throughout the lungs. Each bronchiole further splits into many smaller branches less than a millimeter in diameter called terminal bronchioles. Finally, the millions of tiny terminal bronchioles conduct air to the alveoli of the lungs.

As the airway splits into the tree-like branches of the bronchi and bronchioles, the structure of the walls of the airway begins to change. The primary bronchi contain many C-shaped cartilage rings that firmly hold the airway open and give the bronchi a cross-sectional shape like a flattened circle or a letter D. As the bronchi branch into secondary and tertiary bronchi, the cartilage becomes more widely spaced and more smooth muscle and elastin protein is found in the walls. The bronchioles differ from the structure of the bronchi in that they do not contain any cartilage at all. The presence of smooth muscles and elastin allow the smaller bronchi and bronchioles to be more flexible and contractile.

The main function of the bronchi and bronchioles is to carry air from the trachea into the lungs. Smooth muscle tissue in their walls helps to regulate airflow into the lungs. When greater volumes of air are required by the body, such as during exercise, the smooth muscle relaxes to dilate the bronchi and bronchioles. The dilated airway provides less resistance to airflow and

allows more air to pass into and out of the lungs. The smooth muscle fibers are able to contract during rest to prevent hyperventilation. The bronchi and bronchioles also use the mucus and cilia of their epithelial lining to trap and move dust and other contaminants away from the lungs.

Lungs

The ***lungs*** are a pair of large, spongy organs found in the thorax lateral to the heart and superior to the diaphragm. Each lung is surrounded by a pleural membrane that provides the lung with space to expand as well as a negative pressure space relative to the body's exterior. The negative pressure allows the lungs to passively fill with air as they relax. The left and right lungs are slightly different in size and shape due to the heart pointing to the left side of the body. The left lung is therefore slightly smaller than the right lung and is made up of 2 lobes while the right lung has 3 lobes.

The interior of the lungs is made up of spongy tissues containing many capillaries and around 30 million tiny sacs known as ***alveoli***. The alveoli are cup-shaped structures found at the end of the terminal bronchioles and surrounded by capillaries. The alveoli are lined with thin simple squamous epithelium that allows air entering the alveoli to exchange its gases with the blood passing through the capillaries.

Muscles of Respiration

Surrounding the lungs are sets of muscles that are able to cause air to be inhaled or exhaled from the lungs. The principal muscle of respiration in the human body is the diaphragm, a thin sheet of skeletal muscle that forms the floor of the ***thorax***. When the diaphragm contracts, it moves inferiorly a few inches into the abdominal cavity, expanding the space within the thoracic cavity and pulling air into the lungs. Relaxation of the ***diaphragm*** allows air to flow back out the lungs during exhalation.

Between the ribs are many small ***intercostal muscles*** that assist the diaphragm with expanding and compressing the lungs. These muscles are divided into 2 groups: the internal intercostal muscles and the external intercostal muscles. The internal intercostal muscles are the deeper set of muscles and depress the ribs to compress the thoracic cavity and force air to be exhaled from the lungs. The external intercostals are found superficial to the internal intercostals

and function to elevate the ribs, expanding the volume of the thoracic cavity and causing air to be inhaled into the lungs.

Physiology of the Respiratory System

Pulmonary Ventilation

Pulmonary ventilation is the process of moving air into and out of the lungs to facilitate gas exchange. The respiratory system uses both a negative pressure system and the contraction of muscles to achieve pulmonary ventilation. The negative pressure system of the respiratory system involves the establishment of a negative pressure gradient between the alveoli and the external atmosphere. The ***pleural membrane*** seals the lungs and maintains the lungs at a pressure slightly below that of the atmosphere when the lungs are at rest. This results in air following the pressure gradient and passively filling the lungs at rest. As the lungs fill with air, the pressure within the lungs rises until it matches the atmospheric pressure. At this point, more air can be inhaled by the contraction of the diaphragm and the ***external intercostal muscles***, increasing the volume of the thorax and reducing the pressure of the lungs below that of the atmosphere again.

To exhale air, the diaphragm and external intercostal muscles relax while the internal intercostal muscles contract to reduce the volume of the thorax and increase the pressure within the thoracic cavity. The pressure gradient is now reversed, resulting in the exhalation of air until the pressures inside the lungs and outside of the body are equal. At this point, the elastic nature of the lungs causes them to recoil back to their resting volume, restoring the negative pressure gradient present during inhalation.

External Respiration

External respiration is the exchange of gases between the air filling the alveoli and the blood in the capillaries surrounding the walls of the alveoli. Air entering the lungs from the atmosphere has a higher partial pressure of oxygen and a lower partial pressure of carbon dioxide than does the blood in the capillaries. The difference in partial pressures causes the gases to diffuse passively along their pressure gradients from high to low pressure through the simple squamous epithelium lining of the alveoli. The net result of external respiration is the movement of oxygen from the air into the blood and the movement of carbon dioxide from the blood into

the air. The oxygen can then be transported to the body's tissues while carbon dioxide is released into the atmosphere during exhalation.

Internal Respiration

Internal respiration is the exchange of gases between the blood in capillaries and the tissues of the body. Capillary blood has a higher partial pressure of oxygen and a lower partial pressure of carbon dioxide than the tissues through which it passes. The difference in partial pressures leads to the diffusion of gases along their pressure gradients from high to low pressure through the endothelium lining of the capillaries. The net result of internal respiration is the diffusion of oxygen into the tissues and the diffusion of carbon dioxide into the blood.

Transportation of Gases

The 2 major respiratory gases, oxygen and carbon dioxide, are transported through the body in the blood. Blood plasma has the ability to transport some dissolved oxygen and carbon dioxide, but most of the gases transported in the blood are bonded to transport molecules. Hemoglobin is an important transport molecule found in red blood cells that carries almost 99% of the oxygen in the blood. ***Hemoglobin*** can also carry a small amount of carbon dioxide from the tissues back to the lungs. However, the vast majority of carbon dioxide is carried in the plasma as bicarbonate ion. When the partial pressure of carbon dioxide is high in the tissues, the enzyme carbonic anhydrase catalyzes a reaction between carbon dioxide and water to form carbonic acid. Carbonic acid then dissociates into hydrogen ion and bicarbonate ion. When the partial pressure of carbon dioxide is low in the lungs, the reactions reverse and carbon dioxide is liberated into the lungs to be exhaled.

Homeostatic Control of Respiration

Under normal resting conditions, the body maintains a quiet breathing rate and depth called eupnea. Eupnea is maintained until the body's demand for oxygen and production of carbon dioxide rises due to greater exertion. Autonomic chemoreceptors in the body monitor the partial pressures of oxygen and carbon dioxide in the blood and send signals to the respiratory center of the brain stem. The respiratory center then adjusts the rate and depth of breathing to return the blood to its normal levels of gas partial pressures.

Health Issues Affecting the Respiratory System

When something impairs our ability to exchange carbon dioxide for oxygen, this is obviously a serious problem. Many health problems can cause respiratory problems, from allergies and asthma to pneumonia and lung cancer. The causes of these issues are just as varied – among them, infection (bacterial or viral), environmental exposure (pollution or cigarette smoke, for instance), genetic inheritance or a combination of factors. Sometimes the onset is so gradual, we don't seek medical attention until the condition has advanced. Sometimes, as with the genetic disorder called alpha-1 antitrypsin deficiency (A1AD), symptoms gradually set in and are often under-diagnosed or misdiagnosed. ***DNA health testing*** can screen you for genetic risk of A1AD.

2. Answer the questions.

1. What are the parts of aesophagus?
2. What is the tertiary bronchi?
3. What are intercoastal muscles?
4. What are the functions of the respiratory system?
5. What is the internal inspiration?

3. Study the following prefixes used in medical terminology. Give twenty examples of any of these prefixes with the translation into Ukrainian.

Prefixes in medical terminology

A – Prefixes used in medical terms

Prefixes	**Meanings**	**Examples (Definitions)**
a-, an-	without, lack of	anuria (lack of urine output)
ab-	away from	abnormal (a structure or process that is not normal)

ad-	toward, near	adrenal glands (two small triangular endocrine glands situated one upon the upper end of each kidney)
ambi-	both sides	ambidextrous (using both hands)
ante-	before, forward	antepartum (an event before labour starts in pregnancy)
anti-	against	Antidotes (a therapeutic substance used to counteract the toxic action(s) of a specific substance)
apo-	off, away from	apophysis (growth or protuberance)
auto-	self	autograft (a transplant made using parts of the person's own body)

B – Prefixes used in medical terms

Prefix	**Meaning**	**Example (Definition)**
bi-	two, both	bilateral (occurring on both sides of the body)

C – Prefixes used in medical terms

Prefixes	**Meanings**	**Examples (Definitions)**
cata-	downwards	Catabolism (the process of breaking down complex chemicals into simple chemicals)
con-	with, together	congenital (disease or physical abnormality present from birth)

D – Prefixes used in medical terms

Prefixes	**Meanings**	**Examples (Definitions)**
de-	without	depigmentation (without pigment)
diplo-	double	diplopia (double vision)
dys-	painful, difficult, abnormal	Dyspnoea (difficulty in breathing)

E – Prefixes used in medical terms

Prefixes	Meanings	Examples (Definitions)
ec-, ecto	out, outside	ectoderm (the outer layer of an early embryo)
endo-	within, inside	endoscopy (an examination of the inside of the body using an endoscope)
epi-	above	epigastric (above the stomach)
eu-	normal	euthyroid (normal thyroid function)
ex-	outwards	exostosis (condition of outward, or projecting, bone)
extra-	outside of	extrapleural (outside the pleural cavity)

H – Prefixes used in medical terms

Prefixes	Meanings	Examples (Definitions)
hemi-	half	hemiplegia (paralysis that is limited to one side of the body)
hetero-	different	heterograft (A transplant from one animal to another of a different species)
homo-	same	homoplasty (surgery to replace lost tissues by grafting similar tissues from another person)
hyper-	excessive, much, above	toohyperplasia (an abnormal increase in the number of cells in a tissue.)
hypo-	deficient, below	hypotension (low blood pressure), hypodermic (below the skin)

I – Prefixes used in medical terms

Prefixes	Meanings	Examples (Definitions)
in-	inward, not	inhalation (to breathe in), infertility (not fertile)
Infra-	beneath	infra-axillary (below the axilla)
inter-	between	intervertebral (between the vertebrae)
intra-	within	intramuscular (into the muscle)

J – Prefix used in medical terms

Prefix	Meaning	Example (Definition)
juxta-	near	juxta-articular (near a joint)

M – Prefixes used in medical terms

Prefixes	Meanings	Examples (Definitions)
macro-	large	macroglossia (an abnormally large tongue)
mal-	bad, abnormal	malformation (abnormally formed)
mega-	great, large	megacolon (enlarged colon)
meta-	change, beyond	metaplasia (a change of one tissue to another), metastasis (the spreading of a malignant disease to distant parts of the body through the bloodstream or the lymph system)
micro-	small	microtia (having small ears)
mono-	one	monochromatic (having only one colour)
morph(o)-	shape	morphology (study of the form and structure of organisms)
multi-	many	Multigravida (a pregnant woman who has had more than one pregnancy)

N– Prefixes used in medical terms

Prefixes	Meanings	Examples (Definitions)
neo-	new	neonatal (pertaining to the first month of life.)
nulli-	none	nullipara (a woman who has never borne a child)

O – Prefix used in medical terms

Prefix	Meaning	Example (Definition)
olig(o)-	scanty, little	oliguria (an abnormally low excretion of urine)

P – Prefixes used in medical terms

Prefixes	Meanings	Examples (Definitions)

pan-	all	panacea (a medicine which is supposed to cure everything)
Par(a)-	beside, abnormal	paranasal (beside the nose), paraesthesia (abnormal or an unexplained tingling sensation)
per-	through	percutaneous (through the skin)
peri-	surrounding	periosteum (membrane surrounding a bone)
pico-	one-trillionth	picornavirus (extremely small RNA virus)
poly-	many, much	polyuria (production of excessive amounts of urine)
post-	after	postpartum (after childbirth)
pre-	before	precancer (a growth or cell which is not malignant but which may become cancerous)
pseudo-	false	pseudocyesis (spurious or false pregnancy)

Q – Prefix used in medical terms

Prefix	**Meaning**	**Example (Definition)**
quadri-	four	quadriplegia (paralysis of the four limbs of the body)

R – Prefixes used in medical terms

Prefixes	**Meanings**	**Examples (Definitions)**
re-	again	reinfection (infection of an area for another time after recovery, especially with the same microorganism)
retr(o)-	backward, behind	retrograde (going backwards or deteriorating), retroperitoneal (at the back of the peritoneum)

S – Prefixes used in medical terms

Prefixes	**Meanings**	**Examples (Definitions)**

semi-	Partial, half	semicomatose (almost unconscious or half asleep, but capable of being woken up)
sub-	under, less than	subcutaneous (under the skin)
super-	above	supercilia (the eyebrow)
supra-	above, upon	suprarenal (above the kidneys
syn-	with, together	syndrome (a group of symptoms occurring together regularly, and thus constituting a disease to which some particular name is given)

T – Prefixes used in medical terms

Prefixes	**Meanings**	**Examples (Definitions)**
tetra-	four	tetraplegia (paralysis of the body's four limbs, also called quadriplegia.)
trans-	through, across	transdermal (entering through the skin), transurethral (across the urethra)

U – Prefixes used in medical terms

Prefixes	**Meanings**	**Examples (Definitions)**
un-	not	unconscious (not conscious)
uni-	one	unilateral (affecting one side of the body only)

Text 2. Disorders of the respiratory system

There are two types of respiratory diseases and disorders: infectious and chronic. Pulmonary infections are most commonly bacterial or viral. In the viral type, a pathogen replicates inside a cell and causes a disease, such as the flu. Chronic diseases, such as asthma, are persistent and long-lasting. They can relapse and the patient can go into remission, only to suffer symptoms again at a later time.

1. Smoking Can Lead to Chronic Obstructive Pulmonary Disease (COPD)

COPD is a chronic respiratory disorder caused by long-term exposure to substances that irritate and damage the lungs. These substances include cigarette smoke and other inhaled pollutants. The two main types of COPD are chronic bronchitis and emphysema. In chronic bronchitis, inflamed airways constrict and generate excess mucus, making it hard to breathe. In emphysema, the alveoli in the lungs are damaged. This interferes with oxygen absorption, making the patient feel short of breath.

2. Inflammation and Constriction of the Airways Are Hallmarks of Asthma

Asthma is a chronic disorder involving soreness and swelling of the interior airway walls. It can be triggered by the inhalation of particles from the air. Physical activity or respiratory infections may also contribute. In an asthma attack, the inflamed airways become irritated during inhalation. Smooth muscles in the airway wall tighten, resulting in bronchoconstriction (constriction of the bronchiole tubes) and excess mucus production. The narrow, obstructed airways restrict normal airflow into and out from the lungs. Asthma sufferers wheeze, cough, and have difficulty breathing during an attack.

3. Sinusitis Is the Inflammation of Mucous Membranes in the Nasal Sinuses

The paranasal sinuses are hollow, air-filled spaces in skull bones around the nasal cavities. Mucous membranes line the sinuses. They produce mucus that normally drains into the nasal cavities. Airborne allergens and viral or bacterial infections can inflame the mucous membranes. The inflammation blocks the sinus openings and prevents the mucus from draining. This is a common condition known as *sinusitis.*

4. Influenza Is a Viral Infection of the Respiratory Tract

Influenza, commonly called “the flu,” is a contagious disease: An influenza virus can pass through the air from one person to another. Once inhaled, the flu virus moves into the respiratory tract and enters epithelial cells that line the airways. Infection spreads as the virus replicates, destroying host cells and moving into the bloodstream. The body's immune response causes high fever, chills, and muscle aches.

5. Chest Trauma Can Cause Pneumothorax, a Collapsed Lung

The thoracic cage, or rib cage, normally protects the lungs. Chest trauma can result in a puncture or tear in lung tissue, however. Air escapes from the tear and builds up between the lung and the chest wall. The air pressure pushes on the outside of the lung until it collapses. A complete lung collapse is called *pneumothorax.*

4. Translate into English the following words from the text above.

грудна клітка ……..……..

заразне захворювання ……..……..

бронхоконстрикція ……..……...

повітряно-крапельні алергени ……..

запалені дихальні шляхи …….

рецидив ……..

навколоносові пазухи ..…… …….

6. Try to state the medical conditions described below.

1. It is a swelling of the sinuses, usually caused by an infection. It's common and usually clears up on its own within 2 to 3 weeks. But medicines can help if it's taking a long time to go away. Its symptoms include: pain, swelling and tenderness around your cheeks, eyes or forehead, a blocked nose, a reduced sense of smell, green or yellow mucus from your nose, a sinus headache, a high temperature, toothache, bad breath.

2. It s a chronic inflammatory lung disease that causes obstructed airflow from the lungs. Symptoms include breathing difficulty, cough, mucus (sputum) production and wheezing. It's typically caused by long-term exposure to irritating gases or particulate matter, most often from cigarette smoke. People with this disorder are at increased risk of developing heart disease, lung cancer and a variety of other conditions. Emphysema and chronic bronchitis are the two most common conditions that contribute to this disorder. These two

conditions usually occur together and can vary in severity among individuals with the disorder.

3. It is a condition in which your airways narrow and swell and may produce extra mucus. This can make breathing difficult and trigger coughing, a whistling sound (wheezing) when you breathe out and shortness of breath. For some people, it is a minor nuisance. For others, it can be a major problem that interferes with daily activities and may lead to a life-threatening attack. Rhis condition can't be cured, but its symptoms can be controlled.

7. Prepare the description of two respiratory disorders. Make the class guess what they are.

Text 1.

Urinary and reproductive Systems Anatomy

1. Read the text.

Urinary System Anatomy

Kidneys

The ***kidneys*** are a pair of bean-shaped organs found along the posterior wall of the abdominal cavity. The left kidney is located slightly higher than the right kidney because the right side of ***the liver*** is much larger than the left side. The kidneys, unlike the other organs of the abdominal cavity, are located posterior to the peritoneum and touch the ***muscles of the back.*** The kidneys are surrounded by a layer of adipose that holds them in place and protects them from physical damage. The kidneys filter metabolic wastes, excess ions, and chemicals from the blood to form urine.

Ureters

The ***ureters*** are a pair of tubes that carry urine from the kidneys to the ***urinary bladder***. The ureters are about 10 to 12 inches long and run on the left and right sides of the body parallel to the ***vertebral column***. Gravity and peristalsis of smooth muscle tissue in the walls of the ureters move urine toward the urinary bladder. The ends of the ureters extend slightly into the urinary bladder and are sealed at the point of entry to the bladder by the ureterovesical valves. These valves prevent urine from flowing back towards the kidneys.

Urinary Bladder

The ***urinary bladder*** is a sac-like hollow organ used for the storage of urine. The urinary bladder is located along the body's midline at the inferior end of the ***pelvis***. Urine entering the urinary bladder from the ureters slowly fills the hollow space of the bladder and stretches its elastic walls. The walls of the bladder allow it to stretch to hold anywhere from 600 to 800 milliliters of urine.

Urethra

The ***urethra*** is the tube through which urine passes from the bladder to the exterior of the body. The female urethra is around 2 inches long and ends inferior to the ***clitoris*** and superior to the vaginal opening. In males, the urethra is around 8 to 10 inches long and ends at the tip of the ***penis***. The urethra is also an organ of the male reproductive system as it carries sperm out of the body through the penis.

The flow of urine through the urethra is controlled by the internal and external urethral sphincter muscles. The internal urethral sphincter is made of smooth muscle and opens involuntarily when the bladder reaches a certain set level of distention. The opening of the internal sphincter results in the sensation of needing to urinate. The external urethral sphincter is made of skeletal muscle and may be opened to allow urine to pass through the urethra or may be held closed to delay urination.

Urinary System Physiology

Maintenance of Homeostasis

The kidneys maintain the homeostasis of several important internal conditions by controlling the excretion of substances out of the body.

Ions

The kidney can control the excretion of potassium, sodium, calcium, magnesium, phosphate, and chloride ions into urine. In cases where these ions reach a higher than normal concentration, the kidneys can increase their excretion out of the body to return them to a normal level. Conversely, the kidneys can conserve these ions when they are present in lower than normal levels by allowing the ions to be reabsorbed into the blood during filtration.

The kidneys monitor and regulate the levels of ***hydrogen ions (H+)*** and bicarbonate ions in the blood to control blood pH. H+ ions are produced as a natural byproduct of the metabolism of dietary proteins and accumulate in the blood over time. The kidneys excrete excess H+ ions into urine for elimination from the body. The kidneys also conserve bicarbonate ions, which act as important pH buffers in the blood.

Osmolarity

The cells of the body need to grow in an isotonic environment in order to maintain their fluid and electrolyte balance. The kidneys maintain the body's osmotic balance by controlling the amount of water that is filtered out of the blood and excreted into urine. When a person consumes a large amount of water, the kidneys reduce their reabsorption of water to allow the excess water to be excreted in urine. This results in the production of dilute, watery urine. In the case of the body being dehydrated, the kidneys reabsorb as much water as possible back into the blood to produce highly concentrated urine full of excreted ions and wastes. The changes in excretion of water are controlled by antidiuretic hormone (ADH). ADH is produced in the ***hypothalamus*** and released by the posterior p***ituitary gland*** to help the body retain water.

Blood Pressure

The kidneys monitor the body's blood pressure to help maintain homeostasis. When blood pressure is elevated, the kidneys can help to reduce blood pressure by reducing the volume of blood in the body. The kidneys are able to reduce blood volume by reducing the reabsorption of water into the blood and producing watery, dilute urine. When blood pressure becomes too low, the kidneys can produce the enzyme renin to constrict blood vessels and produce concentrated urine, which allows more water to remain in the blood.

Filtration

Inside each kidney are around a million tiny structures called nephrons. The ***nephron*** is the functional unit of the kidney that filters blood to produce urine. Arterioles in the kidneys deliver blood to a bundle of capillaries surrounded by a capsule called a ***glomerulus***. As blood flows through the glomerulus, much of the blood's plasma is pushed out of the capillaries and into the capsule, leaving the blood cells and a small amount of plasma to continue flowing through the capillaries. The liquid filtrate in the capsule flows through a series of tubules lined with filtering cells and surrounded by capillaries. The cells surrounding the tubules selectively absorb water and substances from the filtrate in the tubule and return it to the blood in the capillaries. At the same time, waste products present in the blood are secreted into the filtrate. By the end of this process, the filtrate in the tubule has become urine containing only water, waste

products, and excess ions. The blood exiting the capillaries has reabsorbed all of the nutrients along with most of the water and ions that the body needs to function.

Storage and Excretion of Wastes

After urine has been produced by the kidneys, it is transported through the ureters to the urinary bladder. The urinary bladder fills with urine and stores it until the body is ready for its excretion. When the volume of the urinary bladder reaches anywhere from 150 to 400 milliliters, its walls begin to stretch and stretch receptors in its walls send signals to the ***brain*** and ***spinal cord***. These signals result in the relaxation of the involuntary internal urethral sphincter and the sensation of needing to urinate. Urination may be delayed as long as the bladder does not exceed its maximum volume, but increasing nerve signals lead to greater discomfort and desire to urinate.

Urination is the process of releasing urine from the urinary bladder through the urethra and out of the body. The process of urination begins when the muscles of the urethral sphincters relax, allowing urine to pass through the urethra. At the same time that the sphincters relax, the smooth muscle in the walls of the urinary bladder contract to expel urine from the bladder.

Production of Hormones

The kidneys produce and interact with several hormones that are involved in the control of systems outside of the urinary system.

Calcitriol

Calcitriol is the active form of vitamin D in the human body. It is produced by the kidneys from precursor molecules produced by UV radiation striking the skin. Calcitriol works together with parathyroid hormone (PTH) to raise the level of calcium ions in the bloodstream. When the level of calcium ions in the blood drops below a threshold level, the ***parathyroid glands*** release PTH, which in turn stimulates the kidneys to release calcitriol. Calcitriol promotes the ***small intestine*** to absorb calcium from food and deposit it into the bloodstream. It also stimulates the osteoclasts of the ***skeletal system*** to break down bone matrix to release calcium ions into the blood.

Erythropoietin

Erythropoietin, also known as EPO, is a hormone that is produced by the kidneys to stimulate the production of red blood cells. The kidneys monitor the condition of the blood that passes through their capillaries, including the oxygen-carrying capacity of the blood. When the blood becomes hypoxic, meaning that it is carrying deficient levels of oxygen, cells lining the capillaries begin producing EPO and release it into the bloodstream. EPO travels through the blood to the ***red bone marrow***, where it stimulates ***hematopoietic cells*** to increase their rate of red blood cell production. Red blood cells contain hemoglobin, which greatly increases the blood's oxygen-carrying capacity and effectively ends the hypoxic conditions.

Renin

Renin is not a hormone itself, but an enzyme that the kidneys produce to start the renin-angiotensin system (RAS). The RAS increases blood volume and blood pressure in response to low blood pressure, blood loss, or dehydration. Renin is released into the blood where it catalyzes angiotensinogen from the liver into angiotensin I. ***Angiotensin I*** is further catalyzed by another enzyme into Angiotensin II.

Angiotensin II stimulates several processes, including stimulating the adrenal cortex to produce the hormone aldosterone. Aldosterone then changes the function of the kidneys to increase the reabsorption of water and sodium ions into the blood, increasing blood volume and raising blood pressure. Negative feedback from increased blood pressure finally turns off the RAS to maintain healthy blood pressure levels.

Female Reproductive System Anatomy

Ovaries

The ***ovaries*** are a pair of small glands about the size and shape of almonds, located on the left and right sides of the pelvic body cavity lateral to the superior portion of the uterus. Ovaries produce female sex hormones such as estrogen and progesterone as well as ova (commonly called "eggs"), the female gametes. Ova are produced from oocyte cells that slowly develop throughout a woman's early life and reach maturity after puberty. Each month during ovulation, a mature ovum is released. The ovum travels from the ovary to the fallopian tube, where it may be fertilized before reaching the uterus.

Fallopian Tubes

The ***fallopian tubes*** are a pair of muscular tubes that extend from the left and right superior corners of the uterus to the edge of the ovaries. The fallopian tubes end in a funnel-shaped structure called the infundibulum, which is covered with small finger-like projections called fimbriae. The ***fimbriae*** swipe over the outside of the ovaries to pick up released ova and carry them into the infundibulum for transport to the uterus. The inside of each fallopian tube is covered in cilia that work with the smooth muscle of the tube to carry the ovum to the uterus.

Uterus

The **uterus** is a hollow, muscular, pear-shaped organ located posterior and superior to the urinary bladder. Connected to the two fallopian tubes on its superior end and to the vagina (via the ***cervix***) on its inferior end, the uterus is also known as the womb, as it surrounds and supports the developing fetus during pregnancy. The inner lining of the uterus, known as the ***endometrium***, provides support to the embryo during early development. The visceral muscles of the uterus contract during childbirth to push the fetus through the birth canal.

Vagina

The ***vagina*** is an elastic, muscular tube that connects the ***cervix of the uterus*** to the exterior of the body. It is located inferior to the uterus and posterior to the ***urinary bladder***. The vagina functions as the receptacle for the ***penis*** during sexual intercourse and carries sperm to the uterus and fallopian tubes. It also serves as the birth canal by stretching to allow delivery of the fetus during childbirth. During menstruation, the menstrual flow exits the body via the vagina.

Vulva

The ***vulva*** is the collective name for the external female genitalia located in the pubic region of the body. The vulva surrounds the external ends of the urethral opening and the vagina and includes the mons pubis, labia majora, labia minora, and clitoris. The mons pubis, or pubic mound, is a raised layer of adipose tissue between the skin and the ***pubic bone*** that provides cushioning to the vulva. The inferior portion of the mons pubis splits into left and right halves called the ***labia majora***. The mons pubis and labia majora are covered with pubic hairs. Inside of the labia majora are smaller, hairless folds of skin called the ***labia minora*** that surround the

vaginal and urethral openings. On the superior end of the labia minora is a small mass of erectile tissue known as the **clitoris** that contains many nerve endings for sensing sexual pleasure.

Breasts and Mammary Glands

The ***breasts*** are specialized organs of the female body that contain mammary glands, milk ducts, and adipose tissue. The two breasts are located on the left and right sides of the thoracic region of the body. In the center of each breast is a highly pigmented ***nipple*** that releases milk when stimulated. The areola, a thickened, highly pigmented band of skin that surrounds the nipple, protects the underlying tissues during breastfeeding. The ***mammary glands*** are a special type of sudoriferous glands that have been modified to produce milk to feed infants. Within each breast, 15 to 20 clusters of mammary glands become active during pregnancy and remain active until milk is no longer needed. The milk passes through milk ducts on its way to the nipple, where it exits the body.

Female Reproductive System Physiology

The Reproductive Cycle

The female reproductive cycle is the process of producing an ovum and readying the uterus to receive a fertilized ovum to begin ***pregnancy***. If an ovum is produced but not fertilized and implanted in the uterine wall, the reproductive cycle resets itself through menstruation. The entire reproductive cycle takes about 28 days on average, but may be as short as 24 days or as long as 36 days for some women.

Oogenesis and Ovulation

Under the influence of ***follicle stimulating hormone (FSH***), and luteinizing hormone (LH), the ovaries produce a mature ovum in a process known as ovulation. By about 14 days into the reproductive cycle, an oocyte reaches maturity and is released as an ovum. Although the ovaries begin to mature many oocytes each month, usually only one ovum per cycle is released.

Fertilization

Once the mature ovum is released from the ovary, the fimbriae catch the egg and direct it down the fallopian tube to the uterus. It takes about a week for the ovum to travel to the uterus. If sperm are able to reach and penetrate the ovum, the ovum becomes a ***fertilized zygote***

containing a full complement of ***DNA***. After a two-week period of rapid cell division known as the germinal period of development, the zygote forms an embryo. The embryo will then implant itself into the uterine wall and develop there during pregnancy.

Menstruation

While the ***ovum*** matures and travels through the fallopian tube, the endometrium grows and develops in preparation for the embryo. If the ovum is not fertilized in time or if it fails to implant into the endometrium, the arteries of the uterus constrict to cut off blood flow to the endometrium. The lack of blood flow causes cell death in the endometrium and the eventual shedding of tissue in a process known as menstruation. In a normal menstrual cycle, this shedding begins around day 28 and continues into the first few days of the new reproductive cycle.

Pregnancy

If the ovum is fertilized by a sperm cell, the fertilized embryo will implant itself into the endometrium and begin to form an amniotic cavity, umbilical cord, and placenta. For the first 8 weeks, the embryo will develop almost all of the tissues and organs present in the adult before entering the fetal period of development during weeks 9 through 38. During the fetal period, the fetus grows larger and more complex until it is ready to be born.

Lactation

Lactation is the production and release of milk to feed an infant. The production of milk begins prior to birth under the control of the hormone prolactin. Prolactin is produced in response to the suckling of an infant on the nipple, so milk is produced as long as active breastfeeding occurs. As soon as an infant is weaned, prolactin and milk production end soon after. The release of milk by the nipples is known as the "milk-letdown reflex" and is controlled by the hormone oxytocin. Oxytocin is also produced in response to infant suckling so that milk is only released when an infant is actively feeding.

Reproductive Health

For many women access to health services via traditional means isn't as convenient as accessing it via an app or website. Check out our unbiased reviews to learn more about these

new avenues and whether they may help you access reproductive health care products and services:

Hers review - Hers connects you with healthcare professionals and offers everything from skincare and hair care to contraception and treatment for yeast infections.

Uqora review - Uqora focuses on UTIs - find out if it can make your life easier.

Nurx review - Nurx may be able to help you with access to testing and treatment for common STIs.

Anatomy of the Male Reproductive System

Scrotum

The scrotum is a sac-like organ made of skin and muscles that houses the testes. It is located inferior to the penis in the pubic region. The scrotum is made up of 2 side-by-side pouches with a testis located in each pouch. The smooth muscles that make up the scrotum allow it to regulate the distance between the testes and the rest of the body. When the testes become too warm to support spermatogenesis, the scrotum relaxes to move the testes away from the body's heat. Conversely, the scrotum contracts to move the testes closer to the body's core heat when temperatures drop below the ideal range for spermatogenesis.

Testes

The 2 **testes**, also known as testicles, are the male gonads responsible for the production of sperm and testosterone. The testes are ellipsoid glandular organs around 1.5 to 2 inches long and an inch in diameter. Each testis is found inside its own pouch on one side of the scrotum and is connected to the abdomen by a spermatic cord and cremaster muscle. The cremaster muscles contract and relax along with the scrotum to regulate the temperature of the testes. The inside of the testes is divided into small compartments known as lobules. Each lobule contains a section of seminiferous tubule lined with ***epithelial cells***. These epithelial cells contain many stem cells that divide and form sperm cells through the process of spermatogenesis.

Epididymis

The ***epididymis*** is a sperm storage area that wraps around the superior and posterior edge of the testes. The epididymis is made up of several feet of long, thin tubules that are tightly coiled

into a small mass. Sperm produced in the testes moves into the epididymis to mature before being passed on through the ***male reproductive organs.*** The length of the epididymis delays the release of the sperm and allows them time to mature.

Spermatic Cords and Ductus Deferens

Within the ***scrotum,*** a pair of spermatic cords connects the testes to the abdominal cavity. The spermatic cords contain the ductus deferens along with nerves, veins, arteries, and lymphatic vessels that support the function of the testes.

The ***ductus deferens***, also known as the vas deferens, is a muscular tube that carries sperm superiorly from the epididymis into the abdominal cavity to the ejaculatory duct. The ductus deferens is wider in diameter than the epididymis and uses its internal space to store mature sperm. The smooth muscles of the walls of the ductus deferens are used to move sperm towards the ejaculatory duct through peristalsis.

Seminal Vesicles

The ***seminal vesicles*** are a pair of lumpy exocrine glands that store and produce some of the liquid portion of semen. The seminal vesicles are about 2 inches in length and located posterior to the urinary bladder and anterior to the ***rectum***. The liquid produced by the seminal vesicles contains proteins and mucus and has an alkaline pH to help sperm survive in the acidic environment of the vagina. The liquid also contains fructose to feed sperm cells so that they survive long enough to fertilize the oocyte.

Ejaculatory Duct

The ductus deferens passes through the prostate and joins with the urethra at a structure known as the ejaculatory duct. The ***ejaculatory duc*****t** contains the ducts from the seminal vesicles as well. During ejaculation, the ejaculatory duct opens and expels sperm and the secretions from the seminal vesicles into the urethra.

Urethra

Semen passes from the ejaculatory duct to the exterior of the body via the urethra, an 8 to 10 inch long muscular tube. The urethra passes through the prostate and ends at the **external**

urethral orifice located at the tip of the penis. Urine exiting the body from the urinary bladder also passes through the urethra.

Prostate

The ***prostate*** is a walnut-sized exocrine gland that borders the inferior end of the urinary bladder and surrounds the urethra. The prostate produces a large portion of the fluid that makes up semen. This fluid is milky white in color and contains enzymes, proteins, and other chemicals to support and protect sperm during ejaculation. The prostate also contains smooth muscle tissue that can constrict to prevent the flow of urine or semen.

Unfortunately the prostate is also particularly susceptible to ***cancer***. Thankfully, **DNA *health testing*** can tell you whether you're at higher genetic risk of developing prostate cancer due to your BRCA1 and BRCA2 genes.

Cowper's Glands

The ***Cowper's glands***, also known as the bulbourethral glands, are a pair of pea-sized exocrine glands located inferior to the prostate and anterior to the anus. The Cowper's glands secrete a thin alkaline fluid into the urethra that lubricates the urethra and neutralizes acid from urine remaining in the urethra after urination. This fluid enters the urethra during sexual arousal prior to ejaculation to prepare the urethra for the flow of semen.

Penis

The ***penis*** is the male external sexual organ located superior to the scrotum and inferior to the ***umbilicus***. The penis is roughly cylindrical in shape and contains the urethra and the external opening of the urethra. Large pockets of erectile tissue in the penis allow it to fill with blood and become erect. The erection of the penis causes it to increase in size and become turgid. The function of the penis is to deliver semen into the ***vagina*** during sexual intercourse. In addition to its reproductive function, the penis also allows for the excretion of urine through the urethra to the exterior of the body.

Erectile dysfunction is a common reproductive issue; in each decade of men's lives, it affects about an equivalent percentage of peers. For instance, roughly 20% of men in their 20s experience a degree of erectile dysfunction. The rate rises to 30% of men experiencing ED

symptoms in their 30s, and 50% of men in their 50s (and so on). Because it's so common, the medical community has responded with increasingly convenient ways to treat ED. Read our ***Hims ED review*** for more information.

Semen

Semen is the fluid produced by males for sexual reproduction and is ejaculated out of the body during sexual intercourse. Semen contains sperm, the male reproductive gametes, along with a number of chemicals suspended in a liquid medium. The chemical composition of semen gives it a thick, sticky consistency and a slightly alkaline pH. These traits help semen to support reproduction by helping sperm to remain within the vagina after intercourse and to neutralize the acidic environment of the vagina. In healthy adult males, semen contains around 100 million sperm cells per milliliter. These sperm cells fertilize oocytes inside the female ***fallopian tubes.***

Physiology of the Male Reproductive System

Spermatogenesis

Spermatogenesis is the process of producing sperm and takes place in the testes and epididymis of adult males. Prior to puberty, there is no spermatogenesis due to the lack of hormonal triggers. At puberty, spermatogenesis begins when luteinizing hormone (LH) and follicle stimulating hormone (FSH) are produced. LH triggers the production of testosterone by the testes while FSH triggers the maturation of germ cells. Testosterone stimulates stem cells in the testes known as spermatogonium to undergo the process of developing into spermatocytes. Each diploid spermatocyte goes through the process of meiosis I and splits into 2 haploid secondary spermatocytes. The secondary spermatocytes go through meiosis II to form 4 haploid spermatid cells. The spermatid cells then go through a process known as spermiogenesis where they grow a flagellum and develop the structures of the sperm head. After spermiogenesis, the cell is finally a sperm cell, or spermatozoa. The spermatozoa are released into the epididymis where they complete their maturation and become able to move on their own.

Fertilization

Fertilization is the process by which a sperm combines with an oocyte, or egg cell, to produce a fertilized zygote. The sperm released during ejaculation must first swim through the

vagina and uterus and into the fallopian tubes where they may find an oocyte. After encountering the oocyte, sperm next have to penetrate the outer corona radiata and zona pellucida layers of the oocyte. Sperm contain enzymes in the acrosome region of the head that allow them to penetrate these layers. After penetrating the interior of the oocyte, the nuclei of these haploid cells fuse to form a diploid cell known as a zygote. The zygote cell begins cell division to form an embryo.

2. Answer the following questions.

1. What are kidneys surrounded by?
2. How much urine can the bladder hold?
3. How is homeostasis managed?
4. What is osmolarity?
5. Where is glomerulus situated?
6. What do ovaries produce?
7. What is endometrium?
8. How is a special type of sudoriferous glands that have been modified to produce milk to feed infants called?
9. What is scrotum?
10. How do testes act?

3. Match the terms with their description.

1. small artery	a.filteration
2. Cup-like collecting region of the renal pelvis	b.arteriole
	c.glomerulus
3. Tube for injecting or removing fluids	d.calyx
4. Hormone secreted by the kidney to stimulate the production of red blood	e.catheter
	f.glomerular capsule

cells by bone marrow. --poietin means a substance that forms. 5. process whereby some substances, but not all, pass through a filter. In the kidney, blood pressure forces materials through the filter (glomerulus). About 180 quarts of fluid are filtered from the blood daily, but the kidney returns 98% to 99% of the water and salts. Only about 1.5 quarts (1500 mL) of urine are excreted daily 6. Enclosing structure surrounding each glomerulus. It is is known as Bowman capsule and it collects the material that is filtered from the blood through the walls of the glomerulus 7. Tiny ball of capillaries (microscopic blood vessels) in the kidney.	g.erythropoietin (EPO)

4. Translate the following sentences into English.

1. Вона відома як капсула Боумена і збирає матеріал, який фільтрується з крові через стінки клубочка.
2. Тестостерон стимулює стовбурові клітини в яєчках, відомі як сперматогоніум, для того, щоб пройти процес розвитку в сперматоцити.
3. Сечовий міхур розташований уздовж середньої лінії тіла в нижньому кінці таза.

4. Рідкий фільтрат в капсулі протікає через низку канальців, вистелених фільтруючими клітинами та оточених капілярами.
5. Пролактин виробляється у відповідь на смоктання немовлям соска, тому молоко виробляється до тих пір, поки відбувається активне грудне вигодовування.

Text 2.

Urinary System Disorders

Diseases of the kidneys or bladder can compromise urinary system functions. Below are some common diseases of the urinary system.

1. Kidney Stones Form from Substances in Urine

The kidneys produce urine to eliminate waste. Kidney stones can form when mineral and acid salts in the urine crystallize and stick together. If the stone is small, it can pass easily through the urinary system and out of the body. A larger stone can get stuck in the urinary tract, however. A stuck kidney stone causes pain and can block the flow of urine.

2. Urinary Incontinence Is the Loss of Bladder Control

Most bladder control issues arise when the sphincter muscles of the urethra are too weak or too active. If the sphincter muscles are too weak, a cough or sneeze can cause urination. Sphincter muscles that are too active can trigger a sudden, strong urge to urinate with little urine in the bladder. These issues are diagnosed as urinary incontinence (UI). Women experience UI twice as often as men. It becomes more common with age.

3. Fluid-filled Cysts Can Develop in the Kidneys

A simple kidney cyst is a rounded pouch or a closed pocket that is usually filled with fluid. In polycystic kidney disease (PKD), clusters of cysts form inside the kidneys and take the place of the normal tissue. The affected kidneys become enlarged and work poorly. PKD is an inherited condition that often leads to kidney failure, requiring dialysis or kidney transplantation. Acquired cystic kidney disease (ACKD) typically affects people

already on dialysis from chronic kidney disease. In ACKD the kidneys do not enlarge and no other symptoms occur.

4. Chronic Kidney Disease Can Lead to Kidney Failure

In chronic kidney disease (CKD), the kidneys are damaged and unable to filter blood properly. This damage can lead to a build-up of waste substances in the body and to other problems, including kidney failure. The most common causes of CKD include diabetes, heart disease, and high blood pressure. A diseased kidney may look smaller and have a granular surface.

Reproductory System Disorders

Reproductive system disease, any of the diseases and disorders that affect the human reproductive system. They include abnormal hormone production by the ovaries or the testes or by other endocrine glands, such as the pituitary, thyroid, or adrenals. Such diseases can also be caused by genetic or congenital abnormalities, infections, tumours, or disorders of unknown cause.

The main divisions of these disorders are concerned with (1) genetic and congenital abnormalities, (2) functional genital disorders, (3) infections, (4) structural changes of unknown cause, and (5) tumours. For discussion of diseases and disorders affecting pregnancy, *see* pregnancy.

Genetic and congenital abnormalities

In the male

Congenital anomalies of the prostate gland and seminal vesicles are rare; they consist of absence, hypoplasia (underdevelopment), or the presence of fluid- or semisolid-filled sacs, called cysts. Cysts of the prostatic utricle (the uterine remnant found in the male) are often found in association with advanced stages of hypospadias (a defect in the urethra, *see below*) and pseudohermaphroditism, a condition in which sex glands are present but bodily appearance is ambiguous as to sex; i.e., the secondary sexual characteristics are underdeveloped. Cysts may also cause urinary obstructive symptoms through local pressure on the bladder neck.

Severe anomalies of the penis are rare and are generally associated with urinary or other systemic defects that are incompatible with life. Anomalies are those of absence, transposition, torsion (twisting), and duplication of the penis. An abnormally large penis frequently is present in males with precocious puberty, dwarfism, an overactive pituitary, or adrenal tumours. A small penis is seen in infantilism and in underdevelopment of the genitals, or undersecretion of the pituitary or pineal gland, and failure of development of the corpora cavernosa (erectile tissue located on the dorsal side of the penis).

The only anomaly of the foreskin is congenital phimosis, characterized by a contracture of the foreskin, or prepuce, which prevents its retraction over the glans (the conical structure that forms the head of the penis); the preputial opening may impede the flow of urine. The condition is treated by circumcision.

There is a considerable variety of urethral anomalies. Stenosis (contracture) of the external opening (meatus) is the most common, but congenital stricture of the urethra occasionally occurs at other points. Valves (or flaps) across the anterior or posterior part of the urethra may cause congenital urethral obstruction in males. Posterior urethral valves are more common than anterior valves and consist of deep folds of mucous membrane, often paper-thin and usually attached at one end to the verumontanum, a small prominence in the back wall of the part of the urethra that is surrounded by the prostate gland. If too tight, the valves may obstruct the urethra and damage the kidneys.

Various defects are associated with incomplete closure of the urethra. One of the most common is hypospadias, in which the underside (ventral side) of the urethral canal is open for a distance at its outer end. Frequently the meatus is narrowed, and the penis also has a downward curvature beyond the meatus. The posterior part of the urethra is never involved; therefore, the muscle that closes the urethra functions normally, and urinary control exists. Although the condition occurs in both sexes, it is seen predominantly in the male. There is a high incidence of partial or complete failure of the testes to develop, of cryptorchidism (failure of one or both of the testes to descend into the scrotum), and of small external and internal genitalia. Epispadias, an opening in the

upper (dorsal) side of the penis, is considerably less common than hypospadias. Dorsal curvature may also be present, but the disabling aspect is that the defect usually extends through the urinary sphincter and causes urinary incontinence. Other less common urethral anomalies include complete absence of the urethra, double urethra, urethra fistula (an opening in the urethra), urethrorectal fistula (an opening between the urethra and the rectum), and urethral diverticulum (a pouch in the wall of the urethra). Most of the above conditions are correctable by surgery.

Anorchism (absence of one or both testes) is rare; it may be associated with the absence of various other structures of the spermatic tract. Generally, if one testis (also called testicle) is absent, the other is found to be within the abdomen rather than in the scrotum. Congenitally small testes may be a primary disorder or may occur because of underactivity of the pituitary. In both disorders, there is a lack of development of secondary sexual characteristics and some deficiency in libido and potency. Supernumerary testicles are extremely rare; when present, one or more of the supernumerary testicles usually shows some disorder such as torsion of the spermatic cord. Synorchism, the fusion of the two testicles into one mass, may occur within the scrotum or in the abdomen. Cryptorchidism, the most common anomaly of the spermatic tract, is the failure of one or both of the testes to descend spontaneously into the scrotum; hormonal treatment may be useful in correcting the condition, but usually surgery is necessary for correction.

In the female

The female external genitalia are less complex than those of the male but have anomalies that can at times severely interfere with the functioning of the female urogenital tract. The clitoris, an erectile structure that corresponds to the penis, except that it does not contain the urethra, may be absent but in other cases may be enlarged on either a congenital or a hormonal basis. Fusion of the labia minora (small folds of skin covering the clitoris, the urethral opening, and the opening of the vagina) is a midline “sealing together”; usually a minute unfused area is left just below the clitoris, through which urine

and menstrual fluid can flow. The chief difficulty with this anomaly is concerned with obstruction to the flow of urine and associated urinary tract infection. An imperforate hymen (the membrane closing off the opening of the vagina) causes distension of the uterus and vagina with fluid other than blood before puberty and with blood after puberty (the two conditions are called hydrometrocolpos and hematocolpometra, respectively). The distended vagina compresses the urethra enough to interfere with urination and commonly may even cause complete retention of urine in the bladder and distension of the entire upper urinary tract. Fusion of the urethra and the hymen is characterized by a dense hymenal ring and a stenosed urethral opening. The consequent urinary obstruction commonly results in persistent urinary infection. Most of the conditions are readily treated by surgery.

Anomalies of the vagina and uterus consist of complete absence, incomplete development, and duplication. The female urethra may have a congenitally narrow opening, or meatus; it may be distended; it may have an abnormal pouch, or diverticulum, in its wall; or it may open abnormally into the vagina. Hypospadias may occur in the female but is far less common than in the male. Epispadias is also present in the female. Reconstructive surgery is the only method of treatment. One of the rarest and most severe of the urogenital-tract anomalies, called urogenital cloaca, consists of congenital intercommunication between the rectum and the urinary bladder and vagina or between the rectum and the urethra and vagina.

Intersexuality

Intersexuality (having both male and female characteristics) may be noticeable at birth or may become apparent after puberty. Intersexuality noticeable at birth may be classified as female or male pseudohermaphroditism or true hermaphroditism. Female pseudohermaphroditism, or female intersex, may be of adrenal or nonadrenal type. The adrenal type develops because of an inborn error in the metabolism of the adrenal hormone cortisol that leads to an increased secretion of corticotropin (ACTH) and consequent excessive secretion of androgens (male sex hormones). A newborn female with this

condition is a chromosomal female and resembles a normal female, but an excess of male hormone has a masculinizing effect on the external genitalia; the vagina tends to be connected to the urethra and the clitoris is enlarged, as are the labia (the labia majora are prominent folds of skin, corresponding to the scrotum in the male). Effective treatment can be achieved by administration of adrenal hormones (e.g., cortisone, hydrocortisone), which suppress the pituitary so that its stimulus to adrenal production of androgenic hormones is minimized. The nonadrenal type of intersex is seen in infants whose mothers have been administered synthetic androgens or progestational compounds (substances that stimulate changes in the uterus that further the implantation and growth of the fertilized ovum) during pregnancy. Rarely, the condition is associated with the presence in the mother of a tumour of the ovary or adrenal gland. The newborn infant is a female with varying degrees of ambiguous genitalia; no treatment is necessary, and normal female development occurs at puberty.

Male pseudohermaphrodites are males with varying deficiencies of internal and external virilization. Most commonly, the male intersex has a markedly hypospadiac penis, undescended testes, a cleft scrotum, and an enlarged prostatic utricle; a complete uterus and fallopian tubes may be found, with the vagina opening into the posterior wall of the urethra. (Such persons are pseudohermaphrodites in that they do not have ovaries.)

True hermaphrodites have recognizable ovarian and testicular tissue. A uterus is always present, but the internal genitalia otherwise vary greatly, often including both male and female structures. The external genitalia are usually ambiguous, and a sizable phallus is present; therefore, most of these children are raised as males. At puberty, over 80 percent of them develop enlarged breasts, and approximately half menstruate. Most hermaphrodites are chromatin positive—that is, they have, within and near the periphery of the nuclei of their cells, a substance, chromatin, that is normally found in the cells of females but not in those of males—and over half have a characteristically female set of chromosomes in their peripheral blood cells.

Surgical and hormonal therapy directed at producing either a male or a female configuration of the body is based on the existing physical and psychological findings. Treatment also depends upon the age at which the diagnosis is made.

Klinefelter syndrome, Turner syndrome, and testicular feminization are intersexuality syndromes that become apparent prior to or after puberty. Klinefelter syndrome is a genetic disorder of males who have an extra sex chromosome (XXY) and subsequently are usually infertile, have small testes, and have enlarged breasts at the time of puberty (gynecomastia). Males with this syndrome have an increased risk of various autoimmune disorders such as diabetes mellitus and lupus.

Turner syndrome is a condition of females who, in the classic form, carry only a single X chromosome (XO). Characteristically, such persons are short, do not menstruate, and have a deficiency of estrogen (a female sex hormone); there is a distinctive cluster of congenital anomalies attached to this syndrome.

Testicular feminization, or androgen insensitivity syndrome, is caused by genetic mutations on the X chromosome that cause a male to be resistant to the action of androgens (male hormones). Affected persons seem to be normally developed females but have a chromosomal sex that is that of the normal male. The gonads are well-developed testes, and evidence indicates that there is a normal production of testosterone (male hormone), but there is cellular resistance to the action of this hormone, and therefore the affected person becomes female in appearance. Because these gonads are apt to form malignant tumours, they are usually removed surgically. Female sexual characteristics are then maintained by the administration of estrogenic hormones.

Functional genital disorders

Affecting both male and female systems

Delayed puberty

The term *delayed puberty* may be a misnomer, because puberty delayed beyond age 19 is in fact a permanent failure of sexual development because of an abnormally low secretion by the pituitary gland of gonadotropic hormone, the hormone that stimulates

growth and activity of the sex glands; this condition is called hypogonadotropic eunuchoidism. The term *delayed puberty* is usually applied to boys who develop more slowly than the average but who still eventually undergo full sexual development. Only in retrospect—i.e., after the affected person reaches the age of 20—can one clearly differentiate these cases from the classic or incomplete forms of hypogonadotropic eunuchoidism. If there are social and psychological problems related to the sexual underdevelopment, therapy may consist of a course of chorionic gonadotropin, a hormone produced by the placenta and secured from the urine of pregnant women. If puberty is merely delayed, it will usually progress normally after this treatment. If it fails to progress, the person does not have delayed puberty but rather has hypogonadotropic eunuchoidism.

Precocious puberty

In healthy girls living in a temperate climate, the earliest sign of puberty (the beginning of breast and pubic-hair growth) has traditionally been considered to occur at a mean age of 10.6 years (standard deviation of 1.2 years). In boys, testicular growth is considered to begin at a mean age of 11.8, with a standard deviation of one year. True precocious puberty is a condition in which normal pituitary-gonadal function is activated at an abnormally early age. “Abnormally early” has traditionally been defined as younger than 9 years in boys and younger than 8 years in girls, though studies undertaken since the 1990s indicate that the normal onset of puberty may be occurring at a younger age in girls in developed countries and that therefore the age of precocious puberty for girls may actually be as low as 6 or 7. Pseudoprecocious puberty includes development of secondary sexual characteristics but not production of spermatozoa or ova; it may involve virilization in the female or feminization in the male.

The causes of true precocious puberty include brain lesions and hypothyroidism (abnormally low secretion by the thyroid glands); the largest proportion of cases are of unknown cause. Precocious pseudopuberty in females may be caused by ovarian tumours or cysts, a tumour of the adrenal cortex (outer substance of the adrenal gland), or congenital overdevelopment of the adrenal gland. In males the

causes include congenital overdevelopment of the adrenal glands, tumour of the adrenal cortex, tumour involving the Leydig cells of the testes, and teratoma (a tumour containing numerous types of tissue; in these circumstances it includes adrenal-cortical tissue).

Infertility

At least 10 percent of couples experience infertility, and deficiencies of sperm production in the male are the causal factor in about one-third of all cases. The common causes of male infertility are deficiencies in maturation of sperm; orchitis (acute inflammation of the testes often resulting from mumps), with destruction of the testes; obstruction of the passageways for sperm; abnormally low thyroid or high adrenal secretion; varicocele (enlargement of the veins of the spermatic cord); or formation of antibodies to sperm by the male or the female. The most important step in the evaluation of male infertility is examination of the semen.

Infertility in the female is related to the faulty production of ova or to interferences in their union with spermatozoa. Disordered ovulation is responsible for approximately 25 percent of female infertility problems; anovulation (failure to ovulate) and oligoovulation (very irregular ovulatory cycles) are among the most common disorders. Other common causes of infertility are blockages and scarring of the fallopian tubes, which can result from infections of the reproductive tract (e.g., pelvic inflammatory disease), uterine fibroids, or endometriosis. (The sperm normally enter the uterus through the cervix and, from the uterus, move into a fallopian tube, where fertilization of an ovum takes place.) During the few days prior to ovulation—release of an ovum from the ovary—the glands within the cervix normally secrete a thin, watery mucus that is beneficial to sperm survival and migration. Various factors, such as infection or estrogen deficiency, may decrease the quality of the mucus. Congenital anomalies of the reproductive organs may also cause infertility. Vaginal causes are usually uncommon, but obstruction may be due to an unruptured hymen or may be functional and arise from enlargement and contraction of the levator ani muscles (these muscles form a supporting sheet under the pelvic cavity, with openings for structures such as the anus and the vagina). Thyroid,

pituitary, adrenal, or ovarian disease may interfere with ovulation, as may the presence of large numbers of cysts in the ovaries (the condition known as Stein-Leventhal syndrome). Finally, emotional factors may play a role in causing infertility.

Treatment consists of the use of various hormones, surgical correction of tubal blockage, and psychotherapy.

Affecting the female system abnormalities of menstrual function include painful menstruation, or dysmenorrhea; excessive blood loss during each menstrual cycle, known as menorrhagia; irregular bleeding, or metrorrhagia; absence of menstruation, called amenorrhea; and dysfunctional uterine bleeding. In addition, many women experience premenstrual syndrome, a group of physical and emotional symptoms that occur before the onset of each cycle. A few women have transient abdominal discomfort at the time of ovulation because of slight bleeding from the follicle into the peritoneal cavity; oral contraceptives will remedy the condition by suppression of ovulation, or the discomfort can be treated with pain medications such as ibuprofen or naproxen.

Dysmenorrhea

Dysmenorrhea is painful cramps felt before or during menstruation; the pain is sometimes so severe as to interfere with daily activities. Pain is adequately controlled with drugs that block prostaglandin formation.

Secondary dysmenorrhea results from pelvic disease such as inflammation of the tubes and ovaries, or from endometriosis. In endometriosis, deposits of endometrium, which undergo cyclic response to the ovarian hormones, are found in the ovaries and in other sites outside of their normal location; these deposits form blood-filled cysts, and pain and excessive bleeding result. In painful menstruation secondary to pelvic disease there is, before menstruation, pain associated with a feeling of congestion, and the menstrual bleeding is often excessive. Treatment is directed toward the underlying disorder.

Menorrhagia

Excessive menstrual bleeding, or menorrhagia, may be due to an imbalance of the thyroid or adrenal hormones, but it may also be the result of local disease of the pelvic organs. This local disease may be inflammation due to infection; it may be a benign tumour such as a fibroid; it may be a polyp, or projecting mass of endometrium; or it may be a cancer, especially after age 35. Some types of local pelvic disease may require removal of the uterus (hysterectomy) or treatment by chemotherapy or radiation, but polyps and some fibroids can be removed without loss of the uterus.

As the menopause approaches, extremely heavy bleeding may occur, causing anemia, tiredness, and ill health. Menorrhagia in this instance is due to overdevelopment of the endometrium as a result of excessive or unbalanced action of estrogens. Younger or childless women can be treated with progestogens; for others removal of the uterus may be necessary.

Metrorrhagia

Bleeding between menstrual periods, after intercourse, and at or after menopause is frequently due to some abnormality of the cervix; the possibility of cancer must be borne in mind. Such bleeding may also come from a polyp on the cervix or a cervical erosion. Treatment is often unnecessary, but erosions are easily treated by cauterization. Polyps require removal.

Irregular bleeding also may occur during pregnancy when there is danger of miscarriage; if any menstrual periods have been missed, this possibility must be considered.

Amenorrhea

Amenorrhea, or absence of menstruation, is normal during pregnancy and for a variable time after delivery. If the mother is breast-feeding her baby, as much as six months may pass before return of menstruation; earlier return of menstruation is not abnormal and is to be expected if the mother is not producing milk. Pregnancy is the most common cause of amenorrhea during the reproductive years.

Primary amenorrhea is the absence of menstruation in a woman who has never previously menstruated. In rare cases, primary amenorrhea is due to gonadal dysgenesis, the failure of the ovaries to develop normally, and may be associated with chromosomal abnormalities. Instead of the normal female complement of 46 chromosomes in each cell, including two X chromosomes, a patient may have only one X chromosome (Turner syndrome) or even a male pattern of an X and a Y chromosome (Swyer syndrome). In such persons the uterus and fallopian tubes often are absent, although the general physique may be female. Even with normal ovaries, absence of the uterus occasionally occurs. A less rare abnormality is vaginal atresia, or closure, an obstruction of the vagina by a membrane just above the level of the hymen; menstruation occurs, but the discharge cannot escape and distends the vagina. This condition, called false amenorrhea or cryptomenorrhea, is easily corrected by an incision in the membrane.

Cessation of periods after menstruation has been established but before the normal time for the menopause is usually the result of some general illness, emotional stress, or mental disorder. It may also be due to disease of the endocrine system, not only of the pituitary gland but of other endocrine glands as well. Secondary amenorrhea results if the ovaries are removed or are irradiated but is unlikely to be caused by ovarian disease, as both ovaries would have to be damaged to stop all function. Stein-Leventhal syndrome is a functional disorder of the ovaries in which production of estrogens is disturbed. Symptoms of this disorder include abnormal growth of facial hair because of abnormal androgenic—that is, masculinizing—activity. An ovarian tumour that secretes androgenic hormone, also called an arrhenoblastoma, is another extremely rare cause of amenorrhea and abnormal growth of hair. Most cases of secondary amenorrhea are temporary, and spontaneous improvement is to be expected, especially when the cause is some general illness or emotional stress. The feasibility of treatment with hormones is determined by a general medical examination and a complete pelvic examination.

Dysfunctional uterine bleeding

Dysfunctional, or anovulatory, uterine bleeding occurs most often in women during early adolescence and immediately before menopause begins. It is thought to be caused by imperfect ovarian functioning. Estrogens are produced in a cycle in amounts sufficient to cause endometrial proliferation, but ovulation does not occur. The endometrium breaks down and bleeds in each cycle as the estrogens are withdrawn. Cycles of this type occur in women who are using oral contraceptives. Dysfunctional bleeding can also be associated with obesity, excessive exercise, or emotional stress.

Affecting the male system

Impotence

Impotence is inability of the male to have satisfactory sexual intercourse and varies in form from the inability to gain an erection to weak erections, premature ejaculation, or loss of normal sensation with ejaculation. It may be caused by subnormal functioning of the testes, by arteriosclerosis (hardening of the arteries), by diabetes, by psychological factors, or by a disease of the nervous system. Certain medications prescribed for the treatment of such diseases as peptic ulcer, hypertension, or psychiatric illness may adversely affect sexual ability. Therapy includes drug therapy (PDE-5 inhibitors such as Viagra), administration of hormones, or psychotherapy.

Priapism

Priapism is prolonged penile erection that is painful and unassociated with sexual stimulation. The blood in the spaces of the corpora cavernosa becomes sludgelike and may remain for hours or even days. About 25 percent of the cases are associated with leukemia, sickle cell anemia, metastatic carcinoma (cancerous development at a distance from the primary site), or diseases of the nervous system, but in the majority of cases the causation is not clear. There have been many forms of treatment, but drug therapy is effective in most cases. Regardless of treatment, impotence is common after an episode of priapism and even more common after repeated episodes of priapism.

Sexually transmitted diseases

Sexually transmitted diseases (STDs), also called venereal diseases, are usually contracted during sexual intercourse with an infected partner. The principal disorders commonly transmitted in this manner include AIDS, syphilis, gonorrhea, chlamydia, and genital herpes.

Syphilis

Syphilis is caused by the bacterial spirochete *Treponema pallidum*. Although known in Europe since the 15th century, syphilis was not recognized as a sexually transmitted disease until some 200 years ago. It first appears as a painless sore, called a chancre, on the skin or mucous membranes of the genitals two to four weeks after unprotected sexual contact with an infected partner, although the initial symptoms may appear in other areas in unusual cases. The infection induces antibodies against *T. pallidum* that can be identified in the bloodstream by various tests some weeks after the initial infection. If untreated, the chancre disappears, and the person develops a rash on the genitals (secondary syphilis). Subsurface nodules, called gumma, appear in the tertiary stage of the disease. The organism invades the nervous system at an early stage, but neurologic symptoms, including behavioral aberrations, often do not occur until the infection has been present for several years. Antibiotics, usually penicillin, are used to treat all stages of syphilis but are most effective during the primary stage; antibiotics can also prevent transmission of the infection from a pregnant woman to her fetus, which could result in miscarriage or severe congenital defects.

Gonorrhea

Gonorrhea is caused by *Neisseria gonorrhoeae*, a type of bacteria with an extremely short incubation period, making it difficult to interrupt the chain of transmission. Infection, almost invariably due to unprotected sexual intercourse with an infected partner, can be prevented by the use of a condom. The chief symptom of gonorrhea in the male is pain or burning during urination, although there also may be a discharge from the penis. Some 50 percent of infected females are asymptomatic; in symptomatic cases the signs of infection are similar to those seen in the male. Gonorrhea

spreads locally along mucosal surfaces, ascending the urethra in the male and either the vagina or the urethra in the female. The bacteria may also be disseminated through the blood to more-distant sites; systemic manifestations include headache and, if untreated, arthritis or heart disease.

Nongonococcal urethritis

Although nongonococcal urethritis (NGU) is caused by a variety of microorganisms, it is most commonly attributed to *Chlamydia* species, which also cause lymphogranuloma venereum (*see below*). In about half the cases, an infectious transmission is strongly implicated. The symptoms are chiefly pain and burning on urination but are generally milder than those of gonorrhea. Treatment is with antibiotics.

Genital herpes

Genital herpes is caused by two types of herpes simplex virus: type 1 (HSV-1; the cause of cold sores of the lips and mouth) and type 2 (HSV-2). The disease first appears as groups of small blisters on the surface of the penis in men and the vulva in women. The initial infection clears spontaneously within two to three weeks, but herpes commonly recurs with varying frequency thereafter, burning or itching at the infection site containing the lesions. Herpes is generally transmitted only when an active lesion is present; it can be prevented by avoidance of intercourse during the active phase. The risk of transmission is diminished by the use of a condom. Active herpes can be fatal to infants during delivery; in a large percentage of cases, it causes blindness or brain damage in newborns. In women, genital herpes has also been associated with cervical cancer. Antiviral treatment early in the course of the disease may decrease the duration of symptoms.

Another common herpesvirus, cytomegalovirus (CMV), is associated with high mortality in persons with weakened immune systems.

Chancroid

Chancroid, also called soft sore, is caused by the microorganism *Haemophilus ducreyi* and occurs chiefly in developing countries. The bacteria has a short incubation period, producing small red pustules generally within fewer than five days after exposure;

the pustules burst to form painful ulcers, and the disease can be diagnosed by culturing bacteria from these ulcers. Unlike syphilis, which it may resemble, chancroid is a purely localized disease of the genitals. Treatment is with antibiotics.

Lymphogranuloma venereum

Lymphogranuloma venereum, which is common in the tropics but very rare in temperate regions, is caused by *Chlamydia trachomatis*. It is usually transmitted through intercourse but may be contracted in other ways. Typically, a transient genital blister is followed by regional inflammation of the lymph nodes. If untreated, this condition may progress to genital elephantiasis. Treatment is with broad-specturm antibiotics. Surgical removal of diseased tissue may be necessary.

Genital warts

Genital warts, also called condyloma acuminata, are caused by human papillomavirus, which is related to the virus that produces common warts. The wart begins as a pinhead-sized swelling that enlarges and becomes pedunculated; the mature wart is often composed of many smaller swellings and may resemble the genital lesions of secondary syphilis.

Granuloma inguinale

Granuloma inguinale is caused by infection with *Calymmatobacterium granulomatis* and occurs primarily in tropical and subtropical climates, including the southern United States. Initial symptoms are painless papules that become ulcerated, ultimately forming granulomatous masses that tend to bleed easily. These lesions occur on the genitals, thighs, and groin of infected persons and may resemble syphilis lesions. Cancer has also been associated with granuloma inguinale. Treatment is with antibiotics.

Candidiasis

Local infections with the yeast *Candida albicans* in men almost always are acquired through sexual contacts, but in women, in whom candidiasis is much more common, the infection can be acquired in a variety of ways. In men, candidiasis involves the surface of the glans penis, causing intense burning or itching. In women, candidiasis

frequently produces vaginal and vulval irritation, production of a thick white discharge, or pain during urination. The diagnosis is made by culturing yeast from the involved area; treatment is by local antifungal agents.

Trichomoniasis

Infection with the flagellate protozoan *Trichomonas vaginalis* is usually, but not exclusively, spread by sexual contact. The condition is commonly asymptomatic in males. In females trichomoniasis has a variety of manifestations, including vaginal discharge, irritation of the genitals, and pain during intercourse or urination. Both sexes may experience complications, such as cystitis and urethritis; males may also develop prostatitis and epididymitis. Treatment with metronidazole, an antibacterial and antiprotozoal agent, is standard.

6. **Translate the underlined and written in bold words into Ukrainian.**

7. **Prepare the description of two urinary and reproductory systems' disorders. Make the class guess what they are.**

TESTS

Test 1.

1._____ protects the all-important brain and supports the other soft tissues of the head.

A coccyx

B the skull

C the articular capsule

2. The _____is the lower, medial part of a construction, or neck, just below the head of the femur.

A lesser trochanter

B navicular bone

C pelvis

3. _____are the remaining five pairs of ribs (the other seven are called true ribs) in which their cartilages do not reach the sternum directly.

A Clavicles

B The anterior longitudinal ligament

C The false ribs

4. The _____, commonly known as the breastbone, is a long, narrow flat bone that serves as the keystone of the rib cage and stabilizes the thoracic skeleton.

A talus

B deltoid ligament

C sternum

5.The _____ is the largest and most superior of the three bones that join to form the hipbone, or os coxa.

A ilium

B talus

C ste_num

6. The _____ is the both the largest bone in the arm and the only bone in the upper arm.

A humerus

B talus

C sternum

7. The _____ is a palmar ligament and is a strong, fibrous band.

A pisometacarpal ligament

B ante_=rior longitudinal ligament

C articular capsule

8. _____ consists of strong, dense fibers, located inside the bodies of the vertebrae.

A The tailbone

B The lesser trochanter

C The anterior longitudinal ligament

9. The _____ is one of the seven bones that make up the tarsus, or ankle bones.

A navicular bone

B cuboid bone

C bone

10. The _____is one of the seven tarsal, or ankle, bones. This bone, along with the other tarsal bones, forms a group called the tarsus.

A cuboid bone

B navicular bone

C talus

Test 2.

1. is a muscle in humans that originates along the upper two-thirds of the lateral (outside) surface of the tibia and inserts into the medial cuneiform and first metatarsal bones of the foot. It acts to dorsiflex and invert the foot. is a muscle in humans that originates along the upper two-thirds of the lateral (outside) surface of the tibia and inserts into the medial cuneiform and first metatarsal bones of the foot. It acts to dorsiflex and invert the foot.

A anterior muscle

sternocleidomastoid

B deltoids

C supinator

2. is the muscle forming the rounded contour of the human shoulder. It is also known as the 'common shoulder muscle', particularly in other animals such as the domestic cat.

A tibilas

B The deltoid muscle

C elbow joint

3. also known as the "abdominal muscle" or simply the "abs", is a paired muscle _unning vertically on each side of the anterior wall of the human abdomen, as well as that of some other mammals.

_____

4. .....is a broad muscle in the posterior compartment of the forearm, curved around the upper third of the radius. Its function is to supinate the forearm.

A occipital bone

B cranius

C The rectus abdominis muscle

5……. is a cranial dermal bone and the main bone of the occiput (back and lower part of the skull). It is trapezoidal in shape and curved on itself like a shallow dish.

_____

6. a complex hinge joint formed between the distal end of the humerus in the upper arm and the proximal ends of the ulna and radius in the forearm.

_____

7.is a ligamentous structure that is triangular in shape and attaches the medial malleolus of the tibia to the navicular, calcaneus, and talus (anteriorly and posteriorly) bones of the tarsus.

_____

8. The_____, commonly known as the breastbone, is a long, narrow flat bone that serves as the keystone of the rib cage and stabilizes the thoracic skeleton.

A shoulder joint

B ilium

C the deltoid ligament

Test 3

1. _____ is a vein on the posterior side of the heart that returns deoxygenated blood from the myocardium to the vena cava.

A red bone marrow

B The coronary sinus

C immune system

2. _____ is a type of protein that is soluble in water and in water half saturated with a salt such as ammonium sulfate.

A Albumin

B Leukocyte

C Red marrow

3. The _____ within plasma include antibodies and albumins.

A albumins

B antibodies

C proteins

4. Also known as _____, platelets are small cell fragments responsible for the clotting of blood and the formation of scabs.

5. The liver removes toxins, stores sugars, and processes the products of digestion before they reach the other body tissues.

T True

F False

6. Albumins connect to arterioles on one end and venules on the other.

T T_ue

F False

7. The endothelium lines the entire circulato_y system, all the way to the inte_ior of the heart, where it is called the _____

8. There are 2 primary circulatory loops in the human body: the *pulmonary circulation loop* and the _____ *circulation loop.*

Test 4

1. _____ are accessory organs that produce a watery secretion known as saliva.

2. Because the pharynx serves two different functions, it contains a flap of tissue known as the _____

3. The esophagus is a muscular tube connecting the pharynx to the stomach that is part of the upper gastrointestinal tract.

A The glands

B The saliva_y glands

C The cords

4. The small intestine is a long, thin tube about 1 inch in diameter and about 2 feet long that is part of the lower gastrointestinal tract

A epiglottis

B larynx

C cord

5. The _____ is a part of the brain located superior and interior to the brain stem and infe_ior to the thalamus.

A thymus

B hype_thalamus

C hypothalamus

6. The pituitary gland, also known as the _____, is a small pea-sized lump of tissue connected to the inferior portion of the hypothalamus of the brain.

T T_ue

F False

7. The anterior pituitary gland is the true glandular part of the pituitary gland.

T True

F False

8. The_____ is a butterfly-shaped gland located at the base of the neck and wrapped around the lateral sides of the trachea.

A thyroid gland

B gland

C pineal gland

Test 5

1. _____ are agranular leukocytes that can fo_m 2 types of cells: macrophages and dendritic cells

2. ·The _____connects the lymphatic vessels of the legs, abdomen, left arm, and the left side of the head, neck, and thorax to the left brachiocephalic vein.

3. _____are small masses of lymphatic tissue found in the ileum of the small intestine.

4.The _____ is a small, triangular organ found just posterior to the sternum and anterior to the heart.

5.

5. _____, also known as nerve cells, communicate within the body by transmitting electrochemical signals.

6. _____, also known as glial cells, act as the "helper" cells of the nervous system.

7. The _____ are the protective coverings of the central nervous system

8. The _____, which means "spider-like mother," is much thinner and more delicate than the dura mater.

Nanotechnological applications in medicine

Author links open overlay panelShelton DCaruthers[12]Samuel AWickline[1]Gregory MLanza[1]

Nanotechnology-based tools and techniques are rapidly emerging in the fields of medical imaging and targeted drug delivery. Employing constructs such as dendrimers, liposomes, nanoshells, nanotubes, emulsions and quantum dots, these advances lead toward the concept of personalized medicine and the potential for very early, even pre-symptomatic, diagnoses coupled with highly-effective targeted therapy. Highlighting clinically available and preclinical applications, this review explores the opportunities and issues surrounding nanomedicine.

Introduction

'Molecular imaging' is a phrase that has come into heavy use within the past decade. It is a broad term, difficult to define. Although the initial use implied imaging novel contrast agents to probe molecular information [1], the current use has evolved to include a wide scope of imaging techniques that use molecular agents or rely on molecular signatures. These include virtually all positron emission tomography imaging (indeed all nuclear medicine techniques requiring radioactive or radiolabeled molecules), magnetic resonance spectroscopy, and other parametric magnetic resonance imaging techniques (like diffusion-weighted imaging). Similarly, the term 'nanomedicine' is difficult to define precisely, as much of what transpires in human biology happens at the nanometer scale. Thus, one might successfully argue that all medicine is 'nanomedicine'. Herein, we discuss nanomedicine as the application of technologies on the scale of approximately 1 to 500 nm toward the goal of diagnosing and treating disease.

Within the past decade, there has been a plethora of new research, development and patent activities around nanoscaled technologies in the health sciences field [2•]. One indicator of this is the flurry of activity around the National Nanotechnology Initiative [3]

of the US government and, in particular, those initiatives of the National Institutes of Health (NIH). Within the National Cancer Institute (NCI) alone, the Alliance for Nanotechnology in Cancer program (http://nano.cancer.gov/) has launched eight Centers of Cancer Nanotechnology Excellence (http://nano.cancer.gov/programs/ccne.asp) and twelve Cancer Nanotechnology Platform Partnerships (http://nano.cancer.gov/programs/nanotech_platforms.asp) [4]. The Program for Excellence in Nanotechnology (http://www.nhlbi-pen.info/) of the National Heart, Lung and Blood Institute is another instance of the profuse programs fueling this growing research arena. To help facilitate the transfer of nanotechnological research into clinical practice, the NCI, in conjunction with the National Institute of Standards and Technology and the US Food and Drug Administration (FDA), has also established the National Characterization Laboratory (http://ncl.cancer.gov/).

The overall goal of nanomedicine is the same as it always has been in medicine: to diagnose as accurately and early as possible, to treat as effectively as possible without side effects, and to evaluate the efficacy of treatment non-invasively. The promise that nanotechnology brings is multifaceted, offering not only improvements to current techniques but also providing entirely new tools and capabilities. By manipulating drugs and other materials at the nanometer scale, the fundamental properties and bioactivity of materials can be altered. These tools can permit control over characteristics of drugs or agents such as solubility, blood pool retention times, controlled release over short or long durations, environmentally triggered controlled release or highly specific site-targeted delivery. Furthermore, by using nanometer-sized particles, the increased functional surface area per unit volume can be exploited in various ways.

This review presents some of the more recent successes of applying various new nanotechnological techniques and tools in diagnostic imaging and therapeutics, including both current products and late-stage preclinical research. It will not delve into screening or *in vitro* diagnostics, although nanotechnological applications certainly abound in these areas (e.g. improvements to ‘laboratory on a chip’ technologies like microarrays and

microfluidics [5, 6]). Nor will this review focus on the many advances in biomedical laboratory research tools and techniques resulting from nanotechnology.

Section snippets

Diagnostic imaging in nanomedicine

Combining advances in related fields such as genomics, proteomics, drug delivery and molecular imaging, nanomedicine offers the potential to move from a ‘one-size-fits-all’ approach to one more individually tailored for higher efficacy [1, 7]. For diagnosis, this translates to recognition and characterization of very early (even pre-symptomatic) disease providing assessment, preferably non-invasively, akin to that of immunohistochemistry. Of course doing so is complex, requiring simultaneous

Controlled drug delivery

Unfortunately, early diagnosis is futile if not coupled with effective therapy. Owing in part to the national nanotechnology initiatives, there has been much activity in applying nanotechnology to therapeutics [38, 39, 40, 41, 42•]. Currently, there are limited numbers of nanomedical products on the market [2•], with the majority being pharmaceuticals that are formulated (or re-formulated) into nanosized structures to manipulate the pharmacodynamics, biodistribution and overall effectiveness.

Limitations and considerations in nanomedicine

Obviously, not all attempts to apply new nanotechnology approaches in medicine have met with the same success as those cited herein. The new tools are not necessarily intuitive and bring with them new challenges and hurdles. Nanometer-sized structures do not behave in the same predictive ways that single, small-molecule interactions occur. Nanoconstructs, especially multifunctional ones, are complex three-dimensional objects with critical dependence on position, size, shape and charge of

Conclusions

Nanotechnology, in general, is experiencing a rapid growth period with major advances arriving quickly. Accordingly, these advances are applied in the biomedical field in numerous diverse ways. Already, a few medical products are providing a glimmer of

the overwhelming benefits nanomedicine will surely provide. Current preclinical research promises new ways to diagnose disease, to deliver specific therapy, and to monitor the effects acutely and non-invasively. This rapid onset and drastic

Disclosure statement

SDC is an employee of Philips Medical Systems. SAW and GML receive research grant funding from Philips Medical Systems and are equity shareholders in Kereos.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

• of special interest

•• of outstanding interest

References (55)

R. Rossin *et al.*

^{64}Cu-labeled folate-conjugated shell cross-linked nanoparticles for tumor imaging and radiotherapy: synthesis, radiolabeling, and biologic evaluation

J Nucl Med (2005) G.R. Reddy *et al.*

Vascular targeted nanoparticles for imaging and treatment of brain tumors

Clin Cancer Res (2006) M.S. Lesniak *et al.*

Drug delivery to tumors of the central nervous system

Curr Neurol Neurosci Rep (2001)

L. Cattel *et al.*

From conventional to stealth liposomes: a new Frontier in cancer chemotherapy

J Chemother (2004)

A.H. Schmieder *et al.*

Molecular MR imaging of melanoma angiogenesis with alphanubeta3-targeted paramagnetic nanoparticles

Magn Reson Med (2005)

M. Manchester *et al.*

Virus-based nanoparticles (VNPs): platform technologies for diagnostic imaging

Adv Drug Deliv Rev (2006) R. Banerjee

Liposomes: applications in medicine

J Biomater Appl (2001) S. Svenson *et al.*

Dendrimers in biomedical applications–reflections on the field

Adv Drug Deliv Rev (2005)

R. Weissleder *et al.*

Ultrasmall superparamagnetic iron oxide: an intravenous contrast agent for assessing lymph nodes with MR imaging

Radiology (1990)

J.H. Sakamoto *et al.*

The molecular analysis of breast cancer utilizing targeted nanoparticle based ultrasound contrast agents

Technol Cancer Res Treat (2005)

Pasma Processes and Polymers

Introduction

In physical sciences, “plasma” refers to the forth state of matter; while in medicine and biology plasma is known as the non-cellular fluid component of blood. Interestingly, the term plasma has been coined by Irving Langmuir to emphasize that the characteristics of ionic liquids ubiquitous in biology and medicine are analogous to plasma in the physical sciences.**1** Despite this historical connection, few applications of plasma in medicine have been explored until recently.**2** This situation is rapidly changing, and the main purpose of this review is to provide an update on the recent research related to applications of plasma in medicine and to possible mechanisms of interaction between plasma and living matter.

Plasma can exist in a variety of forms and can be created in different ways. In many technological applications, for example, plasma exists at low gas pressures. Lightening, on the other hand, is an example of atmospheric pressure thermal plasma. For the purpose of this article, it is important to distinguish between thermal and non-thermal plasma. In all plasmas supported by electric field, electrons receive the external energy much faster than the much heavier ions and have the opportunity to heat up to several thousands of degrees before their environment heats up. In *non-thermal* plasma, cooling of ions and uncharged molecules is more effective than energy transfer from electrons and the gas remains at low temperature. For this reason non-thermal plasma is also called non-equilibrium plasma. In a *thermal* plasma, on the other hand, energy flux from electrons to heavy particles equilibrates the energy flux from heavy particles to the environment only when temperature of heavy particles becomes almost equal to the electron temperature. Of course the terms thermal and non-thermal, equilibrium and non-equilibrium are not very precise. Sometimes even a few tens of degrees difference in the temperature of the heavier species can play a substantial role. This is particularly important when various plasma-chemical processes are considered. It is certainly important when plasma is used to treat heat-sensitive objects.

Some of the earlier applications of plasma in medicine relied mainly on the thermal effects of plasma. Heat and high temperature have been exploited in medicine for a long time for the purpose of tissue removal, sterilization, and cauterization (cessation of bleeding).**3** Warriors have cauterized wounds by bringing them in contact with red hot metal objects since ancient times. Electrocautery is a more modern technique which applies controlled heat to surface layers of tissue by passing sufficiently high current through it.**4** However, contact of tissue with metal surface of a cautery device often results in adhesion of charred tissue to the metal. Subsequent removal of the metal can peel the charred tissue away re-starting bleeding. Some of the earlier applications of plasma in medicine provided an alternative to metal contact electrocautery. In argon plasma coagulation (APC, also sometimes called argon beam coagulation), highly conductive plasma replaced the metal contacts in order to pass current through tissue avoiding the difficulties with tissue adhesion. Hot plasma is also being employed to cut tissue,**3**, **5**-**8** although the exact mechanism by which this cutting occurs remains unclear. Heat delivered by plasma has also been employed recently for cosmetic re-structuring of tissue.**9**-**11**

What differentiates more recent research on applications of plasma in medicine is the exploitation of non-thermal effects. Why are non-thermal effects of plasma so interesting and promising? The main reason is that non-thermal plasma effects can be tuned for various sub-lethal purposes such as genetic transfection,**12**-**14** cell detachment,**15**-**18** wound healing,**19**-**23** and others (i.e.,**2**, **24**, **25**). Moreover, non-thermal effects can be selective in achieving a desired result for some living matter, while having little effect on the surrounding tissue. This is the case, for example, with recent plasma blood coagulation and bacteria deactivation which does not cause toxicity in the surrounding living tissue.**19**, **20** This review will concentrate mainly on these novel non-thermal effects and on possible non-thermal mechanisms of interaction between plasma and living organisms.

Most of the research focusing on the use of non-thermal plasma effects in medicine can be fit into two major categories: that are *direct* plasma treatment and *indirect* plasma treatment.**26** In direct plasma treatment, living tissue or organs play the role of one of the plasma electrodes. In many cases, voltage does not need to be directly connected to this living tissue electrode, but some current may flow through living tissue in the form of either a small conduction current, displacement current, or both. Conduction current should be limited in order to avoid any thermal effects or electrical stimulation of the muscles. Direct plasma treatment may permit a flux of various active uncharged species of atoms and molecules as well as ultraviolet (UV) radiation to the surface of the living tissue. These active uncharged species generated in plasma will typically include ozone (O_3), NO, OH radicals, etc. However, the most important distinguishing feature of the direct plasma treatment is that a significant flux of charges reaches the surface of the living tissue. These charges may consist of both electrons as well as positive and negative ions.

In contrast, indirect plasma treatment employs mostly uncharged atoms and molecules that are generated in plasma, but involves small, if any, flux of charges to the surface. In indirect treatment, the active uncharged species are typically delivered to the surface via flow of gas through a plasma region.

Both indirect and direct non-thermal plasma treatments permit some degree of tuning of the plasma properties.**26** For example, the amount of NO versus ozone produced in plasma can be tuned. It is also possible to tune microstructure of the plasma discharge which can be particularly relevant in direct treatment. The fact that direct plasma treatment involves substantial charge flux provides greater flexibility in tuning the non-thermal plasma effects. Indirect plasma treatment, on the other hand, may have an advantage when the plasma device needs to be at a substantial distance from the surface.

Animal and Human Living Tissue Sterilization

Direct Plasma Medicine, Floating-Electrode Dielectric Barrier Discharge (FE-DBD)

The *direct* plasma treatment implies that living tissue itself is used as one of the electrodes and directly participates in the active plasma discharge processes. For example, Figure **1** illustrates direct plasma treatment (for sterilization) of skin of a live mouse. Dielectric barrier discharge (DBD) plasma is generated in this case between the quartz-surface covered high-voltage electrode and the mouse which serves as a second electrode.

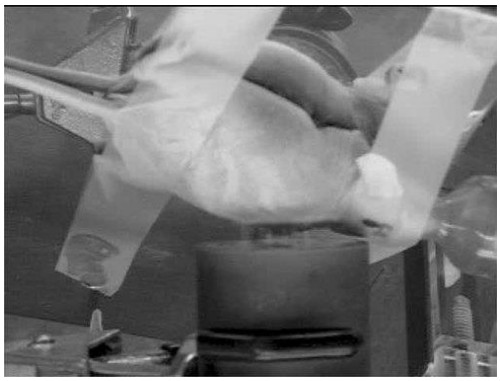

Figure 1

Open in figure viewerPowerPoint

Non-damaging room temperature and atmospheric pressure FE-DBD plasma for the treatment of living tissue: animal treated for up to 10 min remains healthy and no tissue damage is observed visually or microscopically.**20**

Direct application of the high-voltage (10–40 kV) non-thermal plasma discharges in atmospheric air to treat live animals and people requires a high level of safety precautions. Safety and guaranteed non-damaging regimes are the crucial issues in the plasma medicine. Discharge current should be obviously limited below the values permitted for the treatment of living tissue. Moreover, discharge itself should be homogeneous enough to avoid local damage and discomfort. Creation of special atmospheric discharges effectively solving these problems is an important challenge for plasma medicine.

Fridman et al. especially developed for this purpose the floating-electrode DBD (FE-DBD), which operates under the conditions where one of the electrodes is a dielectric-protected powered electrode and the second active electrode is a human or animal skin or organ–without human or animal skin or tissue surface present discharge does not

ignite.**19**, **20**, **26**, **27** In the FE-DBD setup, the second electrode (a human, for example) is not grounded and remains at a floating potential. Discharge ignites when the powered electrode approaches the surface to be treated at a distance (discharge gap) less than about 3 mm, depending on the form, duration, and polarity of the driving voltage.

Simple schematic of the FE-DBD power supply (PS) and voltage/current oscillograms are illustrated in Figure **2**.**19** Typical value of plasma power in initial experiments was kept about 3–5 W, surface power density 0.5–1 $W \cdot cm^{-2}$. Further development of the FE-DBD discharge is related to optimization of shape of the applied voltage to minimize the DBD non-uniformities and related possible damaging effects. The best results so far have been achieved by organization of the FE-DBD in the pulsed mode with pulse duration below 30–100 ns,**28**-**30** which results in the no-streamer discharge regime, sufficient uniformity, and possibility of the non-damaging direct plasma treatment even when the second electrode is a living tissue and therefore wet, dirty, and essentially non-uniform.

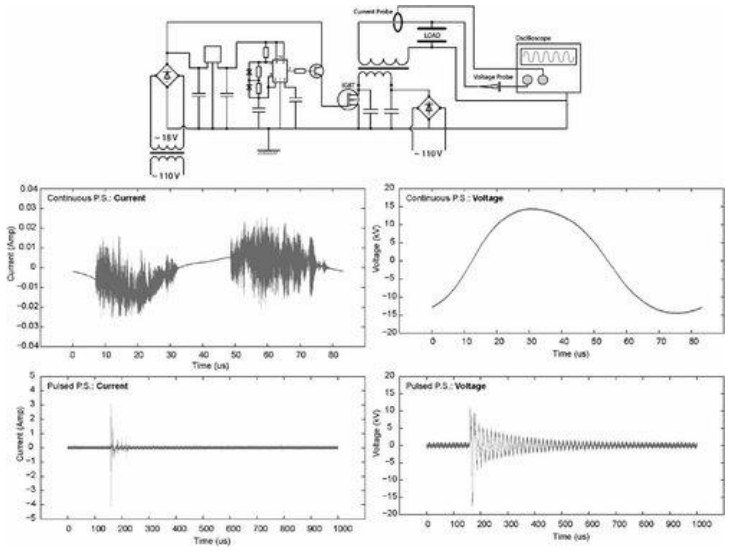

Figure 2

Open in figure viewerPowerPoint

Schematic of FE DBD discharge plasma PS. Voltage and current oscillograms.**19**

As soon as the atmospheric discharge is safe, it can be effectively applied directly to human body as it is illustrated in Figure **3**. Thus, the highly intensive and effective non-

thermal plasma devices can be directly applied to living animal or human tissue for different types of medical and cosmetic treatment. As a first example, let us consider medical sterilization of living tissue.

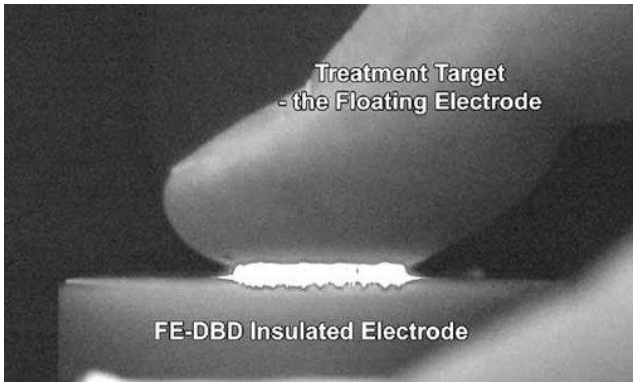

Figure 3

Open in figure viewerPowerPoint

FE-DBD applied directly to the human body.**20**

Direct Plasma-Medical Sterilization of Living Tissue using FE-DBD Plasma

Sterilization of living animal or human tissue with minimal or no damage to this tissue is of importance in a hospital setting. Chemical sterilization does not always offer a solution. For example, transporting chemicals for sterilization becomes a major logistics problem in a military setting, while use of chemicals for sterilization of open wounds, ulcers, or burns is not possible due to the extent of damage they cause to punctured tissues and organs. Non-thermal atmospheric pressure plasma is non-damaging to the animal and human skin but quite a potent disinfecting and sterilizing agent,**20** which is to be discussed below.

Human tissue sterilization has been investigated by Fridman et al.**19**, **20** Bacteria in this case were a mix of "skin flora" – a mix of bacteria collected from cadaver skin containing Staphylococcus, Streptococcus, and Yeast. Direct FE-DBD plasma sterilization leads roughly to a 6-log reduction in bacterial load in 5 s of the treatment (Table **1**). Similar level of the skin flora sterilization using *indirect* DBD approach requires 120 s and longer of plasma treatment at the same level of the discharge power.**26**

Table 1. Bacteria sterilization results (in cfu · mL^{-1}).26

Original concentration	5 s of FE-DBD	10 s of FE-DBD	15 s of FE-DBD
10^9	850 ± 183	9 ± 3	4 ± 4
10^8	22 ± 5	5 ± 5	0 ± 0
10^7	6 ± 6	0 ± 0	0 ± 0

Sterilization of the skin flora on cadaver skin samples occurred in the experiments generally after 4 s of the treatment in most cases and 5–6 s in a few cases, depending on the initial bacterial contamination which varies greatly for different patients and different skin locations. Thus non-thermal atmospheric plasma, especially when it is applied directly, is an effective tool for sterilization of living tissue. It opens interesting possibilities for the non-thermal plasma applications in medicine including, in particular, pre-surgical patient treatment, sterilization of catheters (with points of contact with human body), sterilization of wounds and burns, as well as treatment of internal organs in gastroenterology.

Non-Damaging (Toxicity) Analysis of Direct Plasma Treatment of Living Tissue

Plasma has proven itself as an excellent sterilization tool for different surfaces.**2**, **20**, **24**, **31** One of the key questions in the direct plasma skin sterilization in medicine is if the skin remains intact after the sterilization. Moreover, the problem of non-damaging treatment (in other words: problem of toxicity**a**) is the key issue of all plasma medicine. Obviously, a topical treatment which damages the tissue surface would not be acceptable to medical community and thus first cadaver tissue was tested and then escalating skin toxicity trials were carried out on SKH1 hairless mice and pigs in the FE-DBD experiments of Fridman et al.**20** Cadaver tissue in these experiments was treated by FE-DBD plasma for up to 5 min without any visible or microscopic change in the tissue,

as was verified with tissue sectioning and staining via Hematoxylin and Eosin (H&E) procedure, which is illustrated in Figure **4**.

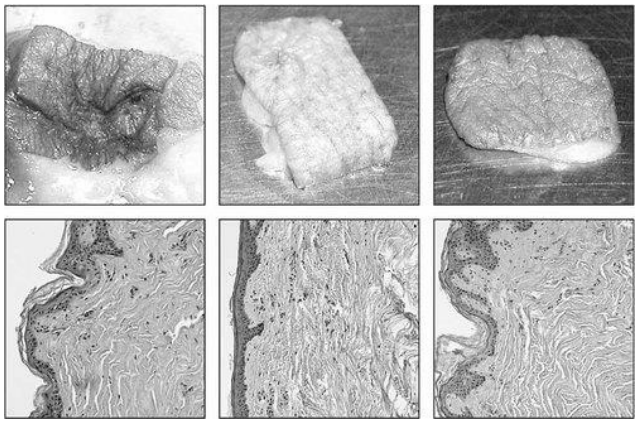

Figure 4

Open in figure viewerPowerPoint

Photos (top) and tissue histology (bottom) of cadaver skin samples after FE-DBD treatment: control (left), 15 s of the treatment (center), and 5 min of the treatment (right) – no visible damage is detected.**19**

Based on the knowledge that FE-DBD plasma has non-damaging regimes, an animal model to assess this was constructed and accomplished in ref.**20** In an SKH1 mouse model, the skin treatment was carried out at varying doses to locate damaging power/time (dose) combination and skin damage was analyzed in two stages. First, the animal was treated at what was deemed to be a toxic (damaging) dose based on trials with cadaver skin tissue (doses of >1 $W \cdot cm^{-2}$ and >10 min). Once the dose where the damage was visible was located, a new animal was treated at a lower dose. If no damage was observed at that dose, two more animals were treated and if no damage was observed in all the three the dose was deemed "maximum acceptable dose". Once the maximum dose was located, three animals were treated at that dose and left alive under close observation for 2 weeks.

Based on the experimental matrix, a dose of 10 min at 0.6 $W \cdot cm^{-2}$ was deemed maximum acceptable prolonged treatment and a dose of 40 s at 2.3 $W \cdot cm^{-2}$ was deemed maximum acceptable high-power treatment. Histological (microscopic) comparison of

control SKH1 skin sample with toxic and non-toxic plasma doses show regions where plasma dose is fairly high while the animal remains unaffected (Figure **5**, animal after the treatment, Figure **6**, histological samples). Of note is that sterilization was achieved at 3 ± 1 s at high-power treatment of 0.8 ± 0.2 W $\cdot$ cm^{-2} and at 10 ± 4 s at half that power. Variation in time necessary for sterilization is attributed to the initial contamination level of the animal (same as for cadaver tissue); in other words, some skin samples are simply cleaner than others.

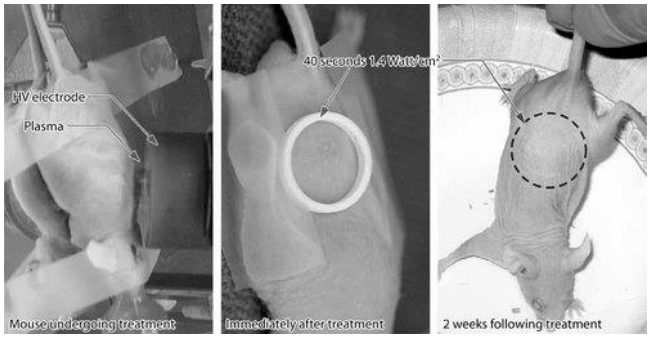

Figure 5

Open in figure viewerPowerPoint

Animal remains fine after a reasonably high plasma dose (more than ten times higher than needed for skin sterilization).**20**

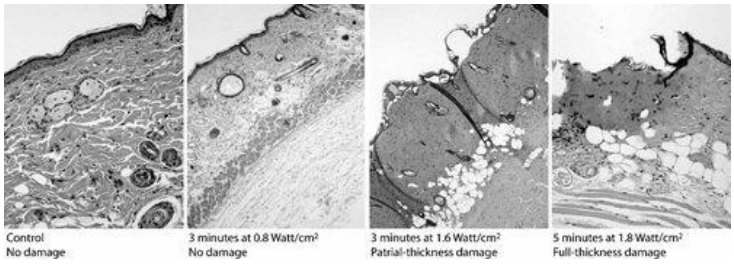

Figure 6

Open in figure viewerPowerPoint

Histology of toxic and non-toxic to animal's skin plasma doses, compared to untreated skin.**20**

Ability of FE-DBD plasma to treat living animal skin without damage to this skin was also confirmed in a second differential skin toxicity trial following the same protocol used for SKH1 mice (see above) but this time with regular swine.**32** Experiments showed

that non-damaging regimes exist and the animal skin exhibits no visible or microscopic damage (Figure **7**). Detailed analysis of any biochemical changes and inflammatory response pathway alteration or initiation is currently underway.**32**

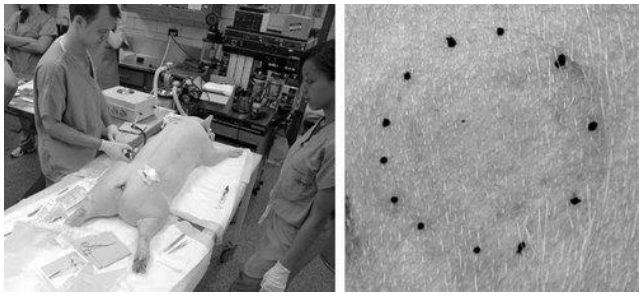

Figure 7

Open in figure viewerPowerPoint

Live pig undergoing treatment (left) and appearance of pig skin immediately following 5 min of FE-DBD treatment (right). Animal survives the treatment and no visible or microscopic tissue damage is observed.**32**

It should be especially noted that the level of toxicity due to the FE-DBD plasma treatment of living tissue not only depends on the treatment dose (discharge power, and treatment duration), but also strongly depends on the shape of voltage applied to the discharge. Pulsing of the DBD discharges can essentially decrease its damaging ability. Application of nanosecond pulses completely prevents the formation of streamers and therefore the DBD microdischarges, which helps significantly, decrease toxicity of the direct plasma-medical treatment of living tissue.**29**, **30**

Sterilization of Non-Living Objects for Medical Applications

Traditionally, sterilization or treatment of non-living objects like metals, plastics, fabrics, and other surfaces have been carried out either by temperature (i.e., autoclaves**33**-**36**), liquid or gaseous chemistry (i.e., by ethylene oxide,**37**, **38** ozone,**39**, **40** chlorine,**41**, **42** etc.), or at reduced pressure by non-equilibrium plasmas.**43**, **44** Details of such approaches are widely available in the literature. In this paper, the focus is on medical application of non-equilibrium plasma at atmospheric pressure and surface sterilization of materials cannot be overlooked because, after all,

these materials later come in contact with living tissue either as implants, dressings, tools, etc.

Alexeff and Laroussi and their coworkers reported a rather interesting modification of a conventional DBD – a resistive barrier discharge (RDB).**2**, **45**, **46** Main feature of the RDB is that it can function in both DC and AC modes, and rather than a dielectric a wetted high resistivity material is used. RDB has been shown to be effective in sterilization of *Escherichia coli*, *Bacillus subtilis*, and other organisms**2**, **31**, **46** without significant damage to the surface being processed. Going back to a more traditional DBD system, Laroussi and coworkers**47**-**50** show that a barrier discharge in helium with small additions of oxygen is not only able to sterilize bacteria but also able to influence metabolic changes in the organisms surviving the treatment.**48** This raises an intriguing question – can plasma-resistant bacteria emerge? Due to the synergetic effect of plasma constituents on bacteria, plasma-resistance might not be possible or statistically probable, however, the authors think that this issue might become rather important in the near future and should be addressed. Two more discharges are studied by Laroussi and coworkers: plasma plume (a helium jet),**51**, **52** and an arc-like discharge between metal and water in air.**53**, **54** Both discharges are also reported to efficiently inactivate various microorganisms.

Massines and coworkers propose a DBD discharge in N_2/N_2O mixture for microorganism inactivation (i.e., *B. subtilis* spores).**55**-**57** Operated at atmospheric pressure, her results indicate a very high dependence of the inactivation efficiency on UV, which is somewhat contrary to results presented by other groups.**55** In fact, the difference is attributed to the fact that the gas composition necessary to achieve the best results is in a very narrow concentration range of the oxidant molecule, which might have simply been overlooked previously. Though this study offers good information on UV, a real-life environment might need a system that is slightly less picky as to the gas mixture concentration ranges. However, one needs to account for effects of UV radiation on bacteria as apparently they cannot be neglected, even in plasmas where doses of UV are lower than in that proposed by Massines and coworkers.**55**

Microplasmas have recently been gaining momentum in bio-medical applications. These systems of 10–500 μm characteristic dimensions capable of generating diffuse atmospheric pressure plasmas offer an interesting solution in, for example, medical diagnostics and environmental sensing. Becker et al.**58**, **59** offer a few different microplasma sources suitable for remediation of gaseous waste streams, removal of volatile organic compounds (VOCs), detection of trace contaminants in gas flow, generation of high intensity UV radiation, and sources suitable for microsized plasma-reactors. Though the temperature of these discharges can be at or near room temperature in noble gases, when a molecular gas (i.e., air) is used plasma temperatures can be high, on the order of 2 000 K. Becker et al. show efficient inactivation of *B. subtilis* spores (1-log reduction in ≈100 s) and *B. stearothermophilus* spores (1-log reduction in ≈90 s) without damage to the substrate; more interestingly they are able to inactivate biofilms of *Chromobacterium violaceum* CV026 achieving 2-log reduction in ≈5 min and 3-log reduction in ≈60 min of plasma afterglow treatment.**58** In general, these microplasmas have not yet found a niche in medicine directly though many potential applications are clearly possible and the reader is encouraged to take a look at a review of the recent developments in that field.**59**

Roth and coworkers have developed a one atmosphere uniform glow discharge plasma (OAUGDP) system capable of addressing a broad range of potential applications.**60**-**66** OAUGDP is a DBD-like bipolar RF plasma discharge operated in air or other gases. The list of potential applications where experimental evidence is very favorable includes increase in surface energy and wettability of fabrics, films, and solid surfaces; sterilization of various surfaces for healthcare and food processing; decontamination of surfaces compromised by chemical or biological warfare agents; a sterilizable air filter to deal with the sick building syndrome; removal of soot and VOCs from diesel engine exhaust; mercury-free atmospheric pressure fluorescent lamps; stripping of photoresist and directional etching in microelectronics; plasma-assisted chemical vapor deposition; and plasma aerodynamic flow control. For details on these

applications reader is encouraged to consult a recent publication by Roth et al.**64** Of note, however, is a less recent publication from Roth's group comparing sterilization efficiency of their system against a multitude of bacteria, yeasts, and viruses.**61** *D*-values, or time to 90% reduction in microorganism load, are ranging from 6 s for *E. coli* bacteria to 6.8 min for bacteriophage Phi X 174 virus. Additionally survivability of these organisms on different substrates is addressed comparing glass, agar, and poly(propylene) with the later showing highest survival times. In general, OAUGDP was not reported to be used in medicine directly; however, sterilization of medical instruments and other surfaces found in the hospital as well as air sterilization in an operating room is on the list of potential medical applications.**64**

Kong and coworkers have investigated inactivation of various organisms by pulsed electric field,**67** and, primarily, by He/O_2 RF plasma afterglow (or jet).**68**-**77** Ability of their plasma setup to inactivate *B. subtilis* spores**68**, **72** and various *E. coli* mutants**73** does not come as a surprise, however the results on inactivation of biofilm-forming bacteria are quite intriguing. Vleugels et al.**75** have successfully achieved inactivation of biofilm-forming *Pantoea agglomerans* in sterilization of foods, specifically of bell peppers (*Capsicum annuum*). He/O_2 plasma afterglow was shown to effectively inactivate the biofilm without causing unacceptable levels of discoloration to the peppers.**75** Detailed analysis of this system reveals that the primary role in inactivation is played by reactive oxygen species (e.g., atomic oxygen and OH) with minor aid from UV photons, charged particles, heat, and electric fields.**68**, **71**, **73**, **74**, **76**, **77** Another interesting idea is not only sterilization of various surfaces but also complete decontamination of them with removal not only of bacterial load but also of the remaining protein debris. Deng et al. show that this RF plasma jet treatment can effectively remove proteins from surface of medical instruments, achieving up to 4.5-log reduction;**69**, **70** here, again, reactive oxygen species are deemed to be the major inactivation factors.

Non-Thermal Plasma-Assisted Blood Coagulation

General Features of the Plasma-Assisted Blood Coagulation

Blood coagulation is an important issue of medicine, in particular regarding wound treatment. Quasi-thermal plasma has been traditionally used for this application in the form of the so-called cauterization devices: APC, argon beam coagulators, etc.**3**, **5**, **8** In these devices, widely used in particular in surgery, plasma is just a source of local high temperature heating, which cauterizes and desiccates (actually cooks) the blood. Recent development of the effective non-thermal plasma-medical systems permits to achieve effective blood coagulation without any thermal effects. In such systems, which are to be discussed below, the cauterization effect is achieved through non-thermal plasma stimulation of specific natural mechanisms of blood coagulation without any "cooking" and damaging of the surrounding tissue.**19**

It should be mentioned that both coagulating the blood and preventing the coagulation could be needed, depending on the specific application. For example, in wound treatment one would want to close the wound and sterilize the surface around. Flowing blood, in that case, would prevent wound closure and create a possibility of re-introduction of bacteria into the wound. Where blood coagulation would be detrimental is, for example, in sterilization of stored blood in blood banks. There, a potential exists for blood to contain or to have somehow acquired bacterial, fungal, or viral infection which needs to be removed for this blood to be usable.**78**, **79** Here, of course, the treatment cannot coagulate the blood. Thus, clearly, an understanding of the mechanisms of blood coagulation by non-thermal plasma is needed. We are going to consider in this section the blood coagulation process stimulated by FE-DBD plasma.**19**, **20**, **80**, **81** Relevant *in vitro* and *in vivo* experiments will be followed up with discussion of the non-thermal plasma-stimulated blood coagulation mechanism.

Experiments with Non-Thermal Atmospheric Pressure Plasma-Assisted *in vitro* Blood Coagulation

FE-DBD plasma was experimentally confirmed to significantly hasten blood coagulation *in vitro*.**19**, **80**, **81** Visually, a drop of blood drawn from a healthy donor and

left on a stainless steel surface coagulates on its own in about 15 min, while a similar drop treated for 15 s by FE-DBD plasma coagulates in under 1 min (Figure **8**). FE-DBD treatment of cuts on organs leads to similar results where blood is coagulated without any visible or microscopic tissue damage. Figure **9** shows a human spleen treated by FE-DBD for 30 s – blood is coagulated and tissue surrounding the treatment area looks "cooked", however the temperature of the cut remains at room temperature (even after 5 min of FE-DBD treatment) and the wound remains wet, which could potentially decrease the healing time as is the case with topical wound sealing agents.**82**, **83**

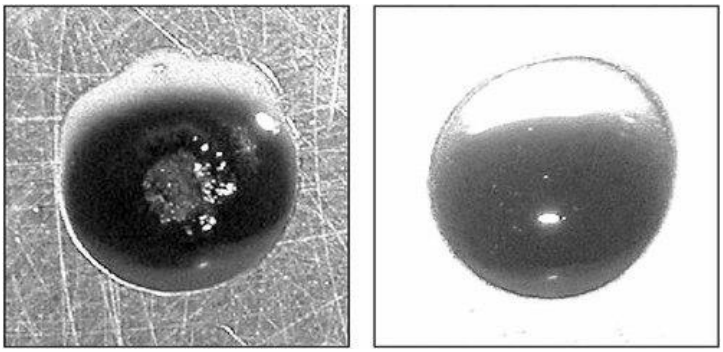

Figure 8

Open in figure viewerPowerPoint

Blood drop treated by FE-DBD: 15 s of FE-DBD (left) and control (right); photo was taken 1 min after the drops were placed on brushed stainless steel substrate; blood was treated immediately after it was placed on metal.**19**

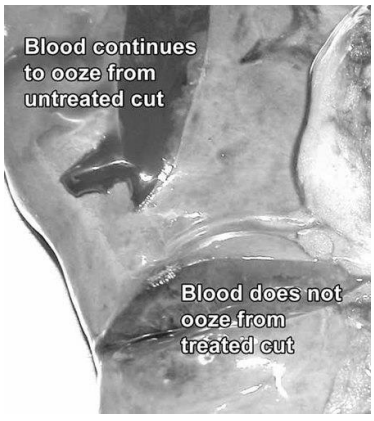

Figure 9

Open in figure viewerPowerPoint

30 s of FE-DBD treatment of human spleen: blood coagulates without tissue damage. Top cut: blood continues to ooze from an untreated area; bottom cut: blood coagulates while the wound remains wet.**19**

Additionally, a significant change in blood plasma protein concentrations is observed after treatment by plasma of blood plasma samples from healthy patients, patients with Hemophilia, and blood samples with various anti-coagulants. Anti-coagulants, like sodium heparin or sodium citrate, are designed to bind various ions or molecules in the coagulation cascade thus controlling coagulation rate or preventing it all together. Analysis of changes in concentration of various blood proteins and clotting factors indicates that FE-DBD plasma aids in promoting the advancement of blood coagulation, or in other words, plasma is able to catalyze the complex biochemical processes taking place during blood coagulation.**19**, **20**, **80**, **81**, **84**-**91**

In vivo Blood Coagulation Using FE-DBD Plasma

Effective plasma stimulation of the *in vivo* blood coagulation has been demonstrated by Fridman et al. in experiments with live SKH1 mice.**20** 15 s of FE-DBD plasma treatment is able to coagulate blood at the surface of a cut Saphenous vein (Figure **10**) as well as tail vein of a mouse. In these experiments only ability of direct non-thermal plasma treatment to coagulate blood was tested and the animal was not left alive to test improvement in healing times. Full investigation of ability of plasma to hasten wound healing through wound sterilization and blood coagulation is discussed by Fridman et al. and Balasubramanian et al.**20**, **32**, **86**, **87**

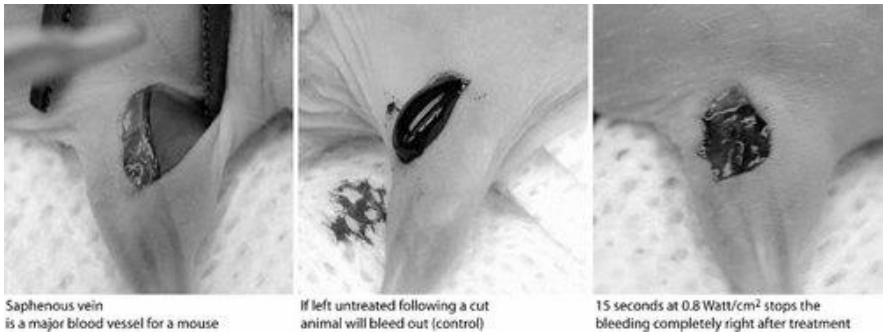

Figure 10

Open in figure viewerPowerPoint

Blood coagulation on a live animal.**32**

Mechanisms of Non-Thermal Plasma-Assisted Blood Coagulation

Detailed bio-chemical pathways of the non-thermal plasma-stimulated blood coagulation remain largely unclear. Several possible mechanisms, however, were investigated.**19**, **80**, **81** Firstly and most importantly, it was demonstrated that direct non-thermal plasma can trigger natural, rather than thermally induced, coagulation processes.**19** Secondly, it was observed that the release of calcium ions and change of blood pH level, which could be responsible for coagulation, is insignificant.**19**, **81** Instead, the evidence points to selective action of direct non-thermal plasma on blood proteins involved in natural coagulation processes.

Mechanisms of plasma interaction with blood can be deduced from the following facts observed in the experiments with FE-DBD plasma: (i) plasma can coagulate both normal and anti-coagulated blood, but the rate of coagulation depends on the anti-coagulant used; (ii) plasma is able to alter ionic strength of the solution and change its pH, but normal and anti-coagulated blood buffers these changes even after long treatment time; (iii) plasma changes natural concentration of clotting factors significantly, thus promoting coagulation; (iv) effects delivered by plasma are non-thermal and are not related to gas temperature or the temperature at the surface of blood; (v) plasma is able to promote platelet activation and formation of fibrin filaments, even in anti-coagulated blood. These experimental facts are discussed in further detail below.

(i)

Anti-coagulants like sodium heparin bind thrombin, in the coagulation cascade thus slowing coagulation while sodium citrate or ethylene diamine tetraacetic acid (EDTA) is designed to bind calcium, an important factor in the cascade, thereby, preventing coagulation altogether.**88** Plasma treatment promotes visible coagulation for all of the above anti-coagulants.

(ii)

Initial plasma coagulation hypothesis was focused on increase in concentration of Ca^{2+}, which is an important factor in the coagulation cascade. It was suggested that plasma stimulates generation of Ca^{2+} through the redox mechanism

$$[Ca^{2+}R^{2hyphen;}]+2Hlowbar;lpar;Hlowbar;2Orpar;^{+}[Hlowbar;2^{+}R^{2hyphen;}]lowbar;lpar;Hlowbar;2Orpar;+Calowbar;lpar;Hlowbar;2Orpar;^{2+}$$

, provided by hydrogen ions produced in blood in a sequence of ion/molecular processes induced by plasma ions.**19** Validity of the hypothesis was tested experimentally by measuring Ca^{2+} concentration in the plasma-treated anti-coagulated whole blood using a calcium selective microelectrode. Calcium concentration was measured immediately after plasma treatment and remained almost constant for up to 30 s of the treatment and then increased slightly for prolonged treatment times of 60 and 120 s. Although, plasma is capable of coagulating anti-coagulated blood within 15 s, no significant change occurs in calcium ion concentration during the typical time of blood coagulation in discharge treated blood. *In vivo*, the pH of blood is maintained in a very narrow range of 7.35–7.45 by various physiological processes. The change in pH by plasma treatment (about 0.1 after 30 s) is less than the natural variation of pH, which indicates that the coagulation is probably not due to the pH change in blood.

(iii)

FE-DBD treatment of whole blood samples was shown to change concentrations of various proteins participating in coagulation cascade. Plasma treatment is shown to "consume" coagulation factors (proteins and enzymes) and a visible film is formed on the surface of the treated samples. Increase in the sample volume and keeping the surface area fixed decrease the effect, indicating that plasma treatment initiates clot formation at the surface, not in the volume (Figure **11**). Corresponding kinetic model of the plasma-assisted blood coagulation indicates a two-fold decrease in clot formation time with plasma treatment (Figure **12**).

(iv)

When the surface of blood is protected by small thin aluminum foil, which prevents contact between blood and FE-DBD plasma but transfers all the heat generated by plasma, no influence of blood is observed. This indicates a non-thermal mechanism of the plasma-stimulated blood coagulation.

(v)

The final step in the natural biological process of blood coagulation is the production of thrombin which converts fibrinogen into fibrin monomers that polymerize to form fibrin microfilaments. FE-DBD plasma treatment of fibrinogen solution in physiological medium coagulates it, which is confirmed visually through a change in the color of the solution (from clear to milky-white) and through dynamic light scattering (DLS). Of note is that plasma does not influence fibrinogen through a pH or temperature change. FE-DBD treatment, however, is unable to polymerize albumin (directly not participating in coagulation cascade) as no change in its behavior is observed both visually and through DLS. Thus, non-thermal plasma selectively affects proteins (specifically, fibrinogen) participating in the natural coagulation mechanism.

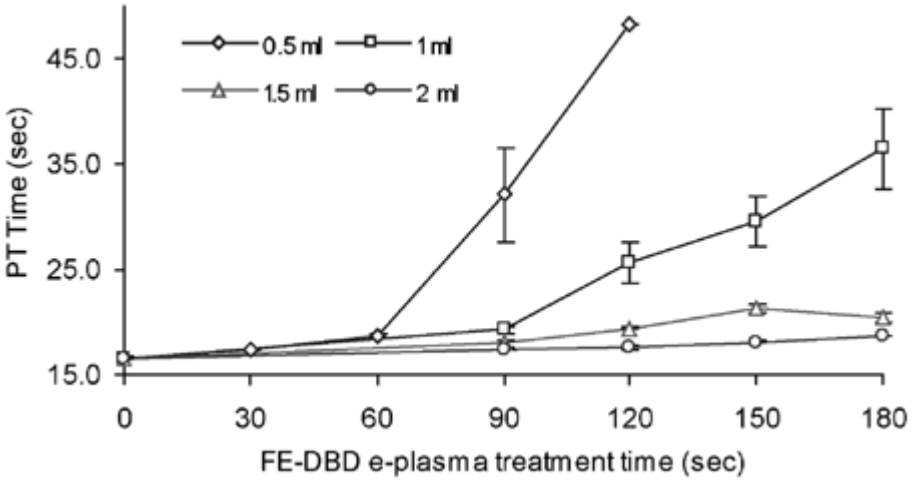

Figure 11

Open in figure viewerPowerPoint

Prothrombin (PT) time for blood samples of different volumes with the same surface area of FE-DBD treatment.**19**

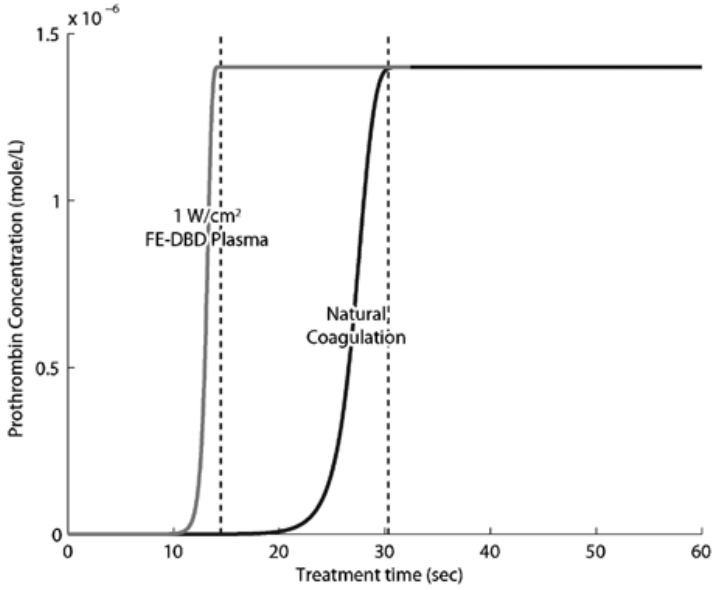

Figure 12

Open in figure viewerPowerPoint

PT kinetics: two-fold decrease in clot formation time with plasma treatment.**19**

To assess plasma influence on protein activity, compared with plasma influence on the protein itself, trypsin [treated with L-1-tosylamido-2-phenylethyl chloromethyl ketone (TPCK) to inhibit contaminating chymotrypsin activity without affecting trypsin activity] was treated by plasma for up to 2 min and its total protein weight and protein activity was analyzed via fluorescence spectroscopy. Total protein weight, or the amount of protein in the treated solution, remains practically intact after up to 90 s of the treatment (Figure **13**); while the enzymatic (catalytic) activity of this protein drops to nearly zero after 10–15 s of treatment. Similar behavior is observed for albumin as well. This effect also proves that plasma effect on proteins is not just destructive but quite selective and natural.

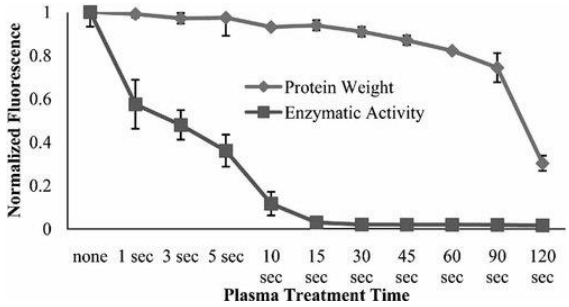

Figure 13

Open in figure viewerPowerPoint

Total protein weight compared to enzymatic activity of trypsin following plasma treatment.**92**

Morphological examination of the clot layer by scanning electron microscopy (SEM) further proves that plasma does not “cook” blood, but initiates and enhances natural sequences of blood coagulation processes. Activation followed by aggregation of platelets is the initial step in the coagulation cascade and conversion of fibrinogen into fibrin is the final step in the coagulation cascade. Figure **14** shows extensive platelet activation, platelet aggregation, and fibrin formation following FE-DBD plasma treatment.

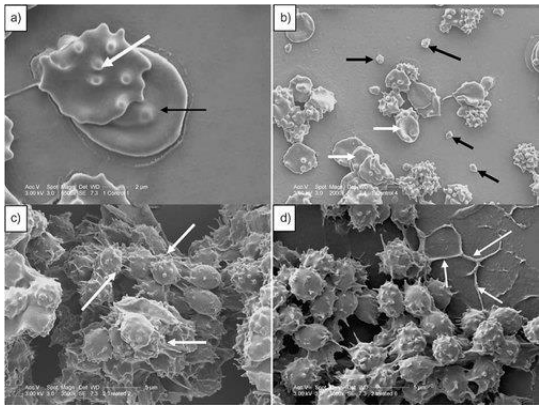

Figure 14

Open in figure viewerPowerPoint

SEM images of untreated (a, b) and treated (c, d) anti-coagulated whole blood. (a) Whole blood (control) showing single activated platelet (white arrow) on a red blood cell (black arrow); (b) whole blood (control) showing many non-activated platelets (black arrows) and intact red blood cells (white arrows); (c) whole blood (treated) showing extensive platelet activation (pseudopodia formation) and platelet aggregation (white arrows); and (d) whole blood (treated) showing platelet aggregation and fibrin filament formation (white arrows).**81**

Plasma-Assisted Wound Healing and Tissue Regeneration

Discharge Systems for Air-Plasma Surgery and Nitrogen Oxide (NO) Therapy

Effective use of plasma in surgery has been first demonstrated in 1960s; plasma afterglow jet of an inert gas has been applied for tissue sectioning with instant blood coagulation. Because of that plasma-surgical devices got a long-standing name of "plasma scalpel" in the hospitals (see, for example, Glover et al.**93**). Significant advancement in the plasma surgery, wound healing, and tissue regeneration is due to development of the "Plazon" system based on the jet of hot air plasma rapidly quenched and providing relatively high NO concentration with significant therapeutic effect.**94**, **95** This plasma device is used in two modes. In the first "hot mode" plasma jet is used for rapid coagulation and sterilization of wound surfaces, destruction and desiccation of dead tissue and pathologic growths, dissection of biological tissues. In the second "cold mode" NO-containing plasma gas flow with temperature of 20–40 °C is used for stimulation of regenerative processes and wound healing.

The Plazon generators**21**, **94**, **95** are the DC arcs with different configurations of the exit channels corresponding to the different applications (blood coagulation, tissue destruction, therapeutic manipulation/stimulation). Main and common elements of the system construction are the liquid-cooled cathode, intra-electrode insert, and anode. Atmospheric air enters the manipulator through the built-in microcompressor, passes through the plasma arc, heats up and thus accelerates, and exits through the hole in the anode of the plasma-generating module. Plasma temperature at the anode exit differs in different configurations of the device, corresponding to different medical applications (see Figure **15**). Further away from the anode, temperature drops rapidly, and at 30–50 mm from the anode, the flow is composed simply of the warm gas and the plasma-generated NO. Nitrogen oxide content in the gas flow is mainly determined by the quenching rate. The necessary quenching rate for effective operation of the medical device is about $\approx 10^7$–10^8 K · s^{-1}. Commonly, the cooling rate of plasma jets is on the order of $\approx 10^6$ K · s^{-1}. Thus, to achieve the cooling rate of $\approx 10^7$–10^8 K · s^{-1}, it is necessary to utilize additional cooling of the plasma jet, which has been achieved by special construction of the plasma nozzles.

Figure 15

Open in figure viewerPowerPoint

"Plazon" apparatus in two working modes: (a) hot mode (b) cold mode with manipulators and accessories (c).**94**, **95**

The therapeutic manipulator-stimulator configuration of the Plazon discharge system is used solely for therapeutic treatment by exogenic nitrogen oxide. The principle difference of this manipulator is that the air-plasma jet does not freely exit into the atmosphere, but rather it exits the anode into the two-step cooling system, gas channels of which are created in a maze scheme to force-cool the jet by the liquid circulating from the cooling system. This construction allows one to obtain NO-containing gas flow (NO-CGF) with sufficiently low temperature, and optimal concentration of nitrogen oxide molecules, which makes it possible to apply this manipulator for the treatment of external body surfaces by using the cooling hose of 150 mm length (temperature of NO-CGF at the exit ≈36 °C). Of course, NO content in the gas flow depends on the distance from the exit channel (Figure **16**). Additionally, for laparoscopic operation, a special manipulator of 350 mm length and 10 mm diameter is utilized.

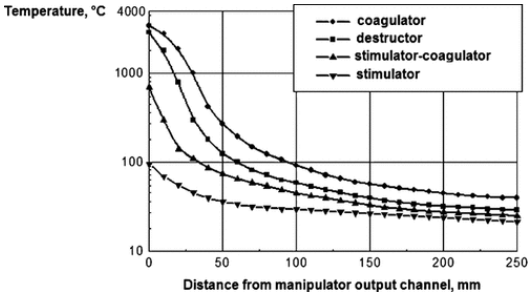

Figure 16

Open in figure viewerPowerPoint

Temperature in the center of the gas flow jet for different manipulators.

The possible operating regimes of the apparatus are defined by the characteristics of the gas flow exiting from the manipulator, main parameters of which are its temperature and the nitrogen oxide content. First group of regimes – regimes of free-flowing plasma off-gas exiting the manipulator; second group of regimes – regimes of the treatment of bio-tissues by completely cooled (20 °C) NO-CGF, to obtain which a manipulator is connected to the internal gas cooler, and delivery of NO-CGF to bio-tissues is achieved through a silicone tube with an attached tip of 130 or 390 mm length, and the exit channel diameter of 0.7 mm. This allows not only direct treatment of the bio-tissues by NO, but also its delivery to a pathologic center through drainage tubes, puncture needles, or any endoscopic devices (gastroscope, broncoscope, cystoscope, rectascope, etc.).

Medical Use of Plasma-Generated Exogenic Nitrogen Oxide

The Nobel Prize in medicine and biology was awarded in 1998 to R. F. Furchgott, L. J. Ignarro, and F. Murad for their work on the function of nitrogen oxide as a signal molecule.**96** Today it is well known that in a human organism, NO serves a multitude of essential biological functions – it regulates blood vessel tone (via relaxation of flat epithelial cells) and blood coagulation, immune system and early apoptosis, neural communication and memory, relaxation of flat bronchial and gastrointestinal muscles, hormonal and sex functions, NO offers anti-microbial and anti-tumor defense, etc. In pathology, NO plays a major role in adaptation, stress, tumor growth, immunodeficiency, cardiovascular, liver, gastrointestinal tract disease, etc. This explains wide possibilities of the plasma-generated exogenic NO in multiple medical applications.

Importance of exogenic NO in infection and inflammation processes is also well studied and is linked with anti-microbial effects; stimulation of macrophages; induction of cytokines, T-lymphocytes, and many immunoglobulins; interaction with oxygen radicals; and influence on microcirculation, cytotoxic and cytoprotective role in different

conditions. During inflammation, macrophages and some other cells (i.e., aibroblasts, epithelial cells, etc.) produce NO via inducible NO-synthase (iNOS) in quantities significantly greater (two orders of magnitude) than normal when NO is formed via constructional NOS: endothelial (eNOS) and neuronal (nNOS).

Exogenic NO is also crucial in trauma wound processes. Activity of iNOS grows substantially in trauma wounds, burn wound tissues, bone fracture site tissues, and others in the inflammatory and proliferation phases of the healing process. Activation of iNOS was also discovered in the cultivation of wound fibroblasts. Macrophage activation in a wound, cytokine synthesis and proliferation of fibroblasts, epithelization, and wound healing processes are all linked with the activity levels of iNOS. In animal models, injection of iNOS inhibitors disrupts all of these processes and especially the synthesis of collagen, while NO synthesis promoters increase the rate of these processes.

Animals with iNOS deficiency demonstrate significant decrease in wound healing rate, however this can be reversed by injection of iNOS gene. In complicated wound models, for example, in experimentally induced diabetes, protein deficiency, injection of corticosteroids, or immunosuppressants, and also in patients with tropic ulcers, lowered activity of iNOS is usually discovered which correlates to slowed healing processes. Exogenic delivery of NO-donors (nitrogen-containing compounds) to the wound promotes and speeds up healing processes in animals with complicated wounds and in animals with inhibited iNOS. This knowledge, coupled with theoretical and experimental data on NO generation in air plasmas, served as a basis for a series of bio-medical experiments focused on use of the plasma-generated exogenic NO, delivered directly to the pathologic site, for control of inflammatory processes and increase in the rate of wound healing.

Experimental Investigations of NO Effect on Wound Healing and Inflammatory Processes

EPR spectroscopy was utilized to investigate the dynamics of level of endogenic and exogenic NO in wound tissues and in organs in an animal model (70 rats).**21** NO

"trap", diethylthiocarbamate (DETC), was injected into rats with a full thickness flat wound of 300 mm^2 area 5 d prior to EPR analysis. Following euthanasia, the samples were collected from the animals: blood, granular tissue from the bottom of the wound, and from internal organs (heart, liver, kidney, and the small intestine). For a portion of the animals, on the 5th day following the initial wound introduction, the wound surface was treated by the NO-CGF (500 ppm). Without the NO treatment, the results indicate high content of endogenic NO in wound tissues [$(10.3 \pm 2.3) \times 10^{-6}$ M). The liver of the animals with the wound contained $(2.3 \pm 1.4) \times 10^{-6}$ M of DETC-ironmononitrosyl complex (IMNC) while the control group (without the wound) – only $(0.06 \pm 0.002) \times 10^{-6}$ M.

Animals without the wound were used for investigation of penetration capability of gaseous exogenic NO through undamaged tissues of abdominal wall. Treatment by NO-CGF was performed for 60 and 180 s. A nearly linear dependence of the amount of DETC-IMNC produced in the liver and blood of the animal on the NO-containing gas treatment time was observed. 2 min following the 180 s treatment a maximum signal was registered in the bowels of the animal – 2.6 times higher than in the control group. In the heart, liver, and kidney the difference was 1.7 times. These results are indicative of the ability of the exogenic NO molecules to penetrate the undamaged tissues.

A more complex relationship was observed in the treatment by exogenic NO of the wound tissues. If the animal was euthanized 30–40 min following the treatment, then NO content in wound tissue and blood was observed to raise 9–11 times more than in the case of the 2-min interval. This is probably due to the formation of peroxinitrite, which can be formed through NO reacting with superoxide anions ($Olowbar;2^{hyphen;}$), as it is known that the superoxide levels are increased in the organism during the inflammatory processes. In response to the oxidative stress, the organism mobilizes the anti-oxidant defense mechanisms first via the increase in the levels of reducing agents (thioles, ascorbate, etc.), and then via activation of synthesis of anti-oxidant enzymes. 30–40 min following the wound treatment by exogenic NO, activation of the first cascade of anti-oxidant defense allowed for significant decrease in the level of superoxide anions. This considerably

decreases its destructive influence on DETC-IMNC and the nitrosyl complexes of the hemoproteins, which leads to the increase in their concentration as is detected by the EPR spectroscopy. Additionally, the activation of NOS by the increase in endogenic NO cannot be neglected. It partially explains the discovered phenomena of stimulation of wound development processes via the influence of exogenic NO, when there is a deficiency of endogenic NO or excess of free radicals including superoxide.

In experiments on the cornea of rabbits, the mucous membrane of the cavity of the mouth of hamsters, and on the meninx membrane of rats, via lifetime biomicroscopy it was found that the effect of the expansion of the opening of the microvessels under the influence of exogenic NO (500 ppm) lasts with varying intensity up to 10–12 h, while the lifetime of NO molecules is no more than 10–15 s.**21**, **94**, **97** The experiments serve as additional evidence that single application of exogenic NO initiates a cycle of cascade reactions, including biosysnthesis endogenic NO, which leads to a long-lasting effect and explains the successes of the NO-therapy.

Action of the exogenic NO on the cellular cultures of the human fibroblasts and rat nervous cells was studied by Shekhter et al.,**21**, **94** Stadler et al.,**98** Ghaffari et al.,**99** and others. Single treatment by the plasma-generated NO of the cell cultures significantly increases (2.5 times) the cell proliferation rate via the increase in DNA synthesis (tested by inclusion of C^{14} thymidine) and to a lesser extent (1.5 times) increase in protein synthesis by the cells (tested by inclusion of C^{14} aminoacids). As expected, the stimulating effect is dose dependent. The action of exogenic NO on the phagocytic activity of the cultured wound macrophages from the washings of the trophic human ulcers, studied by the photochemiluminescence**100** revealed that a maximum increase in the luminous intensity (1.95 times in comparison with control) testifies about the activation of the proteolytic enzymes of macrophages under the effect of NO-CGF. Statistically significant increase in fluorescence of macrophages was observed in less than 24 h following a 30 s treatment.

In vitro investigation of the influence of NO-CGF on *E. coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, and *Candida albicans*, which are typically associated with many hospital infections, showed that 75 s of the treatment by NO-CGF significantly decreases viable colony forming units, 80 s practically removes them all, and no growth is detected at all following 90 s of the treatment.101 Major mechanisms of the NO influence on various pathologic processes can be summarized as:21, 94

(i)

Direct bactericidal effect (through formation of peroxynitrite in the reaction: $NO + Olowbar;2^{hyphen;\rightarrow ONOO^{hyphen}}$);

(ii)

induction of the phagocytosis of bacteria and necrotic detrite by neutrophils and by macrophages;

(iii)

inhibition of the free oxygen radicals, which exert pathogenic influence, and also possible activation of the anti-oxidant protection;

(iv)

normalization of microcirculation due to the vasodilatation, the anti-aggregation, and anti-coagulant properties of NO, that improves vascular trophicity and nutrient exchange;

(v)

improvement of nerve conductance;

(vi)

regulation of immune-deficiencies which are common in wound pathology;

(vii)

secretion of cytokines by the activated macrophages, which increase fibroblast proliferation, angiogenesis factors, chemokines, in particular, monocyte chemoattractant

protein (MCP-1), G-protein, nuclear factor κB (NFkB), and other biologically active factors which regulate wound healing and inflammatory processes;

(viii)

direct induction of proliferation of fibroblasts and synthesis of proteins by them;

(ix)

increase in or regulation of collagen synthesis;

(x)

regulation of apoptosis in remodeling of granular and fibrous tissues;

(xi)

influence on the proliferation of keratinocytes and thus on the epithelization of the wound.

Clinical Aspects of Use of Air Plasma and Exogenic NO in Treatment of Wound Pathologies

Application of air plasma and exogenic NO in the treatment of the trophic ulcers of the vascular etiology in 318 patients showed high efficiency of NO-therapy in the treatment of the venous and arterial trophic ulcers of lower extremities with an area from 6 to 200 cm^2.**21**, **94** For assessment of the effectiveness of the plasma NO-therapy, clinical and planimetric indices were analyzed in the course of the process of sanitation and epithelization of ulcers, a bacteriological study of discharge from the ulcer, cytological study of exudate, a histopathological study of biopsies from the boundary of a trophic ulcer, the indices of microcirculation [according to the data obtained by laser Doppler flowmetry (LDF)], and transcutaneous partial pressure of oxygen (TpO_2). In the main groups of observations, trophic ulcers were processed in the regime NO-therapy (500 and 300 ppm); or prior to beginning the therapy the ulcer surface was treated in the regime of coagulation until the evaporation of necrotic debris. Following initial treatment, the wounds were treated for 10–30 d in the NO-therapy regime. In the control group, proteolytic and anti-microbial drugs were used – in the phase of exudation and necrosis, and wound coatings – in the phase of tissue regeneration and epithelization.

Planimetric observation of the dynamics of decrease in the trophic ulcer area showed that, on average, traditional treatment methods applied in the control group lead to 0.7% per day decrease, while in the experimental group – 1.7% per day. Cleansing of ulcers from necrotic debris and exudate, and appearance of granulation and boundary epithelization were accelerated with NO-therapy on the average 2.5 times. The time to final healing was reduced 2.5–4 times depending on the initial ulcer size (Figure **17**). Larger ulcers tended to close faster than smaller ones. Following the NO-therapy, LDF investigation of microcirculation in the tissue showed normalization of pathologic changes in the amplitude-frequency signal characteristics of the microvasculature and activation of regulatory mechanisms on those tissues.

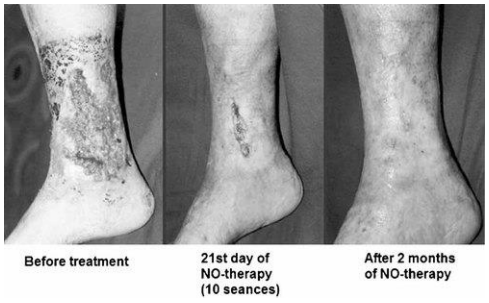

Figure 17

Open in figure viewerPowerPoint

Dynamics of the healing of venous trophic ulcer during NO-therapy.

By 14–18 d the average index of microcirculation, value of root-mean-square deviation, coefficient of variation, and index of fluctuation of microcirculation approached in its value those of the symmetrical sections of healthy skin. In the control group the disturbances of microcirculation remained. Against the background of treatment, normalization of the level of transcutaneous partial pressure of oxygen (TpO_2) happened at a higher rate in the experimental group than in the control group, especially at the NO concentration of 500 ppm (Figure **18**). A bacteriological study of wound discharge from the trophic ulcers showed that in the experimental group, against the background, NO-therapy (especially in combination with the preliminary coagulation of ulcerous surface) reduced the degree of bacterial seeding (microbial associations) and

already by days 7–14 it went below the critical level, necessary for maintaining the infectious process in the wound (Figure **19**).

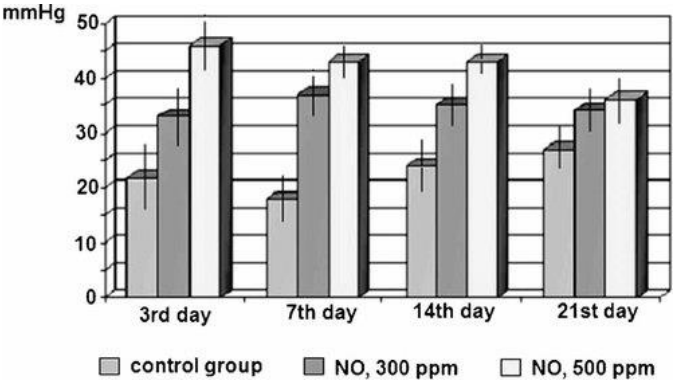

Figure 18

Open in figure viewerPowerPoint

Dynamics of pO_2 level during NO-therapy of venous trophic ulcers.

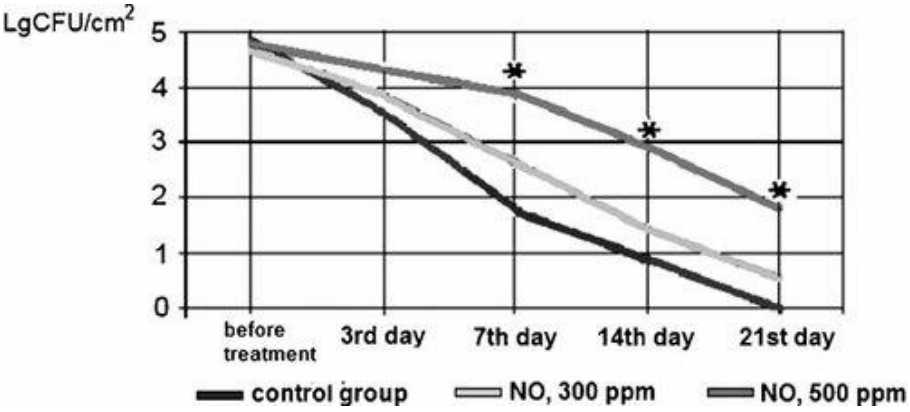

Figure 19

Open in figure viewerPowerPoint

Dynamics of bacterial contamination of trophic ulcers during NO-therapy (* statistical significance, $p < 0.01$).

Using the plasma-generated NO for local treatment of ulcerous and necrotic tissues in patients with diabetes (diabetic foot ulcer) has been demonstrated by Shulutko, Antropova, and Kryuger.**101** Patients were selected for this study following 2 months of unsuccessful treatments by the state-of-the-art techniques. Already from the first few sessions the difference was evident; inflammatory reaction was clearly reduced, patients reported decrease in pain, and cleansing of the ulcer surface was clearly visible. Following

ten sessions, most patients expressed positive healing dynamics: ulcer size decreased to 1/3–1/4 of the original size. LDF markers, pO_2, and bacteriological investigation all showed a positive dynamic. In patients with relatively small-sized ulcers (initial diameter less than 1 cm), full epithelization occurred by 6–8 NO-treatment sessions. Period of stationary treatment and full clinical recovery of patients was noticeably shortened (on an average by 2.3 times). In the cases of large ulcerating wounds, the necessity for amputation decreased 1.9 times (Figure **20**).

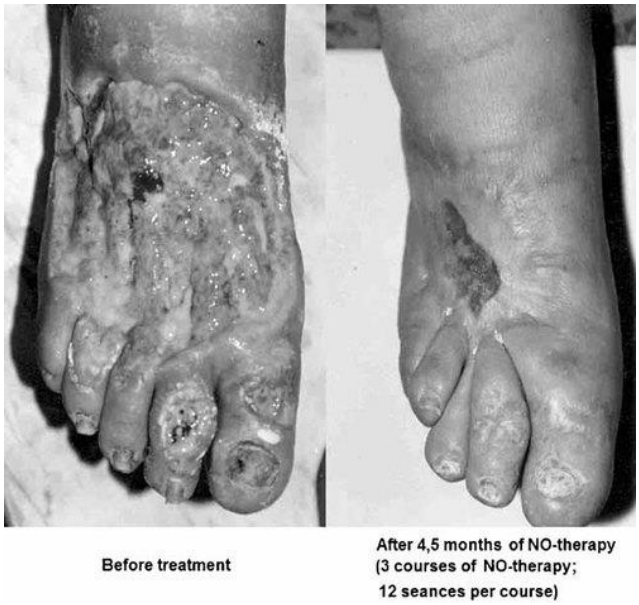

Figure 20

Open in figure viewerPowerPoint

Extensive pyonecrotic ulcer of the foot (neuro-ischemic form of the syndrome of diabetic foot).

Effectiveness of the exogenic NO and air plasma on healing of the pyoinflammatory diseases of soft tissues has been demonstrated studying 520 patients with the purulent wounds of different etiology and 104 patients with the phlegmonous-necrotic form of the erysipelatous inflammation.**102**, **103** By the 5th day of therapy wounds on most of the patients in the experimental group (90%), contrary to the control group, were clear of necrotic tissue, and the wounds began to be covered by bright spots of granular tissue. Microbial infestation of the wound tissue had lowered from 10^6–10^8 colony forming units

(cfu) per gram of tissue to 10^1–10^2. Data from complex analysis of microcirculation (LDF, pO_2) showed significant repair of the microvasculature and blood flow in the wound tissues in most of the patients in the experimental group. The predominant types of cytograms were regenerative and regenerative-inflammatory with a notable increase in fibroblast proliferation – on an average of $18.5 \pm 3.1\%$. Notable morphological changes in the biopsies were the significant development and maturing of the granular tissue and the regeneration of epithelial tissue at the edges. Large suppurated wounds, for example, suppurated burn wounds (Figure **21**), by days 7–10 of the treatment were clear of the pyonecrotic exudate and were beginning to be covered by granular tissue, in other words these wounds were ready for dermautoplasty.

Навчальне видання

Юмрукуз Анастасія Анатоліївна

Навчальний посібник
з дисципліни «Англомовна медична термінологія» для студентів спеціальності 222 «Медицина»

Авторська редакція

Підписано до друку 30.09.22. Формат 60×90 1/16.
Печать офсетна. Папір типографський № 3.
Тираж 300 екз.
Копіювальний центр «Магістр»
м.Одеса, вул.Торгова, 3
тел. 732-18-27