

NCERT Exemplar Solutions of Class 11 Biology – Chapter 7: Structural Organisation in Animals

LONG ANSWER TYPE QUESTIONS

1. Classify and describe epithelial tissue based on structural modifications of cells.

Solution: Epithelial cells are divided into two broad categories based on structural modification of the cells:

(A) Simple Epithelium and (B) Compound (Stratified) Epithelium

Simple Epithelium: It is the epithelium tissue which has a single layer of cells. It is further divided into three: Squamous cells, cuboidal cells and columnar epithelium.

Compound (stratified) Epithelium: It is the epithelium tissue which has two or more layers of cells lined together.

Enhanced Explanation:

Classification of Epithelial Tissues

A. SIMPLE EPITHELIUM (Single Layer)

1. Simple Squamous Epithelium

- **Structure:** Flat, thin cells like floor tiles
- **Nucleus:** Centrally located, appears as a bulge

• **Locations:** Endothelium (blood vessels), mesothelium (serous fluid), pneumocytes (lungs)

• **Functions:** (endothelium) (mesothelium)

• **Locations:** (lungs)

• **Locations:** (kidneys)

• **Locations:** of serous fluid

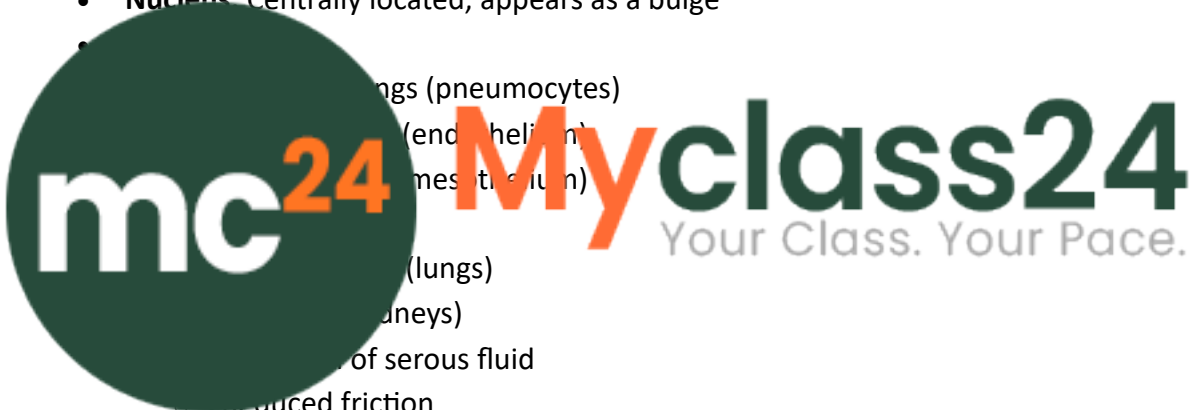
• **Locations:** reduced friction

2. Simple Cuboidal Epithelium

- **Structure:** Cube-shaped cells, height = width
- **Nucleus:** Central, round
- **Locations:**
 - Kidney tubules
 - Thyroid follicles
 - Small glands and ducts
- **Functions:**
 - Secretion (hormones, enzymes)
 - Absorption (kidney filtration)
 - Limited protection

3. Simple Columnar Epithelium

- **Structure:** Tall, rectangular cells
- **Nucleus:** Oval, near base



- **Modifications:**
 - **Ciliated:** With cilia for movement
 - **Non-ciliated:** With microvilli for absorption
- **Locations:**
 - Digestive tract lining
 - Respiratory passages (ciliated)
 - Uterine tubes (ciliated)
- **Functions:**
 - Absorption and secretion
 - Mucus production
 - Protection
 - Transport (ciliated)

4. Pseudostratified Columnar Epithelium

- **Structure:** Appears multilayered but all cells touch basement membrane
- **Nucleus:** At different levels
- **Usually ciliated**
- **Locations:**



ry tract
 ductive ducts
 on
 al (cilia)
 Multiple Layers)
 Epithelium

Non-

- **Locations:** Mouth, esophagus, vagina
- **Function:** Protection from abrasion

Keratinized:

- **Locations:** Skin surface (epidermis)
- **Function:** Waterproofing, protection

2. Stratified Cuboidal Epithelium

- **Rare type**
- **Locations:** Large ducts of sweat glands
- **Function:** Protection, limited secretion

3. Stratified Columnar Epithelium

- **Rare type**
- **Locations:** Large ducts, male urethra
- **Function:** Protection, secretion

4. Transitional Epithelium (Urothelium)

- **Structure:** Changes shape with organ distension

- **Locations:** Urinary bladder, ureters
- **Function:** Allows stretching, prevents urine leakage

C. GLANDULAR EPITHELIUM

Exocrine Glands

- **Structure:** Connected to surface by ducts
- **Types:**
 - **Simple:** Unbranched duct
 - **Compound:** Branched duct
- **Examples:** Sweat glands, salivary glands

Endocrine Glands

- **Structure:** Ductless, secrete into bloodstream
- **Examples:** Thyroid, adrenal glands, pituitary

Functional Significance

- **Protection:** Barrier against environment
- **Absorption:** Nutrient uptake
- **Secretion:** Hormone and enzyme production
- **Sensation:** Modified for sensory reception
- **Excretion:** Waste removal

2. **Write down two main features of connective tissue. Based on structure and function, name any two types of connective tissue, such as cartilage.**

Answer: Connective Tissue: Connective tissues have an important role in the body. They connect different tissues and organs.

They provide structural rigidity, support and protection of the body. They also help in the transport of materials.

- Fibres, cells and matrix are present in connective tissues

Comparison:

Bones

They are firm and brittle

Ossein is present in its matrix as protein

Bidirectional growth

Own blood supply

Cartilage

They are soft and elastic

Aggregate is present in the matrix as protein

Unidirectional growth

Lacks blood supply

Enhanced Explanation:

Common Features of Connective Tissues

1. Structural Components

- **Cells:** Embedded in extracellular matrix
- **Matrix:** Non-living material between cells
- **Fibers:** Collagen, elastic, reticular fibers

2. Origin and Development

- **Embryonic Origin:** Mesoderm (mesenchyme)
- **Regenerative Capacity:** Can repair and replace
- **Cellular Migration:** Cells can move through matrix

3. Functions

- **Structural Support:** Framework for organs
- **Protection:** Shield vital organs
- **Transport:** Blood circulation
- **Storage:** Fat, minerals
- **Immune Defense:** WBCs in loose connective tissue

4. Distribution

- **Widespread:** Found throughout body
- **Connecting:** Links different tissues
- **Filling:** Occupies spaces between organs

Detailed Comparison: Bone vs Cartilage

STRUCTURE

Component	Bone	Cartilage
Matrix	Ossein (collagen + calcium phosphate)	Chondrin (collagen + chondroitin sulfate)
Composition	~5% inorganic salts (calcium phosphate, calcium carbonate)	Low (minimal mineral salts)
Cells	Osteocytes	Chondrocytes
Location	Scattered within matrix	In lacunae within matrix
Organization	Highly organized	Scattered in matrix

PHYSICAL

Property	Bone	Cartilage
Hardness	Very hard, brittle	Soft, flexible
Elasticity	Rigid, minimal bend	Highly elastic
Strength	High compressive strength	Moderate strength
Flexibility	Limited	High

VASCULARITY & NUTRITION

Aspect	Bone	Cartilage
Blood Supply	Rich vascular network	Avascular
Nutrition	Direct from blood vessels	Diffusion from surrounding tissue
Nerve Supply	Innervated	No nerve supply
Lymphatic Supply	Present	Absent

GROWTH PATTERNS

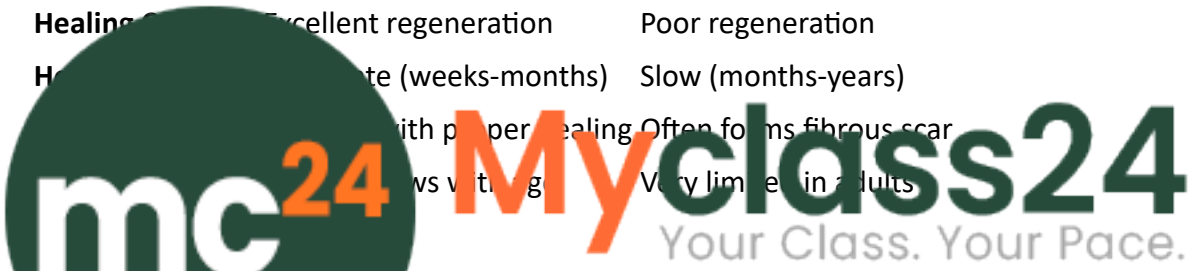
Growth Type	Bone	Cartilage
Appositional	Yes (surface growth)	Yes (surface growth)
Interstitial	Limited	Yes (internal growth)
Direction	Bidirectional	Primarily unidirectional
Growth Factors	Growth hormone, calcitonin	Growth hormone, insulin-like factors

FUNCTIONS

Function	Bone	Cartilage
Support	Major skeletal support	Flexible support
Protection	Protects vital organs	Cushions joints
Movement	Lever for muscle action	Reduces friction
Storage	Calcium, phosphate storage	No storage function
Hematopoiesis	Blood cell formation	None

REPAIR & REGENERATION

Aspect	Bone	Cartilage
Healing	Excellent regeneration	Poor regeneration
Healing time	Fast (weeks-months)	Slow (months-years)
Healing quality	Heals with proper healing	Often forms fibrous scar tissue
Healing in adults	Very little	Very limited in adults



...ise, strong outer layer
 ...fibrous, inner trabecular bone

Cartilage types:

- **Hyaline:** Most common, found in joints
- **Elastic:** Flexible, in ear and epiglottis
- **Fibrocartilage:** Strong, in vertebral discs

CLINICAL SIGNIFICANCE

Bone Disorders:

- Fractures heal well due to good blood supply
- Osteoporosis affects mineral density
- Rickets affects mineralization

Cartilage Disorders:

- Arthritis involves cartilage degeneration
- Poor healing leads to chronic joint problems
- Requires surgical intervention for major damage

3. Comment upon the gametic exchange in earthworm during mating.

Solution: Gamete exchange of earthworms occurs through cross-fertilization and external fertilization.

Process:

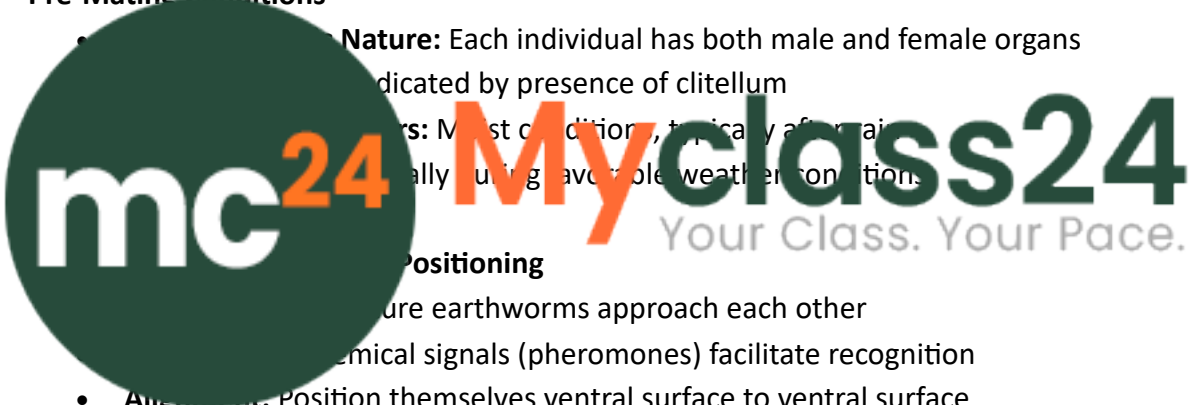
1. Two earthworms come closer to each other and they get ventrally attached in the opposite direction
2. The copulation process begins and the male genital pore (i.e., papilla) of one earthworm is inserted into the spermathecal pore of the other earthworm
3. The earthworm remains mutually close together by the penetration of setae in their bodies
4. Sperm and prostatic fluid of the earthworm are exchanged and the spermathecal pore stores the spermathecae
5. The remains like than for an hour and the sperm and egg passed into cocoon which gets secreted by the clitellar gland present in the 14th to the 16th segment of the earthworm

Enhanced Explanation:

Reproductive Biology of Earthworms

Pre-Mating Conditions

- **Nature:** Each individual has both male and female organs indicated by presence of clitellum
- **Seasons:** Most copulation, typically after rainfall, usually during favorable weather conditions



- **Positioning**
 - **Approach:** Pure earthworms approach each other
 - **Chemical signals (pheromones)** facilitate recognition
 - **Alignment:** Position themselves ventral surface to ventral surface
 - **Orientation:** Head-to-tail positioning (opposite directions)
 - **Segments Involved:** 9th to 11th segments overlap with partner's clitellum

Phase 2: Physical Attachment

- **Mucus Secretion:** Both worms secrete mucus to form temporary tube
- **Setae Grip:** Lateral setae penetrate partner's body wall for firm grip
- **Clitellar Bands:** Clitellum of each worm forms adhesive bands
- **Duration:** Attachment phase lasts 2-3 hours

Phase 3: Sperm Exchange (Cross-Fertilization)

- **Male Pore Location:** 18th segment of each worm
- **Spermathecal Pores:** Located on 6th, 7th, 8th, 9th segments
- **Sperm Transfer:**
 - Male pore of worm A → Spermathecal pores of worm B
 - Male pore of worm B → Spermathecal pores of worm A
- **Prostatic Fluid:** Accompanies sperm, provides nutrition and motility

- **Storage:** Spermatozoa stored in spermathecae for later use

Phase 4: Separation and Cocoon Formation

- **Detachment:** Worms separate after sperm exchange
- **Timing:** Each worm independently forms cocoons
- **Clitellar Secretion:** Clitellum secretes cocoon material
- **Movement:** Worm moves backward, cocoon slides forward
- **Fertilization:** As cocoon passes over:
 - Female pores (14th segment): Eggs added
 - Spermathecal pores: Stored sperm added
 - **Internal Fertilization:** Occurs within cocoon

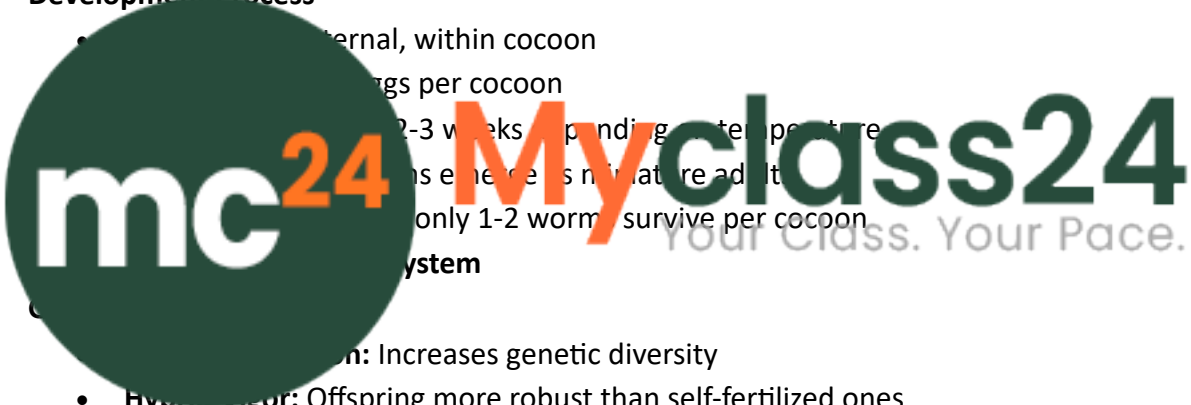
Cocoon Development and Hatching

Cocoon Characteristics

- **Shape:** Lemon-shaped, yellowish structure
- **Size:** About 3-4 mm in length
- **Protection:** Waterproof covering
- **Location:** Deposited in moist soil

Development Process

- **Fertilization:** Internal, within cocoon
- **Eggs:** 1-2 eggs per cocoon
- **Development:** 2-3 weeks depending on temperature
- **Emergence:** Emerges as mature adult
- **Survival:** Only 1-2 worms survive per cocoon
- **System:** System



- **Genetic Diversity:** Increases genetic diversity
- **Hybrid Vigor:** Offspring more robust than self-fertilized ones
- **Population Genetics:** Maintains genetic variability

Reproductive Efficiency

- **Mutual Benefit:** Both partners receive and donate gametes
- **Sperm Storage:** Spermathecae allow delayed fertilization
- **Multiple Cocoons:** Single mating can result in several cocoons
- **Seasonal Advantage:** Can mate when conditions are optimal

Survival Adaptations

- **Protective Cocoon:** Shields developing embryos
- **Environmental Resistance:** Cocoons survive harsh conditions
- **Direct Development:** No larval stage reduces mortality

Reproductive Anatomy Review

Male Reproductive System

- **Testes:** 2 pairs in 10th and 11th segments
- **Seminal Vesicles:** Store and mature sperm

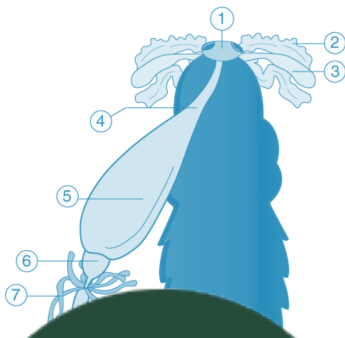
- **Male Pores:** 18th segment, for sperm release
- **Prostatic Glands:** Secrete prostatic fluid

Female Reproductive System

- **Ovaries:** 1 pair in 13th segment
- **Oviduct:** Transport eggs to female pores
- **Female Pores:** 14th segment, for egg release
- **Spermathecae:** 4 pairs, store received sperm

This complex mating system ensures successful reproduction while maximizing genetic diversity and offspring survival in earthworms.

4. Explain the digestive system of Cockroach with the help of a labelled sketch.



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Final consists of three parts: (A) Foregut. Your Class. Your Pace.

(A) **Foregut:** It consists of the mouth in cockroaches. The oesophagus is a narrow tube-like structure which leads to an organ known as a crop. The crop is used to store food materials. It consists of the tongue and hypopharynx.

(B) **Midgut:** Midgut is a narrow and short tube-like structure. It has an organ known as gizzard which grinds the food into simpler components.

(C) **Hindgut:** The hindgut is further divided into three major parts: Ileum, Colon, and Rectum.

Malpighian tubules help in the elimination of the nitrogenous wastes and convert them to uric acid.

The anus is the last part of the digestive system of the cockroach.

Enhanced Explanation:

Complete Digestive System of Cockroach

MOUTHPARTS (External Structures)

Components:

1. **Labrum:** Upper lip, covers mandibles
2. **Mandibles:** Strong, toothed jaws for cutting and crushing

3. **Maxillae:** Secondary jaws with palps for manipulation
4. **Labium:** Lower lip with palps, forms floor of mouth
5. **Hypopharynx:** Tongue-like structure with salivary duct opening

Functions:

- **Mechanical Processing:** Cut, crush, and manipulate food
- **Chemical Processing:** Salivary enzymes begin digestion
- **Food Selection:** Taste and texture recognition

ALIMENTARY CANAL

A. FOREGUT (Stomodeum)

1. Mouth and Buccal Cavity

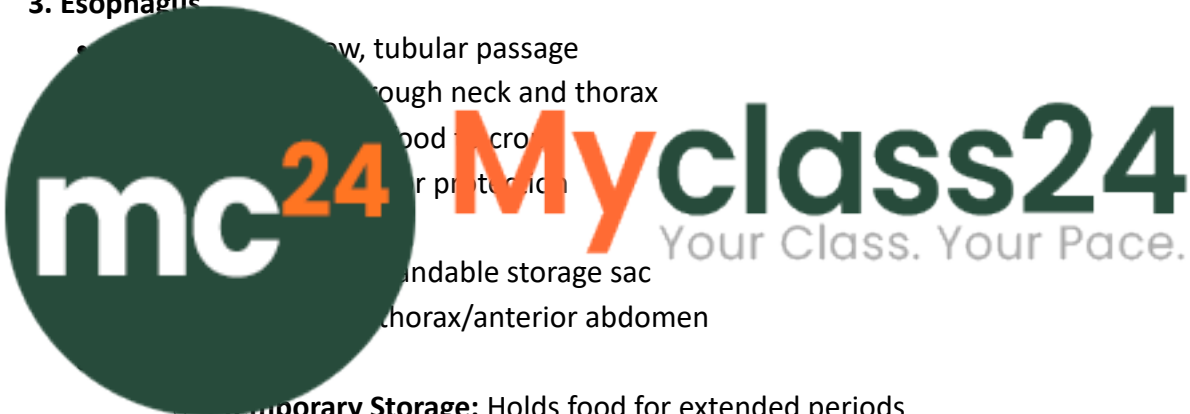
- **Structure:** Cavity behind mouthparts
- **Function:** Initial food processing and mixing with saliva

2. Pharynx

- **Structure:** Muscular chamber
- **Function:** Pumps food into esophagus
- **Control:** Coordinated swallowing reflex

3. Esophagus

- **Structure:** Long, tubular passage through neck and thorax
- **Function:** Transports food through peristalsis
- **Control:** Coordinated by peristaltic reflex
- **Storage:** Limited storage capacity
- **Location:** Thorax/anterior abdomen



- **Temporary Storage:** Holds food for extended periods
 - **Moisture Addition:** Absorbs water
 - **Initial Digestion:** Some enzymatic activity
- **Capacity:** Can expand significantly based on food availability

5. Gizzard (Proventriculus)

- **Structure:** Muscular, heavily sclerotized chamber
- **Internal Features:**
 - Chitinous teeth and ridges
 - Strong circular muscles
 - Grinding surfaces
- **Function:**
 - **Mechanical Breakdown:** Crushes and grinds food particles
 - **Size Reduction:** Prepares food for enzyme action
 - **Mixing:** Combines food with digestive enzymes

B. MIDGUT (Mesenteron)

Structure and Organization

- **Length:** Relatively short compared to foregut and hindgut
- **Lining:** True epithelium (no cuticular lining)
- **Cell Types:** Columnar epithelial cells with microvilli
- **Regeneration:** Cells continuously replaced

Functions

- **Enzyme Production:** Secretes major digestive enzymes
 - **Proteases:** Break down proteins
 - **Lipases:** Digest fats and oils
 - **Amylases:** Convert starches to sugars
 - **Invertases:** Break down complex sugars
- **Nutrient Absorption:** Primary site for absorption
 - **Amino acids:** From protein digestion
 - **Simple sugars:** From carbohydrate digestion
 - **Fatty acids:** From lipid digestion
 - **Vitamins and minerals**

Gastric Caeca (Hepatic Caeca)

- Finger-like projections
- End of foregut and midgut
- Increase absorptive and secretory surface
- **Function:** Additional digestive enzyme secretion
- Nutrient absorption
- Temporary nutrient storage

C. H. (m)

1. Ileum

- **Structure:** Narrow, coiled tube
- **Length:** Longest part of hindgut
- **Function:**
 - **Water Absorption:** Reclaim water from digestive waste
 - **Ion Regulation:** Control salt balance
 - **Bacterial Action:** Beneficial bacteria aid digestion

2. Colon

- **Structure:** Wider than ileum, shorter
- **Function:**
 - **Further Water Absorption:** Concentrate waste material
 - **Waste Compaction:** Form solid fecal pellets
 - **Microbial Activity:** Continued bacterial digestion

3. Rectum

- **Structure:** Expandable terminal chamber

- **Function:**
 - **Waste Storage:** Temporary storage before elimination
 - **Final Water Recovery:** Last chance for water absorption
 - **Defecation Control:** Regulate waste elimination

4. Anus

- **Structure:** Terminal opening with sphincter control
- **Function:** Waste elimination from body

ASSOCIATED STRUCTURES

Malpighian Tubules (Excretory System)

- **Number:** Approximately 150 long, thin tubules
- **Location:** Junction of midgut and hindgut
- **Structure:** Blind-ended tubes extending into body cavity

Functions:

- **Waste Filtration:** Remove nitrogenous wastes from hemolymph
- **Uric Acid Production:** Convert toxic ammonia to less toxic uric acid
- **Water Conservation:** Efficient water retention system
- **Ion Regulation:** Maintain osmotic balance

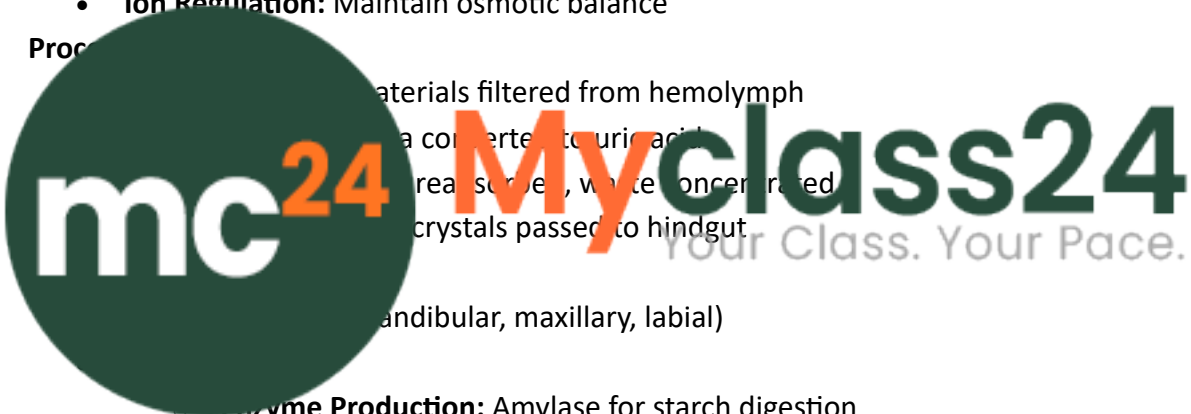
Process

Materials filtered from hemolymph

are converted to uric acid

in Malpighian tubules, waste concentrated

and crystals passed to hindgut



(mandibular, maxillary, labial)

- **Enzyme Production:** Amylase for starch digestion
- **Lubrication:** Moistens food for swallowing
- **pH Regulation:** Buffer digestive acids
- **Antimicrobial:** Some protective compounds

DIGESTIVE PROCESS OVERVIEW

1. Ingestion

- Food captured and processed by mouthparts
- Mixed with saliva containing amylase
- Formed into manageable bolus

2. Storage and Initial Processing

- Food stored in crop for gradual release
- Some enzymatic digestion begins
- Water content adjusted

3. Mechanical Breakdown

- Gizzard grinds food into small particles

- Increases surface area for enzyme action
- Mixing with midgut enzymes

4. Chemical Digestion

- Major enzyme action in midgut
- Gastric caeca contribute additional enzymes
- Complete breakdown of macromolecules

5. Absorption

- Primary absorption in midgut and gastric caeca
- Nutrients enter hemolymph circulation
- Transport to body tissues

6. Water Recovery and Waste Formation

- Water absorbed in hindgut
- Waste concentrated into pellets
- Uric acid from Malpighian tubules added

7. Elimination

- Solid waste pellets eliminated through anus
- Efficient water conservation maintained

ADAPTATION

CROCODILES

- **Food Storage:** Store food in crop
- **Efficient Digestion:** Handle various food types
- **Water Conservation:** Prolonged survival period without food
- **Waste Management:** Extract maximum nutrition

• **Water Conservation:** Minimize water loss

• **Efficient Digestion:** Water-efficient waste removal

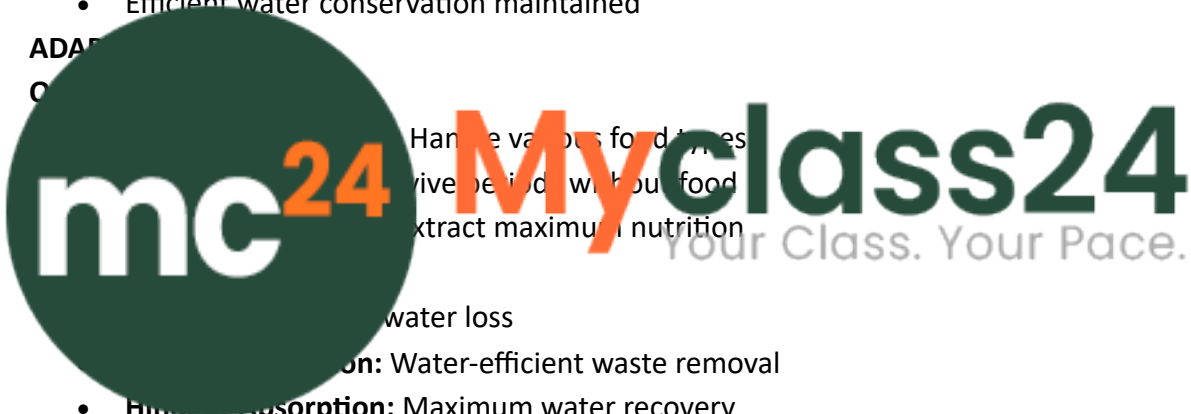
- **Efficient Absorption:** Maximum water recovery

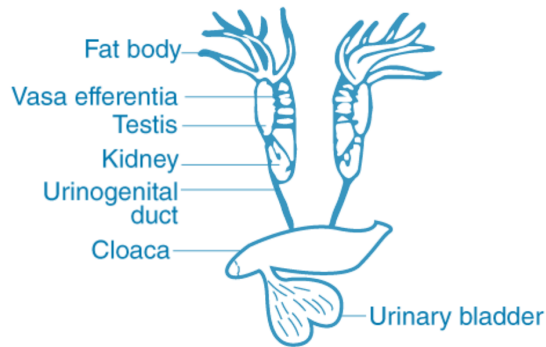
Survival Mechanisms

- **Food Storage:** Crop allows opportunistic feeding
- **Efficient Digestion:** Extract nutrients from poor-quality food
- **Waste Management:** Prevent toxic accumulation

This comprehensive digestive system makes cockroaches highly successful omnivorous insects capable of surviving on diverse food sources while maintaining efficient water balance.

5. Draw a neat and well-labelled diagram of the male reproductive system of a frog.





Solution: [The PDF shows a labeled diagram of the male frog reproductive system showing: Fat body, Vasa efferentia, Testis, Kidney, Urinogenital duct, Cloaca, and Urinary bladder]

Enhanced Explanation:

Male Reproductive System of Frog

REPRODUCTIVE ORGANS

1. Testes (Primary Sex Organs)

- **Number:** Pair of oval-shaped organs
- **Location:** Attached to kidneys by mesorchium
- **Size:** About 1 cm long, varies seasonally

Testis Tubules: Site of sperm production

Interstitial Cells: Hormone production (testosterone)

Supporting Tissue: Support structure

Function: Production of spermatozoa

Endocrine: Testosterone production

Seasonal Changes: Size increases during breeding season

2. Vasa Efferentia

- **Structure:** 10-12 fine tubules per testis
- **Connection:** Link testes to kidneys
- **Function:**
 - **Sperm Transport:** Carry sperm from testis
 - **Connection to Kidney:** Join with kidney tubules
 - **Dual Function:** Share pathway with urinary system

ASSOCIATED STRUCTURES

3. Kidneys (Dual Function)

- **Type:** Mesonephric kidneys
- **Structure:** Elongated, reddish organs
- **Dual Function:**
 - **Excretory:** Filter blood, produce urine
 - **Reproductive:** Transport sperm via kidney tubules

4. Urinogenital Duct (Wolffian Duct)

- **Formation:** Collecting tubules from kidney
- **Function:**
 - **Sperm Transport:** Carry sperm from kidney
 - **Urine Transport:** Carry urine from kidney
 - **Common Pathway:** Single duct for both functions

5. Urinary Bladder

- **Structure:** Thin-walled, expandable sac
- **Location:** Ventral to cloaca
- **Function:**
 - **Urine Storage:** Temporary storage before elimination
 - **Water Regulation:** Helps in osmoregulation
 - **Seasonal Variation:** Size varies with hydration

6. Cloaca

- **Structure:** Common chamber
- **Connections:** Receives urinogenital ducts and rectum
- **Function:**
 - **Common Exit:** Single opening for urinary, reproductive, and digestive systems
 - **Sperm Release:** Final pathway for sperm during mating

7.



7.

8. Fat

- **Structure:** Yellow, finger-like projections
- **Location:** Attached to anterior end of testes
- **Seasonal Changes:** Large before breeding, shrink during breeding
- **Functions:**
 - **Energy Storage:** Lipid reserves for reproduction
 - **Hormone Storage:** Store steroid hormones
 - **Nutritional Support:** Provide energy for gamete production

9. Bidder's Organ

- **Structure:** Small, ovary-like structure
- **Location:** Anterior tip of testis
- **Significance:**
 - **Vestigial Structure:** Remnant of ovarian tissue
 - **Intersex Potential:** Can develop if testes removed
 - **Evolutionary Evidence:** Shows common origin of sexes

PHYSIOLOGICAL PROCESSES

Evolutionary Significance

- **Primitive Features:** Mesonephric kidneys
- **Amphibian Characteristics:** Dual life cycle requirements
- **Vertebrate Plan:** Basic vertebrate reproductive pattern
- **Adaptation to Environment:** Aquatic breeding requirements

This reproductive system efficiently serves the dual aquatic-terrestrial lifestyle of frogs while maintaining the primitive vertebrate reproductive pattern with specific adaptations for external fertilization in aquatic environments.

Summary

This comprehensive guide covers all aspects of structural organization in animals as presented in the NCERT Exemplar for Class 11 Biology. The solutions provide detailed explanations for:

- **Tissue Organization:** From cellular to organ system levels
- **Animal Examples:** Detailed study of earthworm, cockroach, and frog
- **Physiological Processes:** Digestion, reproduction, excretion
- **Evolutionary Adaptations:** Structural modifications for different environments
- **Comparative Biology:** Differences between various animal groups

