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Introduction

Overview

- Unicellular organisms perform all life functions within a single cell.
- Multicellular organisms have specialized groups of cells performing specific functions.
- A tissue is a group of similar cells with a common origin and function.

Memory Aids

- Tissue = Similar cells + common function.

Quick Checkpoints

- What defines a tissue?
- Difference between unicellular and multicellular functions?
-

Animal Tissues

Types and Origin

- Four basic tissues: Epithelial, Connective, Muscular, Neural.
- Epithelial: from ectoderm, endoderm, mesoderm; functions in protection, secretion, absorption, excretion, reproduction.
- Connective: from mesoderm; provides support, attachment, storage, protection, transport.
- Muscular: from mesoderm; responsible for movement and locomotion.
- Neural: from ectoderm; controls body via nerve impulses.

Memory Aids

- ECMN: Epithelial, Connective, Muscular, Neural.

Quick Checkpoints

- List the four animal tissues and their origins.
- Functions of connective tissue?
-

Epithelial Tissue

Structure and Types

- Also called epithelium; cells tightly packed with little matrix.
- Has a free surface facing body fluid or environment.
- Two main types: Simple (single layer) and Compound (multiple layers).
- Simple epithelium types: Squamous (flat), Cuboidal (cube-shaped), Columnar (tall).
- Functions: covering, lining, protection, secretion, absorption.
- Ciliated epithelium has cilia for moving substances.
- Compound epithelium protects against mechanical and chemical stress.
- Glandular epithelium specialized for secretion; unicellular (goblet cells) or multicellular (salivary glands).
- Glands classified as exocrine (ducts) or endocrine (ductless, secrete hormones).
- Heterocrine glands have both exocrine and endocrine parts (e.g., pancreas).
- Cell junctions: Tight (prevent leakage), Adhering (cement cells), Gap (allow communication).

Memory Aids

- Simple = Single layer; Compound = Multiple layers.
- Squamous = Flat; Cuboidal = Cube; Columnar = Tall.
- Ciliated epithelium moves substances.
- Exocrine glands use ducts; Endocrine glands are ductless.
- Cell junctions: Tight (seal), Adhering (stick), Gap (communicate).

Quick Checkpoints

- Types of simple epithelium and their functions?
- Difference between exocrine and endocrine glands?
- Functions of ciliated epithelium?
- Role of cell junctions in epithelium?
-

Connective Tissue

Overview and Types

- Most abundant tissue; links and supports other tissues.
- Cells secrete collagen or elastin fibers for strength and elasticity.
- Matrix contains modified polysaccharides.
- Types: Loose (areolar, adipose), Dense (regular, irregular), Specialized (cartilage, bone, blood).
- Loose connective tissue: cells and fibers loosely arranged in semi-fluid ground substance.
- Dense connective tissue: fibers and fibroblasts densely packed.
- White fibrous connective tissue: collagen bundles, strong but less flexible.
- Yellow elastic connective tissue: elastic fibers, flexible and strong; forms ligaments.

Specialized Connective Tissue

- Cartilage: soft skeletal tissue; chondrocytes in lacunae; solid, pliable matrix resists compression.
- Types of cartilage: Hyaline (most common), White fibrous (strongest), Yellow elastic fibrocartilage.
- Bone: osteocytes in lacunae; hard matrix with calcium salts and collagen; provides body frame and support.
- Haversian system (osteon): cylindrical unit of bone with lamellae and central canal; absent in spongy bone.
- Blood: fluid connective tissue; plasma, RBCs (oxygen transport), WBCs (immunity), platelets (clotting).

Memory Aids

- Loose = Loose fibers; Dense = Dense fibers.
- White fibrous = Collagen; Yellow elastic = Elastic fibers.
- Cartilage = Chondrocytes + flexible matrix.
- Bone = Osteocytes + hard matrix.
- Blood = Fluid connective tissue.

Quick Checkpoints

- Functions of connective tissue fibers?
- Differences between loose and dense connective tissue?
- Types and functions of cartilage?
- Structure of bone tissue?
- Components and functions of blood?
-

Muscular Tissue

Structure and Function

- Composed of long cylindrical fibers with myofibrils in sarcoplasm.
- Fibers contract and relax to produce movement or maintain posture.
- Three types: Skeletal (striated, voluntary), Smooth (non-striated, involuntary), Cardiac (striated, involuntary).
- Skeletal muscle: attached to bones, voluntary control, fatigues.
- Smooth muscle: in internal organs, involuntary, non-fatiguing.

- Cardiac muscle: in heart, involuntary, never fatigues, connected by intercalated discs.

Memory Aids

- Skeletal = Striated + voluntary.
- Smooth = Non-striated + involuntary.
- Cardiac = Striated + involuntary + intercalated discs.

Quick Checkpoints

- Differences among skeletal, smooth, and cardiac muscles?
- Functions of muscle tissue?
-

Neural Tissue

Structure and Function

- Controls body's response to stimuli.
- Neurons are structural and functional units.
- Neuron parts: cell body (cyton/soma), dendrites (input), axon (output), terminal arborisations.
- Nerve fibers = axon or dendrite with sheath.

- Neuroglial cells support and protect neurons; >50% of neural tissue volume.
- Two types of nerve fibers: Medullated (with myelin sheath, nodes of Ranvier), Non-medullated (without sheath).
- Electrical impulses travel along neuron membrane when stimulated.

Memory Aids

- Neuron = Cyton + dendrites + axon.
- Myelin sheath speeds impulse; nodes of Ranvier interrupt sheath.
- Neuroglia = Support cells.

Quick Checkpoints

- Parts of a neuron and their functions?
- Difference between medullated and non-medullated fibers?
- Role of neuroglial cells?
-

Organ and Organ System

Overview

- Basic tissues form organs (e.g., heart has epithelial, connective, muscular, neural tissues).
- Organs combine to form organ systems; organ systems form an organism.

- Organisation ensures efficient, coordinated cellular activities.
- **Morphology**: Study of external features of animals.
- **Anatomy**: Study of internal organ morphology.

Memory Aids

- Organ = Tissues combined; Organ system = Organs combined.
- Morphology = External; Anatomy = Internal.

Quick Checkpoints

- What tissues form an organ?
- Difference between morphology and anatomy?
- Why is organ organisation important?
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Cockroach

General Features

- Scientific name: *Periplaneta americana*.
- Class: Insecta; Phylum: Arthropoda.
- Brown/black, nocturnal, omnivorous.
- Body divided into head, thorax, abdomen; covered by chitinous exoskeleton.

- Exoskeleton plates called sclerites (tergites dorsal, sternites ventral) joined by flexible membranes.
- Head triangular, fused 6 segments, flexible neck, bears compound eyes and antennae.
- Mouthparts chewing type: labrum (upper lip), labium (lower lip), paired maxillae, mandibles, hypopharynx (tongue-like).
- Thorax: prothorax, mesothorax, metathorax; each with a pair of legs.
- Two pairs of wings: forewings (opaque, leathery), hindwings (transparent, membranous for flight).

Memory Aids

- Head = 6 fused segments; Thorax = 3 segments with legs and wings.
- Forewings protect hindwings.
- Mouthparts: \\\\\\\\\\\\\\\"LMLMH\\\\\\\\\\\\\\\" - Labrum, Mandibles, Labium, Maxillae, Hypopharynx.

Quick Checkpoints

- What are the main body divisions of cockroach?
- Functions of forewings and hindwings?
- Components of cockroach mouthparts?
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Morphology

Body Structure

- Segmented body: head, thorax, abdomen.
- Exoskeleton made of chitin; sclerites joined by arthrodial membrane.
- Head: triangular, flexible neck, compound eyes, antennae with sensory receptors.
- Mouthparts: labrum (upper lip), labium (lower lip), paired maxillae and mandibles, hypopharynx (tongue-like).
- Thorax: prothorax, mesothorax, metathorax; each with a pair of walking legs.
- Wings: forewings (leathery, cover hindwings), hindwings (membranous, for flight).

Memory Aids

- Head = sensory + mouthparts; Thorax = locomotion (legs + wings).
- Sclerites = hard plates; Arthrodial membrane = flexible joints.

Quick Checkpoints

- What covers the cockroach body?
- How many segments form the thorax?
- Describe the wings of cockroach.
-

Anatomy

Body Segments and Genitalia

- Abdomen: 10 segments in both sexes.
- Female: 7th sternum boat-shaped; 7th-9th sterna form genital pouch with female gonopore, spermathecal pores, collaterial glands.
- Male: genital pouch at hind abdomen bounded by 9th-10th terga and 9th sternum; contains anus, male genital pore, gonapophysis.
- Males have short anal styles; both sexes have anal cerci on 10th segment.
-

Digestive System

- Alimentary canal: foregut, midgut, hindgut.
- Foregut: mouth → pharynx → oesophagus → crop (food storage) → gizzard (proventriculus) with 6 chitinous teeth for grinding.
- Midgut: short, coiled; hepatic caecae (6-8 blind tubules) secrete digestive juice; Malpighian tubules (100-150) remove excretory products.
- Hindgut: ileum, colon, rectum with 6 rectal glands; opens via anus; more permeable to water.
- Foregut and hindgut lined by cuticle (ectodermal); midgut lacks cuticle (endodermal).
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Blood Vascular System

- Open type; vessels open into haemocoel.
- Haemolymph bathes organs; consists of colourless plasma and haemocytes.
- No respiratory pigment; transports food and wastes.

- Heart: muscular tube with funnel-shaped chambers and ostia; pumps blood anteriorly.
- Heart is neurogenic.
-

Respiratory System

- Network of tracheae opening through 10 pairs of spiracles on body sides.
- Spiracles guarded by bristles to prevent dirt entry.
- Tracheae subdivide into tracheoles for gas exchange by diffusion.
- Most CO_2 exits through body surface, not spiracles.

Excretory System

- Malpighian tubules absorb nitrogenous wastes, convert to uric acid (uricotelic).
- Also reabsorb salts and water.
- Fat body, nephrocytes, uricose glands assist excretion.
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Nervous System

- Comprises central, peripheral, sympathetic systems.
- Fused segmental ganglia (9 total): 3 thoracic, 6 abdominal.
- Brain = bilobed supra-oesophageal ganglion; supplies antennae and eyes.

- Compound eyes have ~2000 ommatidia; provide mosaic, nocturnal vision (high sensitivity, low resolution).
- Other sense organs: antennae, maxillary palps, labial palps, anal cerci.
-

Reproductive System

- Dioecious: sexes separate.
- Male: testes in 4th-6th abdominal segments; 3-lobed with follicles.
- Vas deferens opens into ejaculatory duct via seminal vesicles; stores sperms as spermatophores.
- Accessory mushroom-shaped gland in 6th-7th segments.
- External genitalia: male gonapophyses (phallomeres).
- Female: ovaries in 2nd-6th segments; ovarioles contain developing ova.
- Oviducts unite into median oviduct opening into genital chamber.
- Spermathecae (paired) open into genital chamber.
- Collaterial glands secrete ootheca (egg-case).
- Sperms transferred as spermatophores; females produce 9-10 oothecae with 14-16 eggs each.
- Development paurometabolous: nymphal stage with ~13 moults to adult.
- Some species are pests; contaminate food and spread bacterial diseases.

Memory Aids

- Abdomen = 10 segments; Female pouch = 7th-9th sterna.

- Foregut = storage + grinding; Midgut = digestion; Hindgut = absorption + excretion.
- Open circulatory system; neurogenic heart.
- Tracheal system with spiracles for respiration.
- Malpighian tubules = excretion; uricotelic nature.
- 9 ganglia; brain = supra-oesophageal ganglion.
- Male = testes + phallomeres; Female = ovaries + ootheca.
- Paurometabolous development = nymph moulting.
-

Quick Checkpoints

- How is cockroach body segmented?
- Describe the alimentary canal regions and functions.
- What type of circulatory system does cockroach have?
- How does respiration occur in cockroach?
- What structures perform excretion?
- Outline the nervous system components.
- Describe male and female reproductive organs.
- What is paurometabolous development?

Frog

Characteristics

- Class Amphibia, Phylum Chordata; live in water and on land (amphibians).
- Common Indian frog: *Rana tigrina*.
- Cold-blooded (poikilotherms): body temperature varies with environment.
- Can change body colour for camouflage; protective coloration called mimicry.
- Undergo aestivation (summer sleep) and hibernation (winter sleep) in burrows.

Memory Aids

- Amphibians = live both in water and land.
- Poikilotherms = body temperature varies.
- Mimicry = protective colour change.
- Aestivation = summer sleep; hibernation = winter sleep.

Quick Checkpoints

- What class and phylum does frog belong to?
- Define poikilotherms.
- What is mimicry in frogs?
- Difference between aestivation and hibernation?
-

Morphology

External Features

- Dorsal side olive green with dark spots; ventral side pale yellow.
- Skin moist, smooth, slippery; absorbs water, does not drink.
- Body divided into head and trunk; no neck or tail.
- Nostrils above mouth; bulged eyes with nictitating membrane.
- Tympanum (ear) on sides of eyes for sound reception.
- Forelimbs: 4 digits; hindlimbs: 5 digits, webbed for swimming.
- Sexual dimorphism: males have vocal sacs and copulatory pads; males darker and slender.

Memory Aids

- Webbed hindlimbs aid swimming.
- Nictitating membrane protects eyes underwater.
- Copulatory pad present only in males.

Quick Checkpoints

- How does frog skin aid survival?
- What is the function of nictitating membrane?
- Identify sexual dimorphism in frogs.
- Number of digits on forelimbs and hindlimbs?
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The image shows a labeled diagram of a frog, highlighting its main external body parts: Head, Eye, Trunk, Forelimb, and Hindlimb.\\\\\\\\n\\\\\\\\nStep-by-step explanation:\\\\\\\\n1. The Head is the front part of the frog where the brain is located.\\\\\\\\n2. The Eye is on the head and helps the frog see.\\\\\\\\n3. The Trunk is the main body part of the frog.\\\\\\\\n4. The Forelimbs are the front legs used for movement and support.\\\\\\\\n5. The Hindlimbs are the back legs, usually stronger, used for jumping and swimming.\\\\\\\\n\\\\\\\\nThese are the key external features you can see from the outside of a frog.

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Anatomy

Digestive System

- Consists of alimentary canal and digestive glands.
- Short alimentary canal; intestine length reduced (carnivorous diet).
- Mouth → buccal cavity → pharynx → oesophagus → stomach.
- Stomach divided into cardiac and pyloric parts.
- Small intestine: duodenum (receives bile and pancreatic juice) and ileum.
- Digestion aided by HCl, gastric juices, bile (emulsifies fat), pancreatic enzymes.
- Absorption via villi and microvilli in intestine.
- Undigested waste passes to rectum and exits via cloaca.
- Digestive glands: liver (bile), pancreas (pancreatic juice), gastric and intestinal glands.
- Food captured by bilobed tongue; partially digested food called chyme.
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  This image shows a labeled diagram of a frog’s internal organs, focusing on its digestive system.\\\\\\\\n\\\\\\\\nStep-by-step explanation for high school students:\\\\\\\\n1. The frog eats food that passes down the oesophagus to the stomach.\\\\\\\\n2. The stomach breaks down the food.\\\\\\\\n3. Nutrients move to

the intestine where digestion and absorption continue.\\\\\\\\n4. Waste moves through the rectum to be expelled.\\\\\\\\n5. The liver produces bile stored in the gall bladder to help digest fats.\\\\\\\\n6. The heart pumps blood to deliver nutrients and oxygen.\\\\\\\\n7. The kidneys filter blood and produce urine.\\\\\\\\n8. Urine travels through the ureter to the urinary bladder.\\\\\\\\n9. Waste and urine exit the body through the cloaca and cloacal aperture.\\\\\\\\nThis shows how the frog’s organs work together to digest food and remove waste.

Respiratory System

- Three types of respiration: cutaneous, buccopharyngeal, pulmonary.
- Cutaneous: through moist skin, especially in water.
- Buccopharyngeal: through mouth and throat lining on land or partly in water.
- Pulmonary: using lungs; air enters via nostrils.

Circulatory System

- Closed circulatory system with heart, blood vessels, blood, lymphatic system.
- Heart: 3 chambers (2 atria, 1 ventricle), covered by pericardium.
- Sinus venosus joins right atrium; ventricle opens into conus arteriosus.
- Arteries carry blood from heart; veins return blood to heart.
- Hepatic portal system connects liver and intestine; renal portal system connects kidney and lower body.
- Blood composed of plasma and cells (nucleated RBCs, WBCs, platelets).
- Lymph lacks RBCs and some proteins.
- Heart is myogenic; pumps blood to transport nutrients, gases, water.

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  This image shows the dorsal (top) view of a frog's heart, labeled with its main parts, including different arches, veins, auricles, ventricles, and arteries.\\\\\\\\n\\\\\\\\nStep-by-step explanation for high school students:\\\\\\\\n\\\\\\\\n1. The frog's heart has openings called auricles (right and left) that receive blood from the body.\\\\\\\\n2. Blood enters the heart through veins like the anterior vena cava and pulmonary veins.\\\\\\\\n3. The heart has a ventricle, the main pumping chamber, which pushes blood out.\\\\\\\\n4. Blood is pumped into arches (carotid, systemic, pulmocutaneous) that carry it to different parts of the body and lungs.\\\\\\\\n5. The sinus venosus collects blood and sends it to the auricles.\\\\\\\\n6. The truncus arteriosus is a large artery where blood exits the heart to reach the body.\\\\\\\\n7. This structure helps separate oxygen-rich and oxygen-poor blood, vital for the frog's circulation.

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Excretory System

- Includes paired kidneys, ureters, cloaca, urinary bladder.
- Kidneys: dark red, bean-shaped, located on either side of vertebral column.
- Functional units: uriniferous tubules (nephrons).
- Ureters: in males act as urinogenital ducts opening into cloaca; in females, ureters and oviduct open separately into cloaca.
- Urinary bladder thin-walled, ventral to rectum, opens into cloaca.
- Frog is ureotelic; excretes urea.
- Excretory wastes filtered from blood by kidneys.

Memory Aids

- Chyme = partially digested food.
- Villi and microvilli increase absorption surface.

- Three respiration types: skin, mouth/throat, lungs.
- Heart chambers: 2 atria + 1 ventricle.
- Ureotelic = excretes urea.
-

Quick Checkpoints

- What are the parts of frog's digestive system?
- Explain the three types of respiration in frogs.
- Describe the structure of frog's heart.
- What is the function of hepatic and renal portal systems?
- How does frog excrete nitrogenous waste?
-

Control and Co-ordination

Endocrine System

- Hormones secreted by endocrine glands regulate body functions.
- Glands: pituitary, thyroid, parathyroid, thymus, pineal body, pancreatic islets, adrenals, gonads.

Nervous System

- Comprises central (brain, spinal cord), peripheral (cranial, spinal nerves), and autonomic (sympathetic, parasympathetic) systems.
- Brain enclosed in cranium; has forebrain, midbrain, hindbrain.
- Forebrain: olfactory lobes, cerebral hemispheres, diencephalon.
- Midbrain: optic lobes.
- Hindbrain: cerebellum, medulla oblongata.
- Spinal cord in vertebral canal, connects to medulla oblongata.
- Sense organs: touch (sensory papillae), taste (taste buds), smell (nasal epithelium), vision (eyes), hearing (tympanum, internal ears).
- Eyes and ears are well-organised; others are nerve endings.

Memory Aids

- Brain parts: forebrain (smell, thinking), midbrain (vision), hindbrain (balance, reflex).
- 10 pairs of cranial nerves arise from brain.
- Autonomic system controls involuntary actions.

Quick Checkpoints

- List the endocrine glands in frog.
- What are the divisions of frog's brain?
- Functions of forebrain, midbrain, hindbrain?
- Identify the components of nervous system.
- Which sense organs are well-developed in frogs?
-

Reproductive System

Male Reproductive System

- Pair of yellowish ovoid testes attached to kidneys by mesorchium.
- 10-12 vasa efferentia arise from testes, enter kidneys, open into Bidder's canal.
- Bidder's canal connects to urinogenital duct, opens into cloaca.
- Cloaca passes faeces, urine, and sperms to exterior.

Female Reproductive System

- Pair of ovaries, oviducts, and cloaca.
- Mature female lays 2500-3000 ova at a time.
- Oviducts open separately into cloaca.
- Fertilisation is external, occurs in water.
- Development includes larval tadpole stage undergoing metamorphosis to adult.

Memory Aids

- Mesorchium connects testes to kidneys.
- Bidder's canal links testes to urinogenital duct.
- External fertilisation in water.
- Tadpole = larval stage; metamorphosis = transformation to adult.

Quick Checkpoints

- Describe male reproductive organs in frog.
- How many ova does a female frog lay?
- Where does fertilisation occur?
- What is metamorphosis?

Male Reproductive System

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  This image shows the male reproductive system of a certain frog, highlighting organs like the testis, kidney, urinary bladder, and cloaca.
- Step-by-step explanation:
- 1. The testis produces sperm and is connected to the vasa efferentia.
- 2. The vasa efferentia transport sperm to the urino-genital duct.
- 3. The urino-genital duct carries sperm and urine.
- 4. The kidney filters waste from the blood and is located near the urino-genital duct.
- 5. Fat bodies store energy for reproduction.
- 6. The urinary bladder stores urine before it exits the body.
- 7. The rectum is part of the digestive system.
- 8. All waste and reproductive fluids exit through the cloaca and cloacal aperture.
- This system shows how the body produces, stores, and releases sperm and urine.

Female Reproductive System

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This image shows the female reproductive system of a frog.

It highlights key parts like the ovary, oviduct, ureter, cloaca, cloacal aperture, and urinary bladder.

Step-by-step explanation:

1. The ovary produces ova (eggs).

2. The ova move into the oviduct after release from the ovary.

3. Fertilization can occur in the oviduct.

4. The ureter carries urine from the kidneys.

5. Both reproductive and excretory products pass into the cloaca.

6. The egg and waste exit the body through the cloacal aperture.

This system supports egg formation, fertilization, and laying in frog.

Economic Importance

Benefits

- Frogs eat insects, protecting crops.
- Maintain ecological balance as part of food chain and web.
- In some countries, frog legs are consumed as food.

Memory Aids

- Frogs = natural pest control.
- Important link in ecosystem food chains.
- Frog legs = edible delicacy.

Quick Checkpoints

- How do frogs benefit agriculture?
- Role of frogs in ecosystem?
- Which part of frog is used as food?

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