

AL HUDA SCIENCE ACADEMY

Prepared By: Sir Muhammad Usman Ali

Solved Exercise of BIOLOGY Class 10

**Visit Our YouTube Channel
for Easy Maths & Info**

<https://youtube.com/@AhsaDotPk>

Unit 1: Human Digestive System

A. Multiple Choice Questions

1. The three portions of the small intestine, in the correct order, are:

(a) Duodenum, jejunum, ileum ✓

(b) Ileum, duodenum, jejunum

(c) Colon, caecum, rectum

(d) Caecum, colon, rectum

2. The wavelike movement of muscles that pushes food through the digestive system is called:

(a) Chemical digestion

(b) Mechanical digestion

(c) Peristalsis ✓

(d) Absorption

3. The part of the digestive system where no chemical digestion takes place is:

(a) Oral cavity

(b) Oesophagus ✓

(c) Stomach

(d) Duodenum

4. Which group of enzymes breaks up starches?

(a) Proteases

(b) Lipases

(c) Amylases ✓

(d) Pepsin

5. The pancreas produces digestive enzymes and releases them into:

(a) Colon

(b) Gall bladder

(c) Liver

(d) Duodenum ✓

6. In stomach, pepsinogen is converted into pepsin by the action of:

(a) Bile salts

(b) HCl ✓

(c) Hormones

(d) Bicarbonate

7. In which part are the carbohydrates, lipids and proteins digested?

(a) Oral cavity

(b) Small intestine ✓

(c) Stomach

(d) Large intestine

8. The enzyme trypsin is found in:

(a) Pancreatic juice ✓

(b) Bile

(c) Gastric juice

(d) Saliva

9. The common bile duct carries bile from gall bladder to:

(a) Stomach

(b) Duodenum ✓

(c) Colon

(d) Pancreas

10. Why the small intestine has many folds and contains villi and microvilli?

(a) To slow down the passage of food

(b) To promote food absorption ✓

(c) To prevent the backflow of chyme

(d) To produce enzymes

B. Short Answer Questions

1. State the role of salivary glands in digestion.

Answer: Salivary glands secrete saliva into the oral cavity. Saliva contains water and mucus to lubricate and soften food for easy swallowing, as well as the enzyme salivary amylase, which initiates the chemical digestion of starches into simpler sugars.

2. What do the terms swallowing and peristalsis mean?

Answer:

Swallowing: The coordinated physiological process of moving food or liquid from the oral cavity, through the pharynx, and down into the esophagus.

Peristalsis: The rhythmic, wavelike wave of muscular contractions and relaxations that propagates along the walls of the digestive tract to push food forward through the system.

3. What are the functions of HCl in gastric juice?

Answer: Hydrochloric acid (HCl) serves two primary purposes in the stomach: it kills microorganisms and pathogens ingested with food, and it creates a highly acidic environment necessary to convert inactive pepsinogen into the active enzyme pepsin for protein breakdown.

4. State the role of pancreatic juice in digestion of food.

Answer: Pancreatic juice is released into the duodenum and contains a mixture of critical digestive enzymes: pancreatic amylase for carbohydrates, trypsin for proteins, and pancreatic lipase for lipids. It also contains sodium bicarbonate to neutralize the highly acidic chyme coming from the stomach.

5. Write a brief note on the structure of villi.

Answer: Villi are tiny, finger-like projections lining the inner wall of the small intestine. Each villus is covered by a single layer of epithelial cells (with their own microvilli) to optimize nutrient absorption, and internally contains a rich network of blood capillaries alongside a central lymphatic vessel called a lacteal.

6. What are the causes and symptoms of ulcers?

Answer:

Causes: Infection due to *Helicobacter pylori* bacteria, long-term use of nonsteroidal anti-inflammatory drugs (NSAIDs), excessive alcohol consumption, smoking, and exacerbation by stress.

Symptoms: Abdominal pain, burning sensation in the stomach, loss of appetite, weight loss, and blood vomiting in severe clinical cases.

C. Write Answers in Detail

1. Describe the absorption of food in small intestine.

Answer: Food absorption primarily takes place across the specialized inner lining of the small intestine, which features extensive folds, villi, and microvilli that vastly expand the available surface area. Simple sugars, amino acids, water-soluble vitamins, and mineral salts pass through the single-cell epithelial

layer of the villi via active transport or diffusion and enter the blood capillaries to be carried directly to the liver. Conversely, fatty acids and glycerol are absorbed into the epithelial cells, reassembled, and transported into the central lymphatic vessel (lacteal) before ultimately entering the general blood circulation.

2. Explain the role of oral cavity in the digestive system.

Answer: The oral cavity is responsible for both mechanical and early chemical digestion:

Mastication (Chewing): Teeth mechanically grind and break down large pieces of food into a smaller, manageable bolus, increasing the surface area for enzymes.

Lubrication: The tongue rolls the food while salivary glands secrete saliva to moisten and lubricate it for smooth transit.

Chemical Digestion: Salivary amylase begins breaking down complex starches into maltose and short-chain carbohydrates.

3. Explain the structure and functions of stomach.

Answer:

Structure: The stomach is a muscular, J-shaped sac-like organ located on the left side of the upper abdomen. Its thick muscular walls consist of layers running in different directions, allowing it to contract dynamically, and its inner mucosa contains gastric glands that secrete gastric juice.

Functions: It acts as a temporary storage reservoir for food. It performs mechanical digestion through a vigorous churning action that mixes food with gastric secretions into a semi-liquid mixture called chyme. Chemically, its acidic gastric juice denatures proteins, kills microbes, and utilizes active pepsin to digest large proteins into smaller peptides.

4. Justify the importance of liver and pancreas in digestion.

Answer: While food does not pass directly through them, both act as vital accessory organs:

Liver: Synthesizes and secretes bile, which is stored in the gallbladder and sent to the duodenum. Bile is essential for fat digestion because it emulsifies large lipid droplets into tiny droplets, providing a greater surface area for lipases.

Pancreas: Produces and secretes comprehensive pancreatic juice into the duodenum. This fluid supplies essential enzymes (amylase, trypsin, lipase) capable of breaking down all major macro-nutrients (carbohydrates, proteins, and lipids), alongside bicarbonate ions that shield the intestinal lining by neutralizing acidic gastric juices.

D. Inquisitive Questions

1. Why does someone with liver disease have difficulty in digesting fats?

Answer: The liver is responsible for producing bile, which contains bile salts that mechanically emulsify large fat globules into tiny droplets. If the liver is diseased or damaged, bile production decreases

Visit Our Website: [Ahsa.Pk](https://www.ahsa.pk) for more notes, mcqs, guess papers, schemes, and more

Visit Our YouTube Channel: <https://youtube.com/@ahsadotpk>

significantly, leading to a failure in lipid emulsification. Because lipases cannot efficiently access non-emulsified fats, lipid breakdown is severely impaired.

2. Why is it necessary to store bile in the gallbladder before it is released?

Answer: The liver secretes bile continuously, but digestion only occurs periodically when food enters the small intestine. The gallbladder serves as a temporary storage and concentration reservoir, ensuring a highly concentrated, potent volume of bile can be delivered quickly in response to the arrival of fatty chyme in the duodenum.

3. Why is it important to maintain a healthy balance of gut bacteria?

Answer: A healthy balance of gut microbiota is crucial because these beneficial microorganisms aid in breaking down indigestible dietary fibers, synthesize essential vitamins (such as Vitamin K and certain B vitamins), protect the intestinal lining against pathogenic infections, and modulate immune system responses.

4. How can a malfunction in the cardiac sphincter lead to acid reflux?

Answer: The cardiac sphincter acts as a one-way muscular valve that closes tightly after food passes from the esophagus into the stomach. If this sphincter malfunctions, weakens, or relaxes inappropriately, the highly acidic gastric juice and chyme from the stomach can flow backward up into the esophagus, irritating its sensitive lining and causing the burning sensation known as acid reflux or heartburn.

Visit [Ahsa.Pk](https://www.ahsa.pk) for more.

Join Al Huda Science Academy to
learn subjects easily.

Unit 2: Respiratory System

A. Multiple Choice Questions

1. Breathing means:

- (a) Breakdown of C-H bonds to produce energy
- **(b) Movements that take air in and out of body ✓**
- (c) Getting oxygen from the air and removing carbon dioxide
- (d) Transport of oxygen through blood to different parts of the body

2. Which path does air take immediately after passing through the larynx?

- (a) Pharynx
- (b) Bronchi
- **(c) Trachea ✓**
- (d) Alveoli

3. Why are alveoli surrounded by capillaries?

- (a) To absorb water
- **(b) To exchange gases ✓**
- (c) To produce mucus
- (d) To trap dust particles

4. Which feature of alveoli helps in rapid gas exchange?

- (a) Thick walls
- **(b) Moist surface ✓**
- (c) Large diameter
- (d) Strong muscles

5. Which action increases lung volume during breathing?

- (a) Relaxing the diaphragm
- (b) Closing the trachea
- **(c) Contracting intercostal muscles ✓**
- (d) Stiffening alveolar walls

6. Inhaled air contains 21% oxygen. What is its percentage in exhaled air?

- (a) 0%
- **(b) 16% ✓**
- (c) 21%
- (d) 42%

7. Which factor controls the breathing rate?

- **(a) Carbon dioxide in blood ✓**
- (b) Oxygen in blood
- (c) Carbon dioxide in muscles
- (d) Oxygen in muscles

8. The walls of alveoli are broken in:

- (a) Pneumonia
- (b) Bronchitis
- **(c) Emphysema ✓**
- (d) Asthma

9. Smoking leads to lung cancer by:

- (a) Increasing oxygen uptake
- **(b) Promoting uncontrolled cell division ✓**
- (c) Slowing down healing
- (d) Enlarging the trachea

10. Which chemical in cigarette smoke directly leads to addiction?

- (a) Carbon monoxide
- (b) Tar
- **(c) Nicotine ✓**
- (d) Formaldehyde

B. Short Answer Questions

1. Differentiate between gaseous exchange and breathing.

Answer:

- **Breathing:** The mechanical or physical process of moving air into and out of the lungs to facilitate the intake of oxygen and removal of carbon dioxide.
- **Gaseous Exchange:** The physiological process where gases diffuse across a respiratory membrane (such as oxygen moving from alveoli into blood and carbon dioxide moving from blood into alveoli).

2. Differentiate between breathing and cellular respiration.

Answer:

- **Breathing:** A purely physical, mechanical process involving the inhalation and exhalation of air, occurring outside the cells without any chemical breakdown of food.
- **Cellular Respiration:** A complex biochemical process occurring inside cells where glucose is broken down (specifically breaking C-H bonds) to release energy in the form of ATP.

3. What is the function of cartilages present in the walls of trachea and bronchi?

Answer: The cartilage rings provide structural support and rigidity to the walls of the trachea and bronchi. They prevent these airways from collapsing or closing when air pressure drops during inhalation, keeping the passage permanently open for smooth airflow.

4. What is the average breathing rate in human at rest and during exercise?

Answer:

- **At Rest:** The average human breathing rate is typically about 16 to 20 times per minute.
- **During Exercise:** The rate can surge significantly to around 30 to 40 times per minute to meet the heightened oxygen demands of active muscles.

5. How does the structure of alveoli maximize gas exchange?

Answer: Alveoli maximize gas exchange through several structural adaptations: they are microscopic sacs that present an enormous total surface area; their walls are incredibly thin (only one cell thick); their surfaces are kept moist to dissolve gases; and they are wrapped in an extensive network of blood capillaries.

6. List the symptoms, causes, and treatments of bronchitis.

Answer:

- **Symptoms:** Coughing, production of clear, white, yellowish, or green sputum, shortness of breath, mild fever, chills, and chest discomfort.
- **Causes:** Viral or bacterial infections, or exposure to environmental irritants like cigarette smoke, dust, and industrial fumes.
- **Treatments:** Adequate rest, increased fluid intake, bronchodilators to open airways, and antibiotics if a bacterial infection is present.

7. Mention the symptoms and treatments of emphysema.

Visit Our Website: Ahsa.Pk for more notes, mcqs, guess papers, schemes, and more

Visit Our YouTube Channel: <https://youtube.com/@ahsadotpk>

Answer:

- **Symptoms:** Severe and progressive shortness of breath, chronic coughing, wheezing, fatigue, and unintended weight loss.
- **Treatments:** Oxygen therapy, bronchodilator medications, inhaled steroids, pulmonary rehabilitation programs, and absolute avoidance of tobacco smoke to prevent further damage.

8. What are carcinogens? Name any two carcinogens present in cigarettes.

Answer: Carcinogens are cancer-causing chemical substances or agents that promote uncontrolled cell division in living tissues. Two carcinogens present in cigarette smoke are formaldehyde and benzene.

9. Complete the following table:

Feature	Inspired Air	Expired Air
Oxygen	21%	16%
Carbon dioxide	0.04%	4%
Nitrogen	79%	79%

C. Write Answers in Detail

1. Explain the process of inhalation and exhalation step by step.

Answer:**Inhalation (Inspiration):**

1. The intercostal muscles contract, pulling the ribs upward and outward.
2. The muscular dome-shaped diaphragm contracts and moves downward, flattening out.
3. These synchronized movements expand the internal volume of the chest cavity.
4. The expansion decreases the air pressure inside the lungs relative to the atmospheric pressure outside.
5. Air rushes from the outside through the air passageway and into the lungs to equalize the pressure.

Exhalation (Expiration):

1. The intercostal muscles relax, allowing the rib cage to drop downward and inward.
2. The diaphragm relaxes and returns upward to its natural dome-shaped position.
3. These movements significantly reduce the internal volume of the chest cavity.
4. The reduction in volume increases the pressure inside the lungs compared to the outside atmosphere.

5. Air is compressed and driven out of the lungs through the respiratory tract.

2. Write a short note on the major parts of the human air passageway.

Answer: The human air passageway consists of several distinct sections that guide outside air down to the site of gas exchange:

- **Nasal Cavity:** Air enters via the nostrils into the nasal cavity, which is lined with hair and mucus to filter out dust, warm the cold incoming air, and moisten it.
- **Pharynx:** A muscular passageway common to both food and air, leading down to the openings of the esophagus and larynx.
- **Larynx:** Commonly called the voice box, it houses the vocal cords and contains a cartilaginous flap called the epiglottis that prevents food from entering the windpipe.
- **Trachea:** Also known as the windpipe, a tubular passage reinforced with C-shaped cartilaginous rings that keep the airway securely open.
- **Bronchi and Bronchioles:** The trachea splits into two primary bronchi entering each lung, which continuously subdivide into progressively smaller tubules called bronchioles until they reach the final microscopic clusters.

3. Describe the functions and locations of the bronchus, trachea, and alveoli.

Answer:

- **Trachea:**
 - **Location:** Situated in the neck region, extending directly below the larynx down into the upper thoracic cavity.
 - **Function:** Acts as the primary conduit for airflow, using its internal ciliated mucous membrane to trap dust and sweep debris upward away from the lungs.
- **Bronchus (plural: Bronchi):**
 - **Location:** Positioned at the lower base of the trachea, where it bifurcates into right and left branches to enter the respective right and left lungs.
 - **Function:** Directs air into the individual lungs and branches further to distribute air uniformly into all lung lobes.
- **Alveoli:**
 - **Location:** Located deep within the lungs at the terminal ends of the smallest bronchioles.
 - **Function:** Serve as the primary operational units for respiratory gas exchange, allowing oxygen to diffuse into the bloodstream and carbon dioxide to diffuse out.

4. What are the possible causes of lung cancer? Explain the harmful effects of smoking apart from lung cancer.

Visit Our Website: Ahsa.Pk for more notes, mcqs, guess papers, schemes, and more

Visit Our YouTube Channel: <https://youtube.com/@ahsadotpk>

Answer:

Causes of Lung Cancer: The primary cause is prolonged exposure to carcinogens, most notably tobacco smoke (including active smoking and passive secondhand smoke). Other major causes include the inhalation of industrial radon gas, asbestos fibers, arsenic, radiation, and severe ambient air pollution.

Harmful Effects of Smoking (Apart from Lung Cancer):

- **Cardiovascular System:** Smoking raises blood cholesterol levels, elevates blood pressure, and weakens the structural walls of blood vessels, escalating the risk of stroke and heart disease.
- **Respiratory System:** Smoke particles damage the air passageways, destroying alveolar walls (emphysema) and elevating the risk of developing tuberculosis by two to four times and pneumonia by four times.
- **Oral Health:** It causes heavy staining of the teeth, severe chronic bad breath, and increases tooth loss rates by two to three times compared to nonsmokers.
- **Other Diseases:** Contains harmful chemicals like formaldehyde and benzene that are tied to skin, gastrointestinal, and blood cancers (leukemia).

D. Inquisitive Questions

1. What can happen to breathing if diaphragm stops working properly?

Answer: If the diaphragm stops functioning properly, the mechanical capacity to expand and contract the thoracic cavity drops drastically. The body will struggle to create the internal negative pressure needed to pull air into the lungs, leading to severe respiratory distress, shallow breathing, or total respiratory failure requiring mechanical ventilation.

2. Why is it dangerous when smoke particles settle inside lungs?

Answer: When smoke particles accumulate in the lungs, they coat the respiratory membranes and trigger a chronic inflammatory response. Over time, these toxic particles destroy the delicate elastic walls of the alveoli, trap toxic chemicals (carcinogens) against the tissue, paralyze the sweeping action of cilia, and drastically reduce the available surface area for oxygen absorption.

3. Why does the trachea has C-shaped cartilage rings while bronchioles do not have them?

Answer: The trachea is a wide, main airway that experiences significant changes in negative pressure during breathing and sits right next to the esophagus; its C-shaped rings keep it from collapsing while allowing the esophagus to expand when swallowing food. In contrast, bronchioles are buried deep within the supportive tissue of the lungs and rely on smooth muscle regulation rather than rigid rings to alter their diameter for airflow control.

4. During asthma attacks, patients feel harder to exhale than to inhale. Why is it so?

Answer: During inhalation, the thoracic cavity expands, which naturally pulls the airways slightly open and allows air to slide past obstructions. However, during exhalation, the chest cavity naturally compresses and the internal pressure increases; this extra pressure forces the already inflamed, mucus-

filled, and spasming bronchioles to narrow even further, trapping air inside the lungs and making exhalation exceptionally difficult.

Visit Ahsa.Pk for more.
Join Al Huda Science Academy to
learn subjects easily.

Unit 3: Circulatory System

A. Multiple Choice Questions

1. Which component of blood is mainly responsible for carrying oxygen?

- (a) White blood cells
- (b) Platelets
- **(c) Red blood cells ✓**
- (d) Plasma

2. A person with low platelet count is likely to face difficulty in:

- (a) Fighting infections
- (b) Breathing
- **(c) Clotting blood ✓**
- (d) Transporting oxygen

3. Which of the following layer is found in all blood vessels?

- (a) Smooth muscle
- (b) Skeletal muscle
- **(c) Endothelium ✓**
- (d) Connective tissue

4. Which of the following contains deoxygenated blood in an adult human?

- (a) Left atrium
- (b) Pulmonary vein
- **(c) Pulmonary artery ✓**
- (d) Aorta

5. When fibrinogen makes blood clot it separates from blood and the rest is:

- (a) Plasma
- (b) Lymph
- **(c) Serum ✓**
- (d) Pus

6. Which heart chamber has the thickest walls?

- (a) Right atrium
- (b) Left atrium
- **(c) Left ventricle ✓**
- (d) Right ventricle

7. The exchange of materials between the blood and tissues occurs in:

- (a) Arteries
- (b) Veins
- **(c) Capillaries ✓**
- (d) Arteries and veins

8. All veins carry deoxygenated blood except the vein.

- (a) Vena cava
- (b) Hepatic portal
- **(c) Pulmonary ✓**
- (d) Renal

9. Myocardial infarction is due to blockage of blood flow in:

- (a) Aorta
- (b) Pulmonary artery
- **(c) Coronary artery ✓**
- (d) Hepatic artery

10. If the bicuspid valve is damaged, which flow of blood will be affected?

- **(a) From left atrium to left ventricle ✓**
- (b) From right atrium to right ventricle
- (c) From left ventricle to aorta
- (d) From lungs to left atrium

B. Short Answer Questions

1. List the types of cells present in blood along with their functions.

Answer:

- **Red Blood Cells (Erythrocytes):** They transport oxygen from the lungs to all body tissues and help return carbon dioxide to the lungs.
- **White Blood Cells (Leukocytes):** They defend the body against pathogens, foreign particles, and infectious materials as part of the immune system.
- **Platelets (Thrombocytes):** They play a critical role in blood clotting and coagulation to prevent excessive bleeding from injuries.

2. Differentiate between atria and ventricles.

Answer:

- **Atria:** They are the upper two chambers of the heart that act as receiving chambers, featuring thin walls because they only push blood down into the ventricles below.
- **Ventricles:** They are the lower two chambers of the heart that act as pumping chambers, featuring thick muscular walls to forcefully drive blood out to the lungs and the entire body.

3. Trace the flow of blood from the vena cava to various body parts.

Answer: Vena cava → Right atrium → Tricuspid valve → Right ventricle → Pulmonary artery → Lungs → Pulmonary veins → Left atrium → Bicuspid (mitral) valve → Left ventricle → Aorta → Body tissues and organs.

4. Identify the causes and treatments of myocardial infarction.

Answer:

- **Causes:** Blockage of the coronary arteries due to a buildup of plaque (atherosclerosis or blood clots), which cuts off the supply of oxygenated blood to the heart muscles. Risk factors include smoking, high cholesterol, obesity, lack of exercise, and chronic stress.
- **Treatments:** Immediate administration of blood thinners (like aspirin) or clot-dissolving medications, oxygen therapy, surgical procedures such as angioplasty with stent placement, or coronary artery bypass grafting (CABG), followed by long-term lifestyle changes and cardiac medications.

5. Colour the following diagram of heart to show oxygenated and deoxygenated blood. Label the different structures as marked.

Answer: Use Blue for structures holding deoxygenated blood on the right side and Red for structures holding oxygenated blood on the left side.

C. Write Answers in Detail

1. Describe the functions of the components of blood.

Answer: Blood consists of cellular elements suspended in a liquid matrix, each serving vital functions:

- **Plasma:** The liquid component (about 55% of blood) composed of water, proteins, nutrients, salts, and waste products. It maintains blood pressure, balances pH, and transports nutrients, hormones, and waste molecules throughout the body.
- **Red Blood Cells:** Packed with iron-containing hemoglobin molecules, they bind oxygen molecules in the lungs and efficiently release them into the peripheral body tissues.
- **White Blood Cells:** Acting as cellular warriors, they seek out, engulf, or generate targeted antibodies against invading pathogens like bacteria and viruses to keep the body healthy.
- **Platelets:** Tiny cellular fragments that accumulate rapidly at a wound site, clumping together and working alongside plasma proteins (like fibrinogen) to create a mechanical plug that stops hemorrhage.

2. Explain how blood transports materials throughout the human body.

Answer: The cardiovascular system acts as a high-speed closed transport system:

- **Oxygen and Carbon Dioxide:** Oxygen enters the blood across alveolar membranes, binds to red blood cells, and travels through arteries to capillaries where it is exchanged for carbon dioxide waste, which is carried back via veins to the lungs to be exhaled.
- **Nutrients:** Digested nutrients like glucose, amino acids, and lipids are absorbed from the digestive tract into the bloodstream and directed via the hepatic portal system and general circulation to active tissues.
- **Hormones and Wastes:** Endocrine glands dump systemic hormones directly into blood capillaries to reach far-off target organs. Simultaneously, metabolic waste products like urea are collected from the tissues and directed to the kidneys for filtration and excretion.

3. Explain the structure of the heart with a diagram.

Answer: The human heart is a hollow, muscular organ about the size of a closed fist, divided into right and left sides by a thick muscular wall called the septum:

- **Chambers:** It features four functional chambers: the thin-walled right and left atria at the top, and the highly muscular right and left ventricles at the base.
- **Valves:** One-way valves keep blood flowing in a forward direction. The tricuspid valve separates the right chambers, while the bicuspid (mitral) valve guards the left chambers. Semilunar valves sit at the exits of the pulmonary artery and aorta to block backward leakage.
- **Vessels:** The right side connects to the vena cava (bringing in spent blood) and the pulmonary artery (sending blood to get oxygenated). The left side receives fresh blood via the pulmonary veins and ejects it forcefully out into the body through the thick-walled aorta.

4. Explain the harmful effects of smoking related to heart diseases.

Answer: Smoking directly damages the cardiovascular system through multiple pathways:

- **Atherosclerosis and Arterial Damage:** Nicotine and toxic chemicals within tobacco smoke damage the delicate endothelial linings of the arteries, accelerating the buildup of fatty plaques that restrict blood flow.
- **Reduced Oxygen Delivery:** Carbon monoxide binds strongly to hemoglobin inside red blood cells, taking the place of oxygen and drastically lowering the blood's capacity to deliver oxygen to vital organs.
- **Elevated Blood Pressure and Strain:** Smoking spikes blood cholesterol levels, elevates baseline blood pressure, and weakens structural vessel integrity. It also contributes to peripheral artery narrowing, which strains the heart and increases the risk of myocardial infarction.

5. Compare the structure and function of an artery, a vein and a capillary.

Feature	Artery	Vein	Capillary
Function	Carries blood under high pressure away from the heart to body organs.	Gathers blood under low pressure from body organs and guides it back toward the heart.	Bridges arteries and veins together, acting as the primary site for the rapid exchange of materials between blood and tissues.
Wall Structure	Thick, highly elastic, and muscular walls.	Thinner and less muscular walls.	Microscopic and fragile walls that are only a single endothelial cell thick.
Lumen Size	Narrow lumen.	Wide, flexible lumen.	Extremely narrow lumen (microscopic, allowing cells to pass through in a single file).
Valves	Absent.	Present (internal one-way valves to stop backward blood flow).	Absent.
Blood Pressure	High blood pressure.	Low blood pressure.	Low blood pressure (dropping steadily to allow proper nutrient exchange).

D. Inquisitive Questions

1. Why is oxygenated blood separated from deoxygenated blood in heart?

Answer: Keeping oxygenated and deoxygenated blood completely separated prevents them from mixing, which ensures that tissues receive a highly concentrated supply of oxygen. This separation maximizes metabolic efficiency and enables warm-blooded humans to maintain a stable core body temperature and high activity levels.

2. How does regular exercise strengthen the circulatory system?

Answer: Regular exercise challenges the cardiac muscle, making the heart contract more efficiently and increasing its stroke volume (the amount of blood pumped per beat). Over time, it helps lower resting blood pressure, reduces resting heart rate, clears bad cholesterol levels, and triggers the growth of additional capillary beds in muscle tissues.

3. How can lifestyle choices prevent cardiovascular diseases?

Answer: Adopting healthy lifestyle habits drastically reduces risk factors for cardiovascular disease. Eating a balanced diet low in saturated fats keeps arterial linings free of cholesterol plaques; avoiding tobacco smoking prevents endothelial damage and maintains oxygen carriage; and regular physical activity controls weight, manages stress, and maintains vascular flexibility.

4. If cholesterol levels in the blood are never regulated, how can it impact the heart and blood vessels over time?

Answer: Uncontrolled high cholesterol causes progressive lipid deposits to harden inside the endothelial linings of major blood vessels (atherosclerosis). Over time, this narrows the internal diameter of arteries, restricts blood flow, and elevates blood pressure. If these deposits block a coronary artery entirely, it cuts off the oxygen supply to the cardiac muscles, leading to a myocardial infarction (heart attack).

Visit Ahsa.Pk for more.
Join Al Huda Science Academy to
learn subjects easily.

Unit 4: Homeostasis

A. Multiple Choice Questions

1. The process of regulating the amount of water in body fluid is called:

- (a) Filtration
- (b) Reabsorption
- (c) Tubular secretion
- **(d) Osmoregulation ✓**

2. What happens in the proximal convoluted tubule of nephron?

- (a) Blood is filtered by glomerulus
- **(b) Reabsorption of water and nutrients occurs ✓**
- (c) Urine is stored
- (d) Water is secreted into the bloodstream

3. Which structure is responsible for filtering blood to produce urine?

- **(a) Nephron ✓**
- (b) Renal pelvis
- (c) Ureter
- (d) Renal capsule

4. Which structure in nephron is responsible for filtering blood?

- (a) Loop of Henle
- **(b) Glomerulus ✓**
- (c) Proximal convoluted tubule
- (d) Distal convoluted tubule

5. In which part of nephron, the reabsorption of nutrients occurs?

- (a) Glomerulus
- **(b) Proximal convoluted tubule ✓**
- (c) Loop of Henle
- (d) Distal convoluted tubule

6. Which process in nephron involves the active transport of materials from blood into nephron?

- (a) Filtration
- **(b) Secretion ✓**
- (c) Reabsorption
- (d) Excretion

7. Which is NOT present in the filtrate entering the Bowman's capsule of nephron?

- (a) Water
- (b) Calcium ions
- **(c) Blood cells ✓**
- (d) Urea

8. In which procedure a machine is used to filter blood outside the body?

- (a) Peritoneal dialysis
- **(b) Haemodialysis ✓**
- (c) Lithotripsy
- (d) Renal surgery

9. What is the primary purpose of haemodialysis?

- (a) To rehydrate the body
- (b) To replace lost nutrients
- **(c) To filter waste products from blood ✓**
- (d) To regulate blood pressure

10. In peritoneal dialysis, what acts as the filtering membrane?

- (a) Dialysis machine
- (b) Renal cortex
- **(c) Peritoneal membrane ✓**
- (d) Renal tubules

B. Short Answer Questions

1. Enlist the main parts of the human urinary system.

Answer: The human urinary system consists of a pair of kidneys, a pair of ureters, a urinary bladder, and a urethra.

Visit Our Website: [Ahsa.Pk](https://www.ahsa.pk) for more notes, mcqs, guess papers, schemes, and more

Visit Our YouTube Channel: <https://youtube.com/@ahsadotpk>

2. Briefly describe how kidneys control the composition of blood.

Answer: Kidneys filter metabolic wastes, excess salts, and water from the blood through pressure filtration in the nephrons. They then selectively reabsorb essential nutrients, water, and ions back into the bloodstream while eliminating the remaining wastes as urine, thereby maintaining homeostatic balance.

3. Name the major parts of a nephron.

Answer: A nephron consists of two main parts: the renal corpuscle (which includes the glomerulus and Bowman's capsule) and the renal tubule (which includes the proximal convoluted tubule, loop of Henle, and distal convoluted tubule).

4. What materials in diet can cause kidney stones?

Answer: A diet rich in oxalates (found in spinach, tomatoes, and nuts), excessive intake of calcium, heavy consumption of red meat, dairy products, and high amounts of salt or refined sugars can contribute to the formation of kidney stones.

5. What do you mean by lithotripsy?

Answer: Lithotripsy is a non-surgical medical procedure used to treat kidney stones by utilizing high-energy shock waves from outside the body to break the stones into tiny fragments, allowing them to easily pass out through the urine.

6. Differentiate between:

i. Excretion and osmoregulation

- **Excretion:** The metabolic process of eliminating toxic nitrogenous waste products and unwanted materials from the body fluids.
- **Osmoregulation:** The homeostatic regulation of osmotic pressure to maintain the ideal balance of water and salts in the body fluids.

ii. Renal cortex and renal medulla

- **Renal cortex:** The outer, lighter-colored zone of the internal structure of the kidney situated immediately beneath the renal capsule.
- **Renal medulla:** The inner, darker-colored zone of the kidney's internal structure that is divided into several cone-shaped masses called renal pyramids.

iii. Renal corpuscle and renal tubule

- **Renal corpuscle:** The initial, non-tubular filtering component of a nephron comprising the glomerulus and the surrounding Bowman's capsule.
- **Renal tubule:** The long, continuous, coiled portion of the nephron extending from Bowman's capsule that modifies the filtrate through reabsorption and secretion.

iv. Pressure filtration and tubular secretion

- **Pressure filtration:** The passive movement of water and small solutes from the glomerulus into Bowman's capsule under high hydrostatic blood pressure.
- **Tubular secretion:** The active transport of specific waste ions, drugs, and excess materials from the surrounding capillary blood directly into the renal tubule fluid.

v. Haemodialysis and peritoneal dialysis

- **Haemodialysis:** A mechanical procedure where a patient's blood is pumped outside the body through an artificial kidney machine (dialyzer) to filter out wastes.
- **Peritoneal dialysis:** An internal procedure where dialysis fluid is introduced directly into the patient's abdominal cavity, utilizing the natural peritoneal membrane as the filter.

7. Label the parts of the diagrams (A) and (B):

Diagram (A) [Human Urinary System]: Label the kidneys, ureters, urinary bladder, and urethra.

Diagram (B) [Internal Structure of Kidney]: Label the renal cortex, renal medulla, renal pyramids, and renal pelvis.

C. Write Answers in Detail

1. Write a note on the structure of kidney.

Answer: The human kidney is a dark red, bean-shaped organ located against the posterior abdominal wall on either side of the vertebral column. Its external surface is convex, while the internal medial surface is concave, featuring a deep notch called the hilum where the renal artery enters and the renal vein and ureter exit. Internally, the kidney is divided into three major functional regions: the outer renal cortex, the inner renal medulla containing structural renal pyramids, and the central funnel-like cavity called the renal pelvis, which funnels generated urine down into the ureters.

2. Describe the structure of a nephron and draw a labelled diagram.

Answer: The nephron is the microscopic functional and structural unit of the kidney, with over one million units present in each kidney. Its structure is divided into two principal sections:

- **Renal Corpuscle:** Located in the cortex, this contains the glomerulus—a high-pressure network of blood capillaries—enclosed by Bowman's capsule, a cup-like sac that collects the initial fluid filtered out of the blood.
- **Renal Tubule:** A long conduit extending from Bowman's capsule. It begins as the highly twisted proximal convoluted tubule, straightens down into the medulla to form a U-shaped loop of Henle, returns to the cortex as the distal convoluted tubule, and finally empties into a shared collecting duct that carries urine to the renal pelvis.

3. Describe the process of pressure filtration and re-absorption in kidneys.

Answer:

- **Pressure Filtration:** As blood flows under high pressure through the glomerulus, the thin capillary walls act as a sieve. Water, glucose, amino acids, urea, and salts are forced across the membrane into Bowman's capsule to form the glomerular filtrate, while large proteins and blood cells remain behind in the vessels.
- **Re-absorption:** As the filtrate moves along the renal tubule, about 99% of its volume is recovered. In the proximal convoluted tubule, essential nutrients like glucose and amino acids along with key ions are actively reabsorbed back into the blood capillaries. In the loop of Henle and distal tubule, the body dynamically reabsorbs water and remaining essential salts based on current systemic hydration levels.

4. What is tubular secretion? How it helps in removing wastes from blood?

Answer: Tubular secretion is the active process occurring primarily within the distal convoluted tubules, where epithelial cells selectively transport specific substances from the surrounding peritubular capillaries into the tubular lumen. This mechanism helps clear the blood of remaining metabolic wastes, toxins, hydrogen ions (H^+), potassium ions (K^+), and drug residues that were not cleared during initial filtration. By actively dumping these ions into the forming urine, it provides a vital secondary clearance pathway while directly regulating systemic blood pH.

5. Write a comprehensive note on kidney stones describing the causes, symptoms and treatments.

Answer:

- **Causes:** Kidney stones form when urine becomes highly concentrated, allowing minerals like calcium oxalate, calcium phosphate, and uric acid to crystallize and accumulate. Contributing factors include chronic dehydration, consuming diets excessive in oxalates, calcium, or salts, metabolic disorders, and recurrent urinary tract infections.
- **Symptoms:** Severe, sharp pain radiating from the back or lower flank toward the groin area, painful urination (dysuria), hematuria (blood in urine), nausea, vomiting, and a frequent urgency to urinate.
- **Treatments:** Small stones are typically treated conservatively with high fluid intake and pain medications to flush them out naturally. Moderate stones can be broken down using non-invasive lithotripsy. Large or obstructing stones require surgical intervention (nephrolithotomy) or ureteroscopic removal.

6. Write down the symptoms and causes of kidney failure.

Answer:

- **Causes:** The primary causes of kidney failure (renal failure) include long-standing chronic conditions like diabetes mellitus and hypertension, which gradually destroy renal vasculature. Acute causes include severe bacterial infections, toxic drug overdoses, sudden urinary tract blockages, or severe trauma accompanied by massive blood loss.
- **Symptoms:** Progressive accumulation of urea and other toxins in the blood leads to severe fluid retention (edema) causing swelling in the legs and face, shortness of breath, chronic fatigue, loss

of appetite, nausea, vomiting, mental confusion, and a significant drop in total urine output (oliguria).

7. Define dialysis and describe the processes of peritoneal dialysis and haemodialysis.

Answer: Dialysis is an artificial medical purification technique used to clear metabolic waste materials and excess fluids from the blood of patients suffering from kidney failure.

- **Peritoneal Dialysis:** A sterile dialysis fluid is introduced into the patient's abdominal cavity through a surgically implanted catheter. The natural peritoneal membrane lining the abdomen acts as the filter; wastes diffuse from the blood vessels across this membrane into the fluid. After a few hours, the spent fluid containing the wastes is drained out and replaced.
- **Haemodialysis:** The patient's blood is diverted out of the body through an arterial line into a specialized machine called a dialyzer (artificial kidney). Inside, blood flows past a semipermeable synthetic membrane on the other side of which flows fresh dialysis fluid. Wastes and excess water pass from the blood into the fluid via diffusion, and the purified blood is safely returned to the patient's circulatory system.

D. Inquisitive Questions

1. "Along with excretion, kidneys also play role in osmoregulation." Comment on this statement.

Answer: This statement is entirely true because the kidneys actively adjust the volume and concentration of excreted urine based on the body's hydration state. When water intake is low, the kidneys conserve water by increasing reabsorption in the tubules, producing concentrated urine; when the body is overhydrated, reabsorption decreases, and large amounts of dilute urine are excreted to maintain fluid homeostasis.

2. How does the nephron ensure that essential nutrients are not lost in urine?

Answer: The nephron utilizes specialized transport proteins embedded within the epithelial cell membranes of the proximal convoluted tubule. These proteins actively pump vital nutrients, such as 100% of filtered glucose and amino acids, out of the tubular fluid and back into the surrounding peritubular capillaries against their concentration gradient, ensuring none are wasted.

3. Why is long loop of Henle important in the balance of water and salts in body?

Answer: A long loop of Henle extends deep into the highly concentrated environment of the renal medulla, establishing a steep osmotic gradient. This structural adaptation allows for maximum passive reabsorption of water out of the descending limb and active pumping of salts out of the ascending limb, enabling the body to produce highly concentrated urine and conserve water efficiently.

4. How can chronic diseases like diabetes lead to kidney failure?

Answer: Chronic diabetes results in persistently high blood glucose levels, which damage the delicate, high-pressure capillary networks of the glomeruli over time. This microvascular injury causes the filtration barriers to become scarred and leaky (diabetic nephropathy), allowing vital proteins to escape into the urine and ultimately causing the nephrons to shut down, leading to total kidney failure.

Visit Our Website: Ahsa.Pk for more notes, mcqs, guess papers, schemes, and more

Visit Our YouTube Channel: <https://youtube.com/@ahsadotpk>

Unit 5: Nervous System

A. Multiple Choice Questions

1. Schwann cells are the supporting cells for neurons. They make:

- (a) Cell body
- (b) Axon
- **(c) Myelin sheath ✓**
- (d) Dendrites

2. Which part of the brain controls balance while riding a bicycle?

- (a) Cerebrum
- (b) Medulla
- **(c) Cerebellum ✓**
- (d) Spinal cord

3. Which part is responsible for sensations of temperature, hunger, thirst, and sleep?

- **(a) Hypothalamus ✓**
- (b) Thalamus
- (c) Pons
- (d) Cerebellum

4. If a patient cannot remember things, which part of their brain may be affected?

- **(a) Cerebrum ✓**
- (b) Cerebellum
- (c) Medulla
- (d) Spinal cord

5. During danger, which system activates quickly?

- (a) Parasympathetic
- (b) Skeletal
- (c) Endocrine
- **(d) Sympathetic ✓**

6. Why are reflex actions faster than normal actions?

- (a) Brain processes them quickly
- **(b) Brain is not involved ✓**
- (c) Signals move slower
- (d) They need thinking

7. Which of these acts as exocrine as well as endocrine gland?

- (a) Pituitary
- (b) Thyroid
- (c) Adrenal
- **(d) Pancreas ✓**

8. The chemical messengers of the endocrine system are called:

- (a) Neurotransmitters
- **(b) Hormones ✓**
- (c) Neurons
- (d) Enzymes

9. What could happen if hormone of parathyroid gland were missing?

- **(a) Low calcium levels ✓**
- (b) High blood sugar
- (c) Weak muscles
- (d) Poor digestion

10. Which endocrine gland prepares the body for "fight or flight" response?

- (a) Thyroid
- (b) Pituitary
- **(c) Adrenal ✓**
- (d) Pancreas

B. Short Answer Questions

1. Define stimulus with examples.

Answer: A stimulus is any change in the internal or external environment of an organism that is capable of provoking a specific physiological or behavioral response. Examples include a sudden flash of bright light (external stimulus) or an increase in blood glucose levels (internal stimulus).

2. Differentiate between sensory, motor, and interneurons.

Answer:

- **Sensory neurons:** Nerve cells that conduct electrochemical impulses from sensory receptors throughout the body toward the central nervous system (brain and spinal cord).
- **Motor neurons:** Nerve cells that transmit operational signals and commands away from the central nervous system to effectors, such as muscles or glands, to initiate a response.
- **Inter-neurons:** Nerve cells located entirely within the central nervous system that link sensory and motor neurons together, responsible for integrating and processing sensory input.

3. Define reflex action and the reflex arc.

Answer:

- **Reflex action:** An immediate, involuntary, and automatic response to a specific stimulus that occurs without conscious thought or intervention by the brain.
- **Reflex arc:** The complete anatomical nerve pathway along which an electrochemical impulse travels during a reflex action, typically comprising a receptor, sensory neuron, inter-neuron in the spinal cord, motor neuron, and an effector.

4. Differentiate between the following:

(a) Dendrite and axon

- **Dendrite:** A short, cytoplasmic projection extending from the neuronal cell body that specializes in receiving incoming nerve impulses from other cells and conducting them toward the cell body.
- **Axon:** A single, long, thin cytoplasmic extension that carries nerve impulses away from the neuronal cell body toward terminal branches to communicate with other cells or effectors.

(b) Cerebrum and Cerebellum

- **Cerebrum:** The largest major division of the forebrain, responsible for high-level voluntary actions, conscious thought, memory, logic, speech, and processing complex sensory information.
- **Cerebellum:** A specialized structure of the hindbrain located at the back of the skull, primarily responsible for coordinating complex voluntary muscle movements, maintaining posture, and ensuring body balance.

(c) Thalamus and Hypothalamus

- **Thalamus:** A critical processing structure within the forebrain that serves as a major relay center, sorting and directing conscious sensory impulses to the appropriate functional areas of the cerebral cortex.
- **Hypothalamus:** A small, regulatory center located directly below the thalamus that links the nervous and endocrine systems while managing critical homeostatic conditions including body temperature, hunger, thirst, and sleep cycles.

5. Identify the diagram and label the different parts.

Answer: The provided illustration depicts the microscopic structure of a **Neuron (Nerve Cell)**.

Answer: This cross-sectional illustration depicts the anatomical structure of the **Spinal Cord** paired with a **Reflex Arc**.

C. Write Answers in Detail

1. Describe the structure of a neuron and support your answer with a labelled diagram.

Answer: A neuron is the fundamental structural and functional unit of the human nervous system, highly specialized to generate and conduct electrochemical nerve impulses. It consists of three primary regions:

- **Cell Body (Soma):** The metabolic core of the neuron, housing a well-defined nucleus, cytoplasm, and standard cellular organelles necessary to sustain cell life.
- **Dendrites:** Short, highly branched cytoplasmic extensions radiating outwards from the cell body. They act as local antennas, capturing nerve impulses from neighboring receptors or neurons and conducting them inward toward the soma.
- **Axon:** A single, elongated tubular projection extending from the cell body that carries electrical impulses over long distances toward target organs or adjacent neurons. Axons are frequently insulated by a fatty lipid layer known as the myelin sheath, which is formed at intervals by supporting Schwann cells. The gaps along this sheath are termed the Nodes of Ranvier, which serve to accelerate the speed of impulse propagation via saltatory conduction. At its terminal end, the axon splits into specialized branches that release neurotransmitters across synaptic gaps.

2. What are the differences and similarities among the three types of neurons?

Answer:

Similarities: Sensory, motor, and inter-neurons share the same foundational architecture; they all possess a functional cell body containing a nucleus, utilize cytoplasmic extensions (dendrites and axons) to route information, and generate identical electrochemical nerve impulses to maintain internal communication.

Differences:

- **Sensory Neurons:** Feature a specialized structural shape with long dendrites and short axons. They originate at sensory receptors and end in the central nervous system, transporting incoming sensory details.
- **Motor Neurons:** Feature standard multipolar architecture with short dendrites and exceptionally long axons. They extend out from the central nervous system to terminate at peripheral muscles or glands to trigger actions.
- **Inter-neurons:** Located exclusively within the complex networks of the brain and spinal cord. They exhibit highly branched, compact shapes optimized to form millions of local connections to integrate, evaluate, and store information.

3. Write the major functions of the forebrain, midbrain, and hindbrain.

Answer:

- **Forebrain:** The largest, most complex part of the brain. It controls higher intellectual functions, including abstract reasoning, voluntary movement control, logical planning, language processing, and memory. It also processes primary sensory inputs, manages emotional states, and acts as the central homeostatic hub for regulating body temperature, thirst, and basic survival drives.
- **Midbrain:** A compact relay station positioned between the forebrain and hindbrain. It receives sensory inputs and routes them to the higher processing centers, while playing a critical role in controlling acoustic reflexes and coordinating basic visual and motor tracking movements.
- **Hindbrain:** Comprising the cerebellum, pons, and medulla oblongata, it acts as the primary life-support command center. It regulates critical, involuntary autonomic activities including cardiac rhythm, systemic blood pressure, swallowing, and breathing. Additionally, it coordinates complex voluntary muscle movements, fine-tunes balance during physical activity, and serves as a pathway for major ascending and descending nerve tracts.

4. What is meant by reflex action? Describe an example of reflex action and identify the reflex arc in this example.

Answer:

Reflex Action: An immediate, automatic, involuntary response to a potentially harmful environmental stimulus that takes place without conscious perception or active decision-making by the brain.

Example: Instantly pulling your hand away after accidentally touching a very hot object, like a hot iron plate.

Identification of the Reflex Arc in this example:

1. **Receptor:** Specialized pain and thermal receptors in the skin of the hand detect the intense heat.
2. **Sensory Neuron:** Generates an action potential and carries the danger signal rapidly from the hand up into the spinal cord.

3. **Inter-neuron:** Located in the grey matter of the spinal cord, it receives the input and relays it across a synapse directly to a motor neuron without waiting for the brain.
4. **Motor Neuron:** Exits the spinal cord and carries an urgent command downward to the muscles of the arm.
5. **Effector:** The biceps muscle in the arm acts as the effector, contracting forcefully to pull the hand away from the hot surface.

5. State the hormones of the pituitary gland and write their functions.

Answer: The pituitary gland is divided into lobes that release critical regulatory hormones into the circulation:

- **Growth Hormone (GH / Somatotropin):** Stimulates cell division, protein synthesis, and general tissue growth throughout the body, particularly within the skeletal system and skeletal muscles.
- **Thyroid-Stimulating Hormone (TSH):** Targets the thyroid gland, stimulating it to synthesize and release its own metabolic hormones, thyroxine.
- **Adrenocorticotrophic Hormone (ACTH):** Stimulates the outer cortex of the adrenal glands to release crucial steroid hormones like cortisol during stress.
- **Antidiuretic Hormone (ADH / Vasopressin):** Targets the collecting ducts of the kidneys, increasing water reabsorption to regulate fluid balance and blood pressure.
- **Oxytocin:** Stimulates uterine contractions during childbirth and promotes milk ejection from mammary glands during lactation.
- **Gonadotropins (FSH and LH):** Regulate the development, maturation, and reproductive hormonal secretions of the primary gonads (ovaries and testes).

6. Write notes on adrenal glands, pancreas, ovaries and testes.

Answer:

- **Adrenal Glands:** Paired, pyramid-shaped organs resting on top of each kidney. They consist of an outer cortex and an inner medulla. The medulla secretes epinephrine (adrenaline) to instantly prepare the body for "fight or flight" responses, while the cortex produces vital steroid hormones like aldosterone and cortisol to regulate mineral balance and handle long-term stress.
- **Pancreas:** A dual-purpose, elongated gland located behind the stomach that functions as both an exocrine and endocrine organ. Its endocrine tissue, the Islets of Langerhans, secretes insulin and glucagon directly into the bloodstream to tightly regulate glucose homeostasis. Insulin lowers blood sugar levels by aiding glucose uptake into cells, while glucagon raises low blood sugar by stimulating glycogen breakdown in the liver.
- **Ovaries:** The primary female reproductive organs, located within the pelvic cavity. They function as endocrine organs by secreting estrogen and progesterone, which coordinate the development of female secondary sexual characteristics, regulate the menstrual cycle, and maintain early pregnancy.

- **Testes:** The primary male reproductive organs, located externally within the scrotum. They house interstitial cells that synthesize and secrete androgenic hormones, primarily testosterone, which drives sperm production and maintains male secondary sexual characteristics.

D. Inquisitive Questions

1. Why is the spinal cord important in reflex actions?

Answer: The spinal cord is essential because it acts as a central control hub that routes incoming sensory inputs directly to outgoing motor pathways without needing the signal to travel all the way up to the brain. This structural shortcut minimizes response times, allowing the body to react to danger almost instantly to prevent or reduce tissue damage.

2. Why is adrenaline called an "emergency hormone"?

Answer: Adrenaline is considered an "emergency hormone" because the adrenal medulla releases it in large amounts during moments of sudden stress, fear, or physical danger. It rapidly triggers systematic changes—such as spiking the heart rate, raising blood pressure, dilating airways, and shunting blood toward active skeletal muscles—to maximize the body's survival capacity during a "fight or flight" scenario.

3. If pancreas releases too much insulin, what happens to blood sugar?

Answer: If the pancreas secretes an excessive amount of insulin, it forces cells and liver tissue to rapidly pull glucose out of the blood and convert it into stored glycogen. This sudden shift drains the circulating glucose pool, leading to a severe drop in blood sugar levels known as hypoglycemia, which can cause dizziness, weakness, fainting, or unconsciousness due to energy deprivation in the brain.

4. If the medulla of a patient is injured, which function is most at risk?

Answer: If the medulla oblongata is injured, the patient's critical life-support mechanisms are at immediate risk of failure. Because the medulla houses the autonomic control centers that manage vital functions like breathing, cardiac rhythm, and blood vessel diameter, even minor damage to this area can result in sudden respiratory arrest or heart failure.

Visit [Ahsa.Pk](https://ahsa.pk) for more.
Join Al Huda Science Academy to
learn subjects easily.

Unit 6: Reproduction

A. Multiple Choice Questions

1. In which part of the body oogenesis takes place?

- (a) Oviduct
- **(b) Ovary ✓**
- (c) Uterus
- (d) Fallopian tube

2. Which of the following is NOT a part of the male reproductive system?

- (a) Testes
- (b) Epididymis
- **(c) Uterus ✓**
- (d) Prostate gland

3. Which hormone directly triggers ovulation?

- (a) Oestrogen
- (b) Progesterone
- **(c) Luteinizing hormone (LH) ✓**
- (d) Follicle-stimulating hormone (FSH)

4. Which hormone is responsible for the development of male secondary sexual characteristics?

- (a) Follicle Stimulating Hormone
- (b) Oestrogen
- **(c) Testosterone ✓**
- (d) Luteinizing Hormone

5. What is the function of acrosome?

- (a) Guides the sperm towards egg cell
- **(b) Releases enzymes that help sperm penetrate the egg's outer layers ✓**
- (c) Activates the egg for fertilization
- (d) Helps in the fusion of sperm and egg nuclei

6. What is the function of the Fallopian tubes?

- **(a) Site of fertilization ✓**
- (b) Storage of eggs
- (c) Secretion of oestrogen
- (d) Transport of sperm to testes

7. Which hormone is primarily responsible for the development of male secondary sexual characteristics?

- (a) Oestrogen
- **(b) Testosterone ✓**
- (c) Progesterone
- (d) FSH

B. Short Answer Questions

1. Complete the chart of spermatogenesis by mentioning the names of cells and number of chromosomes ($2n$ or $1n$).

Answer:

- Spermatogonium ($2n$) → Primary Spermatocyte ($2n$) → Secondary Spermatocytes (n) → Spermatids (n) → Spermatozoa (n)

2. Complete the chart of oogenesis by mentioning the names of cells and number of chromosomes ($2n$ or $1n$).

Answer:

- Oogonium ($2n$) → Primary Oocyte ($2n$) → Secondary Oocyte (n) + First Polar Body (n) → Ovum (n) + Second Polar Body (n)

3. Name the parts of the testis and ovary where gamete formation takes place.

Answer:

- **In Testis:** Gamete formation (spermatogenesis) takes place within the highly coiled seminiferous tubules.
- **In Ovary:** Gamete formation (oogenesis) takes place within the cellular structures called ovarian follicles.

4. What happens to the egg after it is released from the ovary?

Answer: After the egg is released from the ovary during ovulation, it is swept into the Fallopian tube (oviduct) by ciliated projections. If sperm are present, fertilization occurs within the Fallopian tube; if unfertilized, the egg disintegrates and is discharged during menstruation.

5. Compare spermatogenesis and oogenesis in terms of the number of gametes produced.

Answer:

- **Spermatogenesis:** Produces four functional, motile sperm cells from each primary spermatocyte.
- **Oogenesis:** Produces only one functional egg cell (ovum) and three non-functional polar bodies from each primary oocyte, conserving cytoplasm for the potential embryo.

6. Describe two major ways through which HIV can be transmitted.

Answer:

- **Unprotected Sexual Contact:** Transfer of infected bodily fluids during unprotected sexual intercourse with an HIV-positive individual.
- **Contaminated Blood or Needles:** Sharing contaminated needles among drug users or receiving transfusions of unscreened, infected blood.

7. Differentiate between:

i. Oestrogen and progesterone

- **Oestrogen:** Secreted by developing follicles; responsible for developing female secondary sexual characteristics and repairing the uterine lining.
- **Progesterone:** Secreted by the corpus luteum; thickens and maintains the uterine lining to support embryo implantation and pregnancy.

ii. Spermatogenesis and oogenesis

- **Spermatogenesis:** The continuous metabolic process in males that forms mature, motile sperm cells within the testes.
- **Oogenesis:** The discontinuous process in females that forms mature egg cells within the ovaries, pausing at developmental checkpoints.

iii. Spermatocyte and oocyte

- **Spermatocyte:** A male diploid cell derived from spermatogonia that undergoes meiotic divisions to eventually generate haploid spermatids.
- **Oocyte:** A female diploid or haploid cell derived from oogonia that undergoes meiotic divisions to eventually produce a single mature ovum.

C. Write Answers in Detail

1. Describe the role of hormones in male sexual development.

Answer: Male sexual development is coordinated by endocrine interactions. Gonadotropin-Releasing Hormone (GnRH) from the hypothalamus stimulates the anterior pituitary to secrete Follicle-Stimulating

Visit Our Website: [Ahsa.Pk](https://www.ahsa.pk) for more notes, mcqs, guess papers, schemes, and more

Visit Our YouTube Channel: <https://youtube.com/@ahsadotpk>

Hormone (FSH) and Luteinizing Hormone (LH). FSH acts directly on the seminiferous tubules to stimulate sperm production. LH triggers the interstitial cells of the testes to secrete testosterone. Testosterone drives the primary development of male reproductive organs and stimulates secondary sexual characteristics during puberty, including muscle expansion, deepening of the voice, and facial hair growth.

2. Describe the role of hormones in female sexual development.

Answer: Female sexual development is regulated by cyclical hormonal pathways. Pituitary FSH stimulates ovarian follicles to grow and secrete oestrogen, which initiates female secondary sexual characteristics and repairs the uterine lining. A surge in pituitary LH triggers ovulation, releasing the mature egg. The remaining follicle transitions into the corpus luteum, secreting progesterone to prepare the uterine lining for implantation. If fertilization does not occur, hormone levels drop, causing the lining to shed during menstruation.

3. Describe the process of spermatogenesis.

Answer: Spermatogenesis is the sequence of cellular divisions that generates male gametes. Diploid stem cells called spermatogonia divide mitotically to produce diploid primary spermatocytes. Each primary spermatocyte undergoes Meiosis I to produce two haploid secondary spermatocytes. These secondary spermatocytes rapidly complete Meiosis II, yielding four haploid spermatids. Finally, these spermatids transform structurally by developing a tail, midpiece, and an enzyme-filled acrosome head to become mature, functional sperm.

4. Describe the functions of the major parts of male reproductive system.

Answer: The male reproductive system consists of several specialized structures:

- **Testes:** The primary gonads responsible for producing sperm and secreting testosterone.
- **Epididymis:** A coiled tube resting on each testis where immature sperm are stored to gain motility.
- **Vas Deferens:** The transport duct that conducts mature sperm from the epididymis toward the urethra.
- **Accessory Glands (Prostate and Seminal Vesicles):** Secrete nutrient-rich fluids that protect sperm, collectively forming semen.
- **Urethra:** The shared urogenital canal that delivers semen out of the body.

5. Describe the functions of the parts of female reproductive system.

Answer: The female reproductive tract is adapted for gamete production and supporting development:

- **Ovaries:** Produce mature egg cells and secrete the steroid hormones oestrogen and progesterone.
- **Fallopian Tubes (Oviducts):** Catch the ovulated egg and serve as the standard site for fertilization.

- **Uterus (Womb):** A hollow, muscular organ lined with vascular tissue designed to nourish and shelter a developing fetus.
- **Cervix:** The narrow neck of the uterus that regulates passage into the uterine cavity.
- **Vagina:** The muscular canal serving as the birth canal and receiving sperm during intercourse.

6. Explain AIDS as an example of sexually transmitted diseases.

Answer: Acquired Immunodeficiency Syndrome (AIDS) is a severe condition caused by the Human Immunodeficiency Virus (HIV). It serves as a classic example of a sexually transmitted disease because its primary mode of transmission is through unprotected sexual contact, which spreads the virus via mucosal linings. HIV directly infects and destroys helper T-lymphocytes, progressively disabling the host's immune system. As a result, the body can no longer defend against opportunistic pathogens, leading to weight loss, chronic diarrhea, severe pneumonia, and certain cancers.

D. Inquisitive Questions

1. Why only one egg is usually produced from one primary oocyte?

Answer: During the meiotic divisions of oogenesis, cytokinesis is highly unequal. Almost all of the cellular cytoplasm and organelles are funneled into a single daughter cell, while the remaining genetic material is discarded in tiny polar bodies. This unequal distribution ensures that the resulting single egg cell has enough nutrient reserves to support early cellular divisions after fertilization.

2. How does the structure of a sperm cell relate to its function?

Answer: A sperm cell's streamlined structure is optimized for motility and fertilization. The head contains a haploid nucleus carrying paternal genes and is capped with an acrosome that releases enzymes to penetrate the egg's outer layers. The midpiece is packed with mitochondria that generate ATP energy, powering the whip-like movements of the flagellum tail to propel the sperm toward the egg.

3. What steps can individuals take to prevent HIV transmission?

Answer: Transmission can be prevented by adopting protective health measures: avoiding unprotected sexual contact, ensuring that blood transfusions use thoroughly screened blood products, and strictly using sterile, disposable syringes and needles. Educating communities about safe medical practices helps control the spread of the virus.

Visit Ahsa.Pk for more.
Join Al Huda Science Academy to
learn subjects easily.

Unit 7: Genetics

A. Multiple Choice Questions

1. Chromosomes of eukaryotes are made of:

- (a) Lipids and proteins
- (b) Lipids and DNA
- (c) RNA and proteins
- **(d) DNA and proteins ✓**

2. What is the relationship between a gene and an allele?

- **(a) Alleles are alternative forms of a gene ✓**
- (b) Genes are alternative forms of an allele
- (c) Genes mask the effects of genes
- (d) Alleles mask the effects of alleles

3. The central dogma of molecular biology is best represented by:

- (a) DNA → RNA = Protein
- (b) DNA → RNA → Protein
- **(c) DNA → RNA → Protein ✓**
- (d) Protein → RNA → DNA

4. What happens during transcription?

- (a) A new polypeptide is created
- (b) RNA is scanned by a ribosome
- (c) A new copy of DNA is produced
- **(d) A copy of RNA is made ✓**

5. What is the role of DNA in protein synthesis?

- (a) Produces amino acids
- **(b) Provides the template for mRNA formation ✓**
- (c) Transports proteins
- (d) Stores proteins

6. The allele that is expressed, when two separate alleles are inherited:

- **(a) Dominant ✓**
- (b) Recessive
- (c) Homozygous
- (d) Heterozygous

7. Which of these is a reason why pea plants were suitable for Mendel's experiments?

- (a) Long life cycle
- **(b) Easy to cross-pollinate ✓**
- (c) Few seeds produced per plant
- (d) No variation in traits

8. What does Mendel's Law of Segregation state?

- (a) Genes are linked together
- **(b) Each allele separates during gamete formation ✓**
- (c) Dominant traits appear in all generations
- (d) Alleles blend together

9. In peas, allele for purple flower (P) is dominant over the allele for white flower (p). If a white flower is crossed with a heterozygous purple flower (Pp), what will be the ratio of offspring?

- (a) 100% purple
- (b) 75% purple & 25% white
- **(c) 50% purple & 50% white ✓**
- (d) 100% white

B. Short Answer Questions

1. Write down the combination of alleles in the gametes of a plant, which has genotype Rryy.

Answer: The plant will produce two types of gametes due to independent sorting: **Ry** and **ry**.

2. State Mendel's law of segregation.

Answer: It states that the two alleles for each inheritable trait separate (segregate) from each other during gamete formation, so that each gamete receives only one allele for each gene pair.

3. State Mendel's law of independent assortment.

Answer: It states that alleles of two or more different genes sort independently of one another into gametes during meiosis, meaning the inheritance of one trait does not influence the inheritance of another.

4. Mention three traits of pea plants studied by Mendel along with their dominant and recessive forms.

Answer:

- **Seed Shape:** Round (Dominant) vs. Wrinkled (Recessive)
- **Seed Colour:** Yellow (Dominant) vs. Green (Recessive)
- **Flower Colour:** Purple (Dominant) vs. White (Recessive)

5. Draw a cross between two pea plants. One of them has round green seeds (RRyy) while the other has wrinkled yellow seeds (rrYY).

Answer:

- **Parents (P₁):** RRyy (Round, Green) × rrYY (Wrinkled, Yellow)
- **Gametes:** All Ry from the first parent, all rY from the second parent.
- **F₁ Generation Genotype:** 100% RrYy
- **F₁ Generation Phenotype:** 100% Round, Yellow seeds.

6. Differentiate between:

i. Gene and allele

- **Gene:** A specific functional segment of DNA located on a chromosome that contains instructions to determine a particular biological trait.
- **Allele:** An alternative or variant form of a specific gene that occupies the same locus on homologous chromosomes.

ii. Dominant and recessive

- **Dominant allele:** An allele that completely masks the expression of its partner allele and manifests physically in both homozygous and heterozygous conditions.
- **Recessive allele:** An allele whose expression is completely hidden in a heterozygous state and can only manifest physically when inherited in a homozygous condition.

iii. F₁ and F₂ generations

- **F₁ generation (First Filial):** The immediate generation of offspring resulting directly from the cross-pollination of two pure-breeding parental strains.
- **F₂ generation (Second Filial):** The generation of offspring produced by self-pollination or crossing individuals belonging to the F₁ generation.

iv. Homozygous and heterozygous

Visit Our Website: [Ahsa.Pk](https://www.ahsa.pk) for more notes, mcqs, guess papers, schemes, and more

Visit Our YouTube Channel: <https://youtube.com/@ahsadotpk>

- **Homozygous:** An organism that possesses two identical alleles for a particular gene pair (e.g., RR or rr).
- **Heterozygous:** An organism that possesses two different alleles for a particular gene pair (e.g., Rr).

v. Genotype and phenotype

- **Genotype:** The specific genetic makeup or combination of alleles inherited by an organism for particular traits (e.g., BB, Bb, or bb).
- **Phenotype:** The observable physical expression, morphological appearance, or physiological traits of an organism resulting from its genetic constitution.

7. In the following diagram of a cell, label the components and the processes.

Answer: Label the DNA, mRNA, ribosome, and protein synthesis process.

8. Label the components in the following diagram.

Answer: Based on eukaryotic chromosome structure, label the chromatids, centromere, and telomeres.

C. Write Answers in Detail

1. Write a note on the structure and composition of chromosome.

Answer: Eukaryotic chromosomes are highly organized, dynamic nuclear structures designed to package, protect, and distribute genetic information during cell division. Each metaphase chromosome appears as a distinct X-shaped structure comprised of two identical, longitudinal strands called sister chromatids joined at a narrow constricted area known as the centromere. Chemically, chromosomes are composed of chromatin, which consists of approximately 40% DNA and 60% specialized structural proteins called histones. To fit within the microscopic nucleus, the long strands of double-helical DNA wrap securely around assemblies of eight positive histone proteins, creating bead-like structures called nucleosomes. These nucleosome strings coil intricately into dense chromatin fibers, which fold further into thick chromosomal structures.

2. Why did Mendel choose pea plants for his genetic experiments?

Answer: Gregor Mendel chose the garden pea (*Pisum sativum*) for his pioneering genetic experiments due to several distinct practical advantages:

- **Distinct, Contrasting Traits:** They exhibit highly distinct, easily recognizable contrasting variations for specific characteristics (such as yellow vs. green seeds, or tall vs. short stems) with no intermediate blending.
- **Controlled Pollination:** The floral anatomy naturally encloses the reproductive organs, promoting self-pollination. However, they can be easily cross-pollinated manually by removing the immature anthers.

- **Short Life Cycle:** They grow rapidly and complete their reproductive cycles within a single season, allowing data collection across multiple generations quickly.
- **High Offspring Yield:** Each plant produces a large quantity of seeds per pod, providing a large sample size necessary for statistical analysis.

3. Describe Mendel's experiment on two-character inheritance and state the law he proposed.

Answer:

Experiment: Mendel conducted dihybrid crosses by pairing pure-breeding plants with two distinct traits: round yellow seeds (RRYY) and wrinkled green seeds (rryy). The resulting F1 generation plants all possessed a heterozygous round yellow phenotype (RrYy). Mendel then allowed these F1 plants to self-pollinate. In the F2 generation, instead of producing only parental combinations, he obtained four distinct phenotypes in a consistent 9:3:3:1 ratio: 9/16 Round Yellow, 3/16 Round Green, 3/16 Wrinkled Yellow, and 1/16 Wrinkled Green.

Proposed Law: Based on these results, he formulated the **Law of Independent Assortment**. It states that when two or more pairs of traits are inherited together in a cross, the alleles for each pair segregate entirely independently of the alleles for other pairs during the formation of gametes.

4. Describe Mendel's Law of Segregation. Give an example.

Answer:

Description: The Law of Segregation states that every individual organism contains pairs of alleles for each inherited characteristic. During the process of gamete formation (meiosis), these homologous alleles separate or segregate from each other so that each resulting gamete receives only one allele from the pair. At fertilization, the random union of gametes restores the diploid paired condition in the offspring.

Example: In pea plants, purple flower color (P) is completely dominant over white flower color (p). When a homozygous purple plant (PP) is crossed with a white plant (pp), the F1 hybrids are all heterozygous purple (Pp). When the F1 generation is self-pollinated, the P and p alleles separate during gamete production, yielding an F2 generation with a phenotypic ratio of 3 purple-flowered plants to 1 white-flowered plant.

5. Describe how DNA and RNA take part in the synthesis of a protein.

Answer: Protein synthesis follows the two-step molecular pathway known as the Central Dogma:

Transcription: This initial process takes place within the cell nucleus. The genetic code stored in a specific gene segment of the double-stranded DNA molecule serves as a structural template. RNA polymerase reads this template to synthesize a single-stranded messenger RNA (mRNA) molecule. Once edited, this mRNA exits through nuclear pores into the cytoplasm.

Translation: This secondary process takes place at a ribosome in the cytoplasm. The ribosome binds to the mRNA strand and reads its nucleotide bases in consecutive sets of three, called codons. Transfer RNA (tRNA) molecules carrying specific amino acids match their matching anti-codons to the mRNA template. The ribosome links these delivered amino acids together with peptide bonds, forming a functional protein chain.

D. Inquisitive Questions

1. How do genes control the traits and characteristics of an organism?

Answer: Genes control organismal traits by acting as a coded blueprint for protein synthesis. The specific sequence of nucleotide bases within a gene dictates the assembly order of amino acids to build structural proteins and functional enzymes. These generated enzymes then catalyze and manage the metabolic pathways responsible for developing physical structures, pigmentation, and physiological characteristics.

2. Why can different alleles of the same gene lead to different physical traits?

Answer: Different alleles of the same gene possess minor variations in their nucleotide base sequences due to ancestral mutations. These changes modify the instructions for protein synthesis, resulting in proteins with altered shapes or differing enzymatic activity levels. These functional differences directly change how traits manifest, leading to distinct physical variations like purple versus white flowers.

Visit Ahsa.Pk for more.
Join Al Huda Science Academy to
learn subjects easily.

Unit 8: Biotechnology

A. Multiple Choice Questions

1. Why are bacteria commonly used in genetic engineering for producing products?

- (a) They naturally produces the required products
- **(b) They grow quickly and accept human genes ✓**
- (c) They resist all infections
- (d) They have a human-like immune system

2. In genetic engineering, the first step is:

- (a) Inserting DNA into the organism
- **(b) Cutting the desired gene from DNA ✓**
- (c) Growing the modified organism
- (d) Making proteins from the gene

3. Which of these is often used as a vector in genetic engineering?

- **(a) Virus ✓**
- (b) Fungi
- (c) Yeast
- (d) Blood cell

4. In genetic engineering, the desired gene is usually inserted into a bacterium by using:

- (a) Protein
- (b) Another bacterium
- **(c) Vector ✓**
- (d) Enzyme

5. In genetic engineering, after inserting the gene, the host cell is allowed to:

- (a) Mutate randomly
- (b) Die naturally
- **(c) Multiply and express the gene ✓**
- (d) Produce waste

6. In genetic engineering, "recombinant DNA" means:

- (a) Natural DNA
- (b) DNA copied by mistake
- **(c) DNA joined from two sources ✓**
- (d) DNA destroyed by enzymes

7. A gene for toxin production is inserted into a plant for:

- (a) Reducing water need
- (b) Increasing vitamin content
- **(c) Resisting insect attacks ✓**
- (d) Speeding up flowering

8. Genetically modified bacteria produce the following products, except:

- **(a) Hepatitis B vaccine ✓**
- (b) Growth hormone
- (c) Insulin
- (d) Interferon

9. Which biotechnology products help against viral infections?

- (a) Antibiotics
- **(b) Vaccines ✓**
- (c) Clotting factors
- (d) Growth hormone

10. Golden rice is a genetically modified plant to increase:

- (a) Protein
- **(b) Vitamin A ✓**
- (c) Iron
- (d) Calcium

B. Short Answer Questions

1. What is the relation between biotechnology and genetic engineering?

Answer: Biotechnology is a broad field of biology that involves using living organisms, cells, or biological systems to develop useful products for humans. Genetic engineering is a specialized, advanced branch

Visit Our Website: [Ahsa.Pk](https://www.ahsa.pk) for more notes, mcqs, guess papers, schemes, and more

Visit Our YouTube Channel: <https://youtube.com/@ahsadotpk>

of biotechnology that directly manipulates, alters, or transfers an organism's genes to introduce specific, desirable traits.

2. What is a plasmid? Why biologists use plasmids in genetic engineering?

Answer:

- **Plasmid:** A small, circular, double-stranded extra-chromosomal DNA molecule found naturally in the cytoplasm of bacterial cells, distinct from their chromosomal DNA.
- **Why used:** Biologists use them as vectors because they can be easily isolated, cut open to insert foreign genes, and re-introduced into bacterial cells, where they replicate independently to distribute the foreign gene.

3. The following diagram shows how a gene is transferred to bacterial cell. Identify the structures labelled as 1 to 5.

Answer: Label the plasmid, restriction enzyme, gene of interest, recombinant DNA, and transformed bacterium.

4. What do you mean by genetically modified organism?

Answer: A genetically modified organism (GMO) is any plant, animal, or microorganism whose genetic material (DNA) has been altered, modified, or engineered using biotechnology techniques to include a specific foreign gene that expresses a brand-new, desirable trait.

5. List two types of medical products that can be produced using genetic engineering.

Answer:

- **Human Insulin:** Used to manage diabetes mellitus.
- **Human Growth Hormone:** Used to treat growth deficiencies and dwarfism.

6. List two ways by which genetic engineering may improve crops.

Answer:

- **Pest and Insect Resistance:** Inserting toxin genes to allow crops to resist insect attacks without chemical pesticides.
- **Nutritional Enhancement:** Modifying food crops to increase essential nutrient or vitamin levels, such as developing Golden Rice.

C. Write Answers in Detail

1. Explain with examples that food biotechnology has advanced agriculture.

Answer: Food biotechnology has revolutionized agricultural practices by altering crop genomes to improve yield, defense, and nutritional value. A prime example is the creation of insect-resistant crops, such as Bt cotton and Bt corn, which carry a gene from the bacterium *Bacillus thuringiensis* that

produces a natural toxin against pests, reducing chemical dependency. Additionally, biotechnology has addressed global nutritional deficiencies through biofortification, as seen in Golden Rice, which is engineered with plant genes to produce beta-carotene, a vital precursor for Vitamin A. Crops have also been engineered for herbicide tolerance, allowing farmers to eliminate weeds without damaging their primary food yield.

2. Explain with examples that medical biotechnology has advanced healthcare in diabetes and cancer.

Answer: Medical biotechnology has dramatically advanced modern clinical therapies:

- **In Diabetes:** Traditionally, diabetic patients relied on insulin extracted from slaughtered animals, which frequently triggered allergic immune reactions. Biotechnology solved this by inserting the human insulin gene into *E. coli* bacteria or yeast, enabling the mass production of pure, bio-identical human insulin via microbial fermentation.
- **In Cancer:** Genetic engineering is used to produce specialized biopharmaceuticals like interferons—proteins that help the human immune system recognize and fight viral infections and malignant tumor cells. Furthermore, biotechnology enables the mass production of monoclonal antibodies and engineered vaccines that precisely target cancer cells while preserving surrounding healthy tissues.

3. Explain the role of yeast in the production of bread and ethanol.

Answer: Yeast (*Saccharomyces cerevisiae*) acts as a vital biological catalyst via anaerobic respiration, known as fermentation:

- **In Bread Production:** Yeast is mixed into dough, where it ferments available carbohydrates into ethanol and carbon dioxide gas (CO_2). The trapped carbon dioxide bubbles expand within the gluten matrix, causing the dough to rise. During baking, the gas pockets expand further to create a soft texture, while the residual alcohol cleanly evaporates.
- **In Ethanol Production:** Yeast is cultivated on a large scale with carbohydrate-rich agricultural crops like corn or sugarcane. The yeast metabolizes these sugars under oxygen-free conditions, converting them into bulk industrial ethanol. This ethanol is harvested, purified, and blended with petrol to make cleaner-burning biofuel.

4. Enlist the steps for transferring a human gene into a bacterial cell.

Answer: The standard molecular process involves several distinct steps:

1. **Isolation:** The desired human gene of interest (such as the insulin gene) is located and isolated from donor human cells, and plasmids are extracted from bacterial cells.
2. **Cutting (Cleavage):** Special molecular scissors, called restriction enzymes, are used to cut out the human gene and slice open the bacterial plasmid vector at precise nucleotide sequences.
3. **Ligation (Joining):** The isolated human gene is mixed with the opened plasmid. An enzyme called DNA ligase welds their ends together, forming a molecule known as recombinant DNA.
4. **Transformation (Insertion):** The recombinant DNA plasmid is re-inserted back into a host bacterial cell using physical or chemical treatments.

5. **Cloning and Expression:** The modified host bacterium is placed in a nutrient-rich fermenter, where it multiplies rapidly by binary fission. As it divides, it copies the recombinant plasmid and expresses the human gene to synthesize target therapeutic proteins.

5. Describe the advantages of gene editing.

Answer: Gene editing offers unprecedented precision, speed, and efficiency compared to traditional breeding and older transgenic techniques. It allows scientists to make highly specific modifications—such as adding, removing, or silencing nucleotide bases—at precise locations within an organism's native genome. In medicine, this enables doctors to directly correct faulty genes responsible for hereditary disorders like sickle cell anemia or cystic fibrosis. In agriculture, it allows for the rapid development of climate-resilient crops with enhanced drought tolerance, improved shelf life, and superior disease resistance without incorporating large pieces of foreign DNA from other species.

6. Discuss the potential risks of genetic modification.

Answer: Despite its profound benefits, genetic modification presents several potential risks and challenges:

- **Health Concerns:** Consuming genetically modified foods could potentially introduce unexpected allergens or trigger adverse long-term physiological reactions in humans.
- **Environmental Impact:** Genetically modified crops can cross-pollinate with nearby wild relative plants, unintentionally transferring modified traits into natural ecosystems.
- **Loss of Biodiversity:** Over-reliance on uniform GM crop varieties could lead farmers to abandon traditional, naturally diverse crop strains, increasing vulnerability to widespread agricultural blights.
- **Resistant Pests and Weeds:** Prolonged exposure to pest-resistant GM crops can cause target insects to evolve into "super-pests" that bypass built-in crop defenses.
- **Ethical Issues:** Many communities express serious ethical, moral, or religious concerns regarding the artificial manipulation of life's fundamental genetic blueprints.

D. Inquisitive Questions

1. How can inserting a gene into a plant make it pest-resistant?

Answer: Inserting a specific gene (such as a Bt gene from a soil bacterium) into a plant provides it with a new set of genetic blueprints to synthesize a specific, target-oriented defense protein inside its tissues. When a pest feeds on the modified plant, it ingests this protein, which binds to specific receptors in its digestive tract, disrupting its gut and neutralizing the pest. Since the plant produces its own defense, it stays protected without the need for external chemical sprays.

2. How can biotechnology help in developing vaccines quickly, like for COVID-19?

Answer: Traditional vaccine development requires cultivating huge quantities of live or weakened viruses, which takes months. Biotechnology bypasses this entirely by using genetic sequencing to isolate

only the gene responsible for a virus's outer surface protein (like the spike protein). Scientists insert this gene into plasmid vectors or mRNA templates, which can be synthesized chemically in factories within days. This allows for rapid mass production to respond quickly to global pandemics.

3. Why is it important to carefully study the effects of genetically modified foods on health?

Answer: It is important because genetic modification rearranges or introduces foreign nucleotide sequences, which can alter complex cellular pathways. Thorough, long-term testing is necessary to ensure these genetic changes do not produce unintended toxic compounds, create new allergens, or reduce the nutritional value of food, ensuring it remains safe for human consumption.

Visit Ahsa.Pk for more.
Join Al Huda Science Academy to
learn subjects easily.

Unit 9: Diseases and Immunity

A. Multiple Choice Questions

1. A doctor finds bacteria in a patient's blood sample. What type of disease is the patient suffering from?

- **(a) Infectious disease ✓**
- (b) Non-infectious disease
- (c) Genetic disorder
- (d) Nutritional deficiency

2. Which of the following is an example of an infectious disease?

- (a) Diabetes
- (b) Hypertension
- **(c) Influenza ✓**
- (d) Osteoporosis

3. A person develops rabies after being bitten by a dog. This is an example of:

- (a) Non-infectious disease
- (b) Food-borne illness
- **(c) Zoonotic disease ✓**
- (d) Genetic disorder

4. Which of the following is a vector-borne disease?

- (a) AIDS
- **(b) Malaria ✓**
- (c) Tuberculosis
- (d) Diabetes

5. A person develops dengue fever after a mosquito bite. In this case, the mosquito acts as:

- (a) Host
- (b) Pathogen
- **(c) Vector ✓**
- (d) Reservoir

6. Which of the following is the first line of defence against pathogens?

- (a) Antibodies
- **(b) Skin and mucous membranes ✓**
- (c) T cells
- (d) B cells

7. Skin is categorized as:

- **(a) Non-specific defence ✓**
- (b) Specific defence
- (c) Acquired immunity
- (d) Passive Immunity

8. What triggers an allergic reaction?

- (a) Pathogens
- **(b) Allergens ✓**
- (c) Antigens
- (d) Antibodies

B. Short Answer Questions

1. Define infectious diseases.

Answer: Infectious diseases are illnesses caused by pathogenic microorganisms—such as bacteria, viruses, fungi, or parasites—that can be transmitted or spread directly or indirectly from one infected individual, animal, or environmental reservoir to another healthy host.

2. Define zoonotic diseases. Also give examples.

Answer:

- **Definition:** Zoonotic diseases are infectious diseases caused by harmful pathogens that are naturally transmitted from vertebrate animals to humans.
- **Examples:** Rabies (transmitted via dog bites) and Brucellosis (transmitted via raw unpasteurized dairy).

3. Enlist allergies with some common types.

Answer: An allergy is an overreaction of the body's immune system to normally harmless environmental substances known as allergens. Common types include:

- **Respiratory Allergies:** Such as allergic rhinitis (hay fever) and asthma, triggered by pollen or dust mites.

- **Food Allergies:** Immune responses triggered by specific foods like peanuts, shellfish, or milk.
- **Skin Allergies:** Such as contact dermatitis or hives, triggered by insect stings, latex, or cosmetic chemicals.

4. Differentiate between innate and acquired immunity.

Answer:

- **Innate Immunity:** The non-specific, natural defense system that an individual is born with. It acts immediately against any foreign invader using physical barriers like skin, without requiring prior exposure to the pathogen.
- **Acquired Immunity:** The specific, adaptive defense system that develops throughout a person's life following exposure to a particular pathogen or vaccine. It features a memory component to combat future encounters using specialized lymphocytes and antibodies.

5. Describe the role of skin as a component of defence system.

Answer: The skin serves as a vital component of the primary, non-specific first line of defense:

- **Physical Barrier:** Its outer layer of dead, keratinized cells forms a continuous, tough structural shield that blocks the entry of microbes.
- **Chemical Shield:** Sebum and sweat secreted by skin glands contain lactic acid, fatty acids, and lysozyme enzymes that lower skin pH, creating a hostile environment that suppresses microbial growth.

6. State the role of mucous membranes in defence.

Answer: Mucous membranes line the internal passageways open to the exterior (respiratory, digestive, and urogenital tracts) to provide defense:

- **Trapping Mechanics:** They secrete a thick, sticky fluid called mucus that traps dust particles, bacteria, and viruses before they reach vulnerable tissues.
- **Ciliary Clearance:** In the respiratory tract, microscopic hair-like cilia sweep the trapped pathogens upward out of the airways to be swallowed or expelled.

C. Write Answers in Detail

1. Describe infectious and non-infectious diseases and their types with examples.

Answer:

Infectious Diseases: These are communicable health disorders caused by multiplying pathogens like bacteria, viruses, fungi, or parasites. They can spread across populations.

Types & Examples: Direct contact illnesses (e.g., Influenza, chickenpox), food/water-borne illnesses (e.g., Cholera, typhoid), and vector-borne conditions (e.g., Malaria, dengue).

Non-Infectious Diseases: These are non-communicable health disorders that cannot be transmitted from person to person. They are caused by factors other than pathogens.

Types & Examples: Metabolic or endocrine disorders (e.g., Diabetes mellitus), cardiovascular diseases (e.g., Hypertension, stroke), degenerative conditions (e.g., Osteoporosis), and genetic disorders (e.g., Down syndrome, hemophilia).

2. Describe vector-borne diseases with examples.

Answer: Vector-borne diseases are infectious illnesses transmitted to humans by intermediate organisms, known as vectors, which carry pathogens from an infected reservoir to a healthy host without catching the disease themselves. Most vectors are blood-feeding arthropods.

- **Malaria:** Caused by the single-celled Plasmodium parasite and transmitted to humans via the bite of an infected female Anopheles mosquito. It features cycles of severe shaking chills and high fevers.
- **Dengue Fever:** A painful viral infection transmitted by the bite of an infected Aedes aegypti mosquito. It causes high fevers, severe muscle and joint pain, and characteristic skin rashes.

3. Describe the roles of T-cells and B-cells in immunity.

Answer: T-cells and B-cells are the primary functional lymphocytes of the specific, acquired immune defense system:

- **Role of B-cells (Humoral Immunity):** B-cells recognize specific free-floating foreign antigens on pathogens. Upon activation, they differentiate into plasma cells that mass-produce specialized proteins called antibodies. These antibodies circulate in blood and lymph, binding to matching pathogens to neutralize them or mark them for destruction by phagocytes. B-cells also form memory cells for long-term immunity.
- **Role of T-cells (Cell-Mediated Immunity):** T-cells do not produce antibodies; instead, they target compromised host cells directly. Helper T-cells coordinate the immune response by releasing chemical signals that activate B-cells and other white blood cells. Cytotoxic (Killer) T-cells directly identify, bind to, and destroy virally infected host cells, foreign tissue grafts, and cancer cells by puncturing their cell membranes.

4. Write a note on blood clotting.

Answer: Blood clotting (coagulation) is a crucial physiological protective defense mechanism designed to prevent excessive blood loss from vascular injuries and block environmental pathogens from invading the body. The molecular cascade proceeds smoothly through coordinated phases:

1. **Vascular Spasm:** Immediately following tissue injury, the smooth muscles in the broken blood vessel wall contract heavily to restrict regional blood flow.
2. **Platelet Plug Formation:** Circulating blood platelets rapidly adhere to exposed collagen fibers at the damaged wound site. They release chemical signals that recruit more platelets, packing tightly together to form a temporary plug.

3. **Coagulation Cascade:** Injury triggers a chemical reaction that converts the inactive plasma protein prothrombin into the active enzyme thrombin. Thrombin then converts soluble fibrinogen proteins into long, insoluble strands of fibrin.
4. **Clot Retraction and Repair:** The sticky fibrin strands weave into a net that traps red blood cells and platelets, forming a solid clot that seals the wound. Platelets within this clot contract to reduce the wound size, while underlying tissues undergo mitotic repair. Once the vessel is fully repaired, a specific plasma protein breaks down and dissolves the fibrin clot to restore normal circulation.

D. Inquisitive Questions

1. Why do infectious diseases spread faster in crowded places?

Answer: Infectious diseases spread rapidly in dense, crowded conditions because the physical distance between individuals is reduced. This proximity significantly increases the statistical probability of breathing in airborne respiratory droplets expelled through coughing or sneezing, facilitates direct skin-to-skin contact, and accelerates exposure to contaminated shared surfaces.

2. How can genetics increase a person's risk of developing non-infectious diseases?

Answer: Genetics increases disease risk through inherited alterations or specific mutations within a person's DNA sequences. These variations can alter structural proteins, produce faulty metabolic enzymes, or cause structural weaknesses in organs. For instance, inheriting variations that alter cell surface receptors or metabolic pathways can cause a strong hereditary predisposition to chronic conditions like type 2 diabetes or cardiovascular diseases, even before environmental triggers occur.

3. Why do some people develop allergies while others do not?

Answer: The development of allergies depends on an individual's unique genetic profile and their history of environmental exposures. Certain individuals possess a genetic predisposition known as atopy, which causes their immune system to over-produce Immunoglobulin E (IgE) antibodies when exposed to harmless environmental proteins. In contrast, individuals without this genetic sensitivity maintain normal immune tolerance and do not experience allergic inflammation when exposed to the same substances.

Visit Ahsa.Pk for more.
Join Al Huda Science Academy to
learn subjects easily.

Unit 10: Evolution

A. Multiple Choice Questions

1. The survival and reproduction of individuals with advantageous traits is called:

- (a) Mutations
- (b) Gene flow
- **(c) Natural selection ✓**
- (d) Asexual reproduction

2. A population is split by a river. After many generations, both population evolve into different species. What type of speciation may occur?

- (a) Sympatric
- (b) Genetic drift
- (c) Mutation
- **(d) Allopatric ✓**

3. Which characteristics in whales supports that their ancestors lived on land?

- (a) Big body
- (b) Fins
- **(c) Pelvic bones ✓**
- (d) Stream-lined

4. Farmers choose best cows to breed. It is an example of:

- (a) Natural selection
- **(b) Selective breeding ✓**
- (c) Adaptation
- (d) Genetic mutation

5. Darwin's observation of finches proved that:

- (a) Climate was same on all islands
- (b) All finches were identical
- **(c) They adapted to different foods on different islands ✓**
- (d) Finches never migrated

6. A new variation appears suddenly and helps survival. What happens next?

- (a) It disappears
- **(b) It spreads through population ✓**
- (c) It causes disease
- (d) It's removed by natural selection

7. Which of these is a vestigial structure?

- **(a) Human ear muscles ✓**
- (b) Wings of Sparrow
- (c) Beak of duck
- (d) Tail of cat

8. Which pair are homologous structures?

- (a) Bird wings and butterfly wings
- (b) Dolphin fins and shark fins
- **(c) Human arms and dolphin fins ✓**
- (d) Bat wings and bird wings

9. Human appendix is a vestigial organ because it:

- (a) Has a major digestive function
- (b) Is part of the immune system
- **(c) Is no longer useful for digestion ✓**
- (d) Helps in absorbing nutrients

10. Artificial selection is similar to natural selection because:

- (a) Environmental conditions play role in both
- (b) Both occur over millions of years
- (c) Both are carried out by humans
- **(d) Both depend upon variations among individuals ✓**

B. Short Answer Questions

1. Write a short note on selective breeding.

Answer: Selective breeding, also called artificial selection, is an intentional process where humans choose plants or animals with specific, desirable phenotypic traits to mate and reproduce. Over generations, this domestic cultivation enhances targeted characteristics, providing visible evidence of how variations change under selective pressures.

2. What are the two types of speciation?

Answer:

- **Allopatric Speciation:** Occurs when a biological population becomes physically isolated by geographical barriers (like a river or mountain range) and evolves independently into a separate species.
- **Sympatric Speciation:** Occurs when a new species evolves from a single ancestral species while living within the exact same geographic region, without physical separation.

3. Provide examples of homologous structures.

Answer: Homologous structures are organs or skeletal elements across different species that share a similar structural blueprint and developmental origin, despite performing different functions. Examples include:

- The human arm (used for grasping) and a dolphin's flipper (used for swimming).
- The wing of a bat (used for flying) and the front leg of a cat (used for walking).

4. List the steps in the process of natural selection.

Answer:

1. **Variation:** Individuals within a population possess varied, heritable traits.
2. **Overproduction:** Organisms produce more offspring than their local environment can support, leading to competition.
3. **Survival of the Fittest:** Individuals with advantageous variations cope better and survive environmental pressures.
4. **Reproduction and Inheritance:** Surviving individuals reproduce, passing their beneficial alleles to the next generation, altering the population's genetic makeup over time.

C. Write Answers in Detail

1. Explain the theory of evolution by natural selection.

Answer: The theory of evolution by natural selection, proposed by Charles Darwin, states that organisms change over generations as environmental conditions screen heritable traits. Because resources are limited, a struggle for existence occurs. Individuals born with advantageous variations that suit their surroundings have higher survival and reproductive rates. They pass these beneficial genetic

traits to their offspring. Over long periods, these accumulated adaptations cause populations to diverge, giving rise to entirely new species that are finely tuned to their ecological niches.

2. Write a note on the observations Darwin made during his voyage.

Answer: During his global journey on the HMS Beagle, Charles Darwin made critical natural observations, notably on the Galapagos Islands. He noticed that while island species shared common structural bonds with mainland South American wildlife, they exhibited distinct regional differences. For instance, he documented a variety of finches distributed across different islands. Each island group possessed a uniquely shaped beak tailored precisely to harvest the dominant local food source—such as large, heavy beaks for crushing hard seeds or slim beaks for catching insects. These observations led him to conclude that species are not static, but adapt over time from a shared ancestor based on geographical constraints.

3. Describe the sources of variation.

Answer: Genetic variation provides the raw working material for evolutionary mechanisms, originating from three primary biological sources:

- **Genetic Mutations:** Spontaneous, permanent changes in DNA sequences that generate entirely new alleles and sudden traits within a gene pool.
- **Meiotic Recombination:** During meiosis, genetic material is reshuffled through crossing over and the independent assortment of homologous chromosomes, producing unique allele combinations.
- **Random Fertilization:** The unpredictable fusion of a unique sperm with a unique egg ensures that every resulting offspring features a completely distinct genetic profile.

4. Justify how fossil record provides an evidence of evolution.

Answer: The fossil record acts as a preserved historical archive of life embedded within chronological rock strata. It documents the existence of long-extinct organisms and showcases a clear structural transition from ancient, simple life-forms found in deep sedimentary layers to more complex organisms located in younger upper layers. Crucially, the fossil record yields transitional fossils that bridge structural gaps between major animal classes such as showing the gradual limb modifications of land mammals evolving into modern marine whales, as evidenced by remnant pelvic bones.

5. Write a note on homologous structures as an evidence of evolution.

Answer: Homologous structures provide compelling evidence for evolution by demonstrating anatomical divergence from a shared ancestral archetype. When different species possess structures that share identical bone arrangements, nerve pathways, and embryonic origins—such as a human arm, a bat's wing, and a dolphin's fin—it reveals that these diverse animals inherited the fundamental blueprint from a single common ancestor. Over evolutionary time, natural selection modified these basic limbs to perform distinct specialized tasks (grasping, flying, and swimming) via adaptive radiation.

6. What are vestigial structures? Explain how they provide evidence of evolution.

Answer: Vestigial structures are anatomical remnants or reduced organs within an organism that have lost all or most of their original physiological functions through generations of disuse. Examples include human ear muscles, the human appendix, and pelvic bones in whales. They serve as evidence of evolution because they represent inherited features that were fully developed, functional, and necessary in ancestral species. Their current reduced and non-functional state charts the historical trajectory of a species adaptation to new lifestyle habits or diets.

D. Inquisitive Questions

1. Why is variation among individuals important for evolution?

Answer: Variation is essential for evolution because it ensures a population maintains diverse traits to withstand sudden environmental shifts. If all individuals were genetically identical, a single severe disease outbreak or sudden climate shift could potentially wipe out an entire population. Genetic variations provide options for natural selection, allowing individuals with suitable traits to survive and continue the species.

2. How do fossils help scientists understand the history of life on Earth?

Answer: Fossils allow scientists to reconstruct past ecosystems, trace ancestral lineages, and determine when specific traits appeared. By analyzing the physical traits of fossils and calculating their age using rock layers, paleontologists can observe structural changes over time, map mass extinction events, and see how species adapted to prehistoric environments.

3. Why can isolation lead to the formation of new species?

Answer: Isolation splits a single parent population into separate groups, cutting off gene flow between them. When these groups face different environments, climates, and food sources, they experience different natural selection pressures. Over many generations, unique mutations accumulate in each group separately, leading to genetic differences. Eventually, these differences prevent them from interbreeding, resulting in distinct species.

Visit Ahsa.Pk for more.
Join Al Huda Science Academy to
learn subjects easily.