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PRACTICAL HANDBOOK OF ZOOLOGY (B. Sc. I)

AS PER NEP-2020 (2.0) SYLLABUS OF
SHIVAJI UNIVERSITY, KOLHAPUR



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PREFACE

We are delighted to present this practical handbook to the B.Sc. students. This book is meticulously aligned with the revised syllabus of the NEP Shivaji University, Kolhapur, implemented from June 2024. In preparing this book, we have consulted various reference books and also gathered information from the internet. To facilitate students' understanding, we have used simple language and included large, accurate, and neatly labeled diagrams.

We extend our heartfelt gratitude to President Prof. K. V. Kurade and Prof. Anil Kurade, Secretary of Karmveer Vittal Ramaji Shinde Shikshan Sanstha, Gadhinglaj, as well as Ashok Anna Charati, President of Janata Education Society, Ajara and our management team for their continuous and supportive encouragement. We also thank to Hon. Mr. Satej D. Patil (MLA), President, Shri Mouni Vidyapeeth, Gargoti and Management of Shri Mouni Vidyapeeth for their support and encouragement.

We are also deeply thankful to Principal Prof. (Dr.) S. M. Kadam of Shivraj College, Gadhinglaj, and Dr. A. N. Sadale, Principal of Ajara Mahavidyalaya, Ajara, for their essential guidance and support.

We sincerely hope that this book will meet the needs and expectations of B.Sc. first-year Zoology students. We invite readers to point out any mistakes, typographical errors, and to make any suggestions. Corrections and worthy suggestions will be incorporated into the next edition.

- Mr. K. J. Adate

Dr. V. V. Ajagekar

Dr. S. A. Vhanalakar

Dr. V. M. Deshmukh

B. Sc. Part – I Semester – I

ZOOLOGY Practical– I

ZOOPR 103 (ANIMAL DIVERSITY AND CELL BIOLOGY)

Practical: 60 hrs.

Marks-50 (Credits: 02)

I: Practical course based on Animal Diversity

1. One example of each non-chordate phyla
2. One example of each chordate subphyla/class
3. One example of each mode of nutrition
4. Dissection of cockroach digestive system
5. Dissection of cockroach nervous system
6. Placing the animals on a world map according to zoo-geographical distribution
7. One example of each rare, endangered, critically endangered and extinct animal as per the red data book.
8. DIGI studio

II: Practical course based on Cell Biology

9. Cytological experiments

- a) Study of light microscope: Principles of microscopy; study of its parts; focusing of a slide at low power and high power and study of Image Formation.
- b) Study of cells by micrometry.
- c) Isolation of Nucleus and Staining of the nucleus by any nuclear stain

10. Cytological Preparations

- a) Study of constitutive heterochromatin (Barr body)
 - b) Staining of mitochondria by Janus green B in oral mucosa or any suitable tissue.
 - c) Study of osmosis using salt solutions
11. Study of mitosis in onion root tips
 12. Study of meiosis – observation of permanent slides
 13. Study of anemia and diabetic wound and histology of cancerous tumor

I: Practical course based on Animal Diversity

ONE EXAMPLE OF EACH NON-CHORDATE PHYLA

Non-chordates, also known as invertebrates, are animals that lack a notochord, a flexible rod-like structure that is present in chordates. Non-chordates encompass a vast majority of animal species and exhibit a wide range of forms and complexities. Here's a detailed overview of their general organization and basis of classification:

General Organization of Non-Chordates

Body Symmetry

- a) Asymmetry: No symmetry; found in sponges (Phylum Porifera).
- b) Radial Symmetry: Body parts arranged around a central axis; seen in cnidarians (e.g., jellyfish) and echinoderms (e.g., starfish).
- c) Bilateral Symmetry: Body has left and right halves that are mirror images; common in most non-chordates (e.g., insects, mollusks).

Body Layers

- a) Diploblastic: Two germ layers (ectoderm and endoderm); found in cnidarians and ctenophores.
- b) Triploblastic: Three germ layers (ectoderm, mesoderm, and endoderm); found in more complex non-chordates (e.g., annelids, arthropods).

Body Cavity (Coelom)

- a) Acoelomate: No body cavity; found in flatworms (Phylum Platyhelminthes).
- b) Pseudocoelomate: Body cavity not fully lined with mesoderm; found in roundworms (Phylum Nematoda).
- c) Coelomate: True body cavity fully lined with mesoderm; found in annelids, mollusks, arthropods, echinoderms, etc.

Digestive System

- a) Incomplete Digestive System: Single opening for both ingestion and egestion; found in cnidarians and flatworms.
- b) Complete Digestive System: Separate openings for mouth and anus; common in more complex non-chordates.

Nervous System

- a) Simple Nerve Nets: Found in cnidarians.
- b) Ganglia and Nerve Cords: Found in more complex non-chordates like annelids and arthropods.

Circulatory System

- a) Open Circulatory System: Blood is not always enclosed within blood vessels; found in arthropods and most mollusks.
- b) Closed Circulatory System: Blood is always contained within blood vessels; found in annelids and cephalopods (a class of mollusks).

Respiratory System

- a) Diffusion: Direct diffusion through body surface; found in small and simple non-chordates like flatworms.
- b) Gills, Tracheae, or Lungs: Specialized respiratory organs found in more complex non-chordates.

Excretory System

- a) Protonephridia: Flame cells; found in flatworms.
- b) Metanephridia: Tubular structures; found in annelids.
- c) Malpighian Tubules: Found in arthropods.

Basis of Classification of Non-Chordates

Non-chordates are classified based on various morphological, anatomical and genetic characteristics. Here are the primary criteria used for classification:

Body Symmetry and Organization

- Asymmetrical, radial or bilateral symmetry.

Levels of organization: cellular, tissue, or organ-system level.

Germ Layers

- Diploblastic or triploblastic organization.

Body Cavity (Coelom)

- Presence or absence of a body cavity: acoelomate, pseudocoelomate, or coelomate.

Segmentation

- Presence or absence of body segmentation (metamerism).

Developmental Patterns

- Protostome or deuterostome development.
- Larval forms and developmental stages.

Nervous System

- Type and complexity of the nervous system.

Circulatory and Respiratory Systems

- Type of circulatory and respiratory systems.

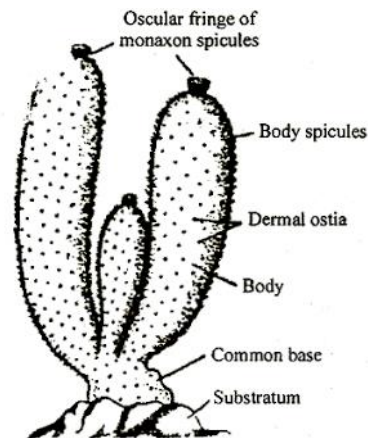
Reproductive Systems

- Modes of reproduction: sexual, asexual, or both.
- Presence of larval stages.

Major Phyla of Non-Chordates

Porifera (Sponges)

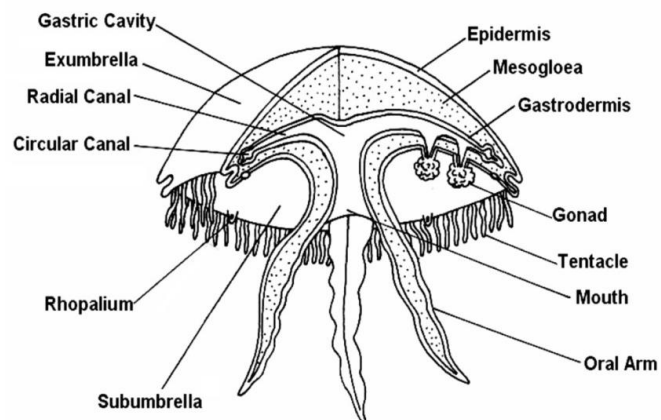
- Simplest multicellular animals.
- Asymmetrical, no true tissues or organs.
- Filter feeders with a porous body.



Ex. Sycon

Cnidaria (Jellyfish, Corals)

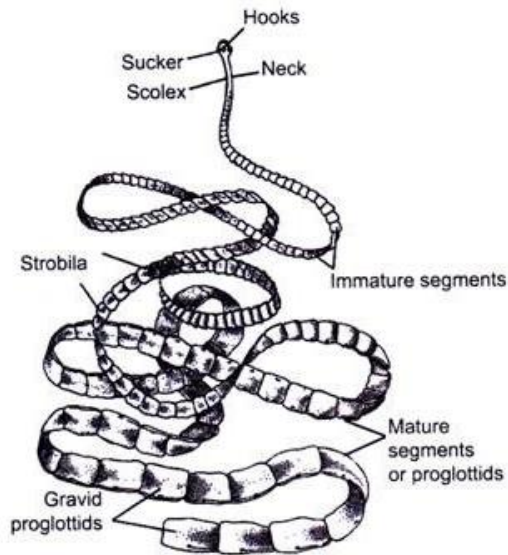
- Radial symmetry, diploblastic.
- Possess cnidocytes (stinging cells).
- Body forms: polyp and medusa.



Ex. Jelly fish

Platyhelminthes (Flatworms)

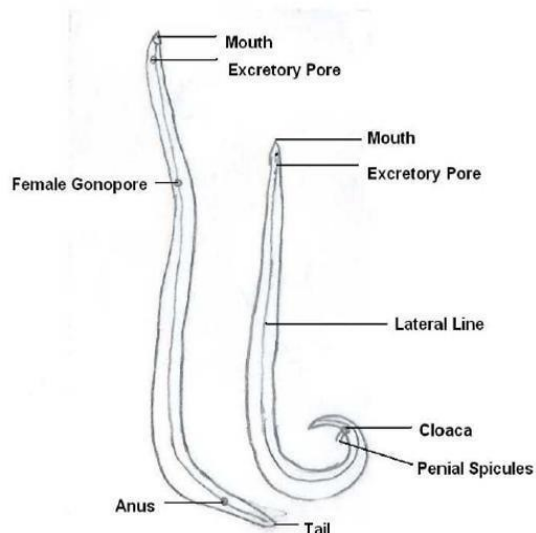
- Bilateral symmetry, triploblastic, acoelomate.
- Incomplete digestive system.
- Includes free-living and parasitic species.



Ex. Tapeworm

Nematoda (Roundworms)

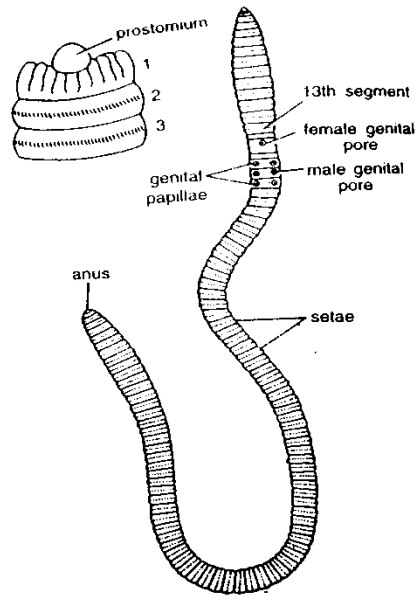
- Bilateral symmetry, triploblastic, pseudocoelomate.
- Complete digestive system.
- Includes free-living and parasitic species.



Ex. Ascaris

Annelida (Segmented Worms)

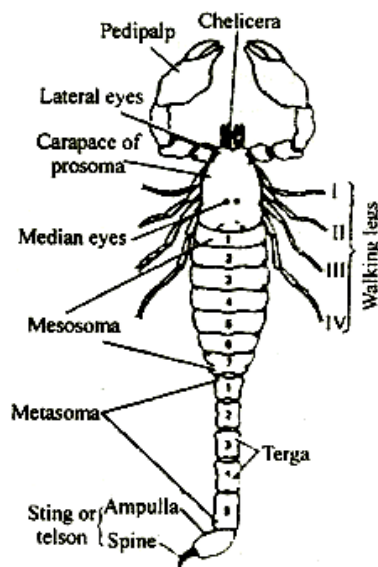
- Bilateral symmetry, triploblastic, coelomate.
- Segmented body with a true coelom.
- Closed circulatory system.



Ex. Earthworm

Arthropoda (Insects, Arachnids, Crustaceans)

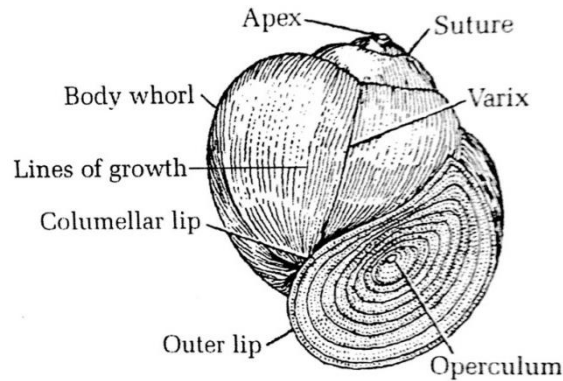
- Bilateral symmetry, triploblastic, coelomate.
- Segmented body with exoskeleton and jointed appendages.
- Largest phylum with diverse species.



Ex. Scorpion

Mollusca (Snails, Clams, Squid)

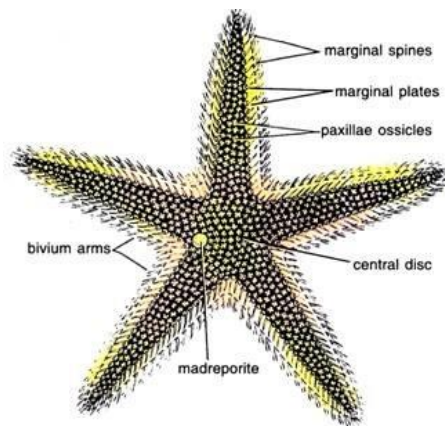
- Bilateral symmetry, triploblastic, coelomate.
- Body divided into head, foot, and visceral mass.
- Many have a calcareous shell.



Ex. Pila

Echinodermata (Starfish, Sea Urchins)

- Radial symmetry in adults, bilateral in larvae.
- Triploblastic, coelomate.
- Water vascular system for locomotion.



Ex. Star fish

Non-chordates exhibit diverse forms and complex organization, ranging from simple sponges to highly specialized arthropods and mollusks. Their classification is based on multiple criteria, including body symmetry, germ layers, body cavity, segmentation, and various physiological systems. Understanding these characteristics helps in categorizing the vast array of non-chordate species and studying their evolutionary relationships.

ONE EXAMPLE OF EACH CHORDATE SUBPHYLA/CLASS

Chordates are animals that belong to the phylum Chordata. They are characterized by possessing, at some stage of their development, five key features:

- 1. Notochord:** A flexible, rod-shaped structure that provides support. It is present during the embryonic stage in most chordates and may be retained in adulthood in some species.
- 2. Dorsal Hollow Nerve Cord:** A tube-like structure located above the notochord. In vertebrates, it develops into the brain and spinal cord.
- 3. Pharyngeal Slits:** Openings in the pharynx (the region just behind the mouth) that can function in filter-feeding or as gills. In terrestrial vertebrates, these are modified during development.
- 4. Endostyle or Thyroid Gland:** A glandular groove in the floor of the pharynx that secretes mucus to trap food particles. In vertebrates, it becomes the thyroid gland.
- 5. Post-Anal Tail:** An extension of the body past the anal opening, providing additional locomotor capabilities in many aquatic species.

General Organization of Chordates

Chordates display a variety of body plans and adaptations, but their basic organization can be described as follows:

a) Body Plan

- **Bilateral Symmetry:** The body is symmetrical along a central axis, with a distinct head (anterior), tail (posterior), back (dorsal), and belly (ventral).
- **Segmented Body:** The body is divided into segments, although this segmentation is more obvious in some groups (e.g., vertebrae in vertebrates).

b) Support and Movement

- **Notochord:** Provides axial support, replaced by the vertebral column in most vertebrates.
- **Muscular System:** Well-developed, especially in vertebrates, facilitating complex movements. Muscles are usually arranged in segmented blocks (myomeres).

c) Nervous System

- **Dorsal Hollow Nerve Cord:** Expands anteriorly to form the brain in vertebrates, connected to a spinal cord.
- **Complex Sensory Organs:** Eyes, ears, and other sensory organs are well-developed in vertebrates.

d) Circulatory System

- **Closed Circulatory System:** Blood is contained within vessels.
- **Heart:** A muscular heart pumps blood through the body, varying in complexity from simple tubular hearts in primitive chordates to multi-chambered hearts in vertebrates.

e) Respiratory System

- **Gills:** Used for gas exchange in aquatic chordates.
- **Lungs:** Developed in terrestrial vertebrates for breathing air.

f) Digestive System

- **Complete Digestive Tract:** Mouth to anus, with specialized regions for digestion and absorption.
- **Liver and Pancreas:** Accessory organs aiding in digestion.
- **Excretory System:**
- **Kidneys:** Main organs for excretion and osmoregulation in vertebrates.
- **Nephridia:** Present in some non-vertebrate chordates.

g) Reproductive System

- **Sexual Reproduction:** Predominantly, with separate sexes in most chordates.
- **Gonads:** Produce gametes (sperm and eggs).

h) Development

- **Embryonic Stages:** Includes the formation of the notochord, nerve cord and pharyngeal slits.
- **Metamorphosis:** Seen in some groups, like amphibians, where there is a significant transformation from larval to adult stages.

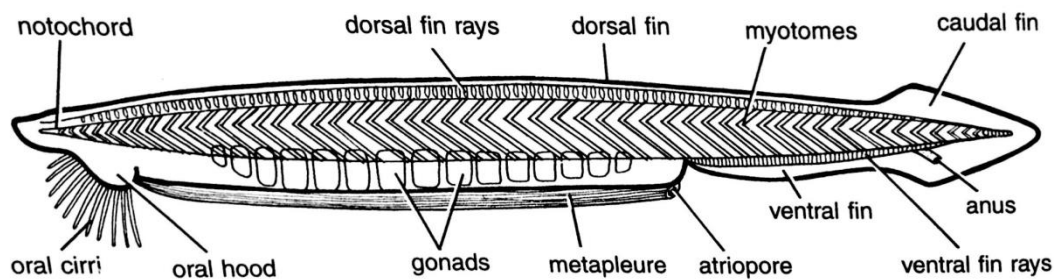
Major Groups of Chordates

1. **Cephalochordata** (Lancelets): Small, fish-like marine animals that retain all key chordate features throughout life.
2. **Urochordata** (Tunicates): Marine animals with a larval stage that has all chordate features, but adults are often sessile and lack most chordate characteristics.
3. **Vertebrata:** The largest group, characterized by a vertebral column. Includes fishes, amphibians, reptiles, birds and mammals.

One example of each chordate subphyla/class

1. Subphylum Cephalochordata

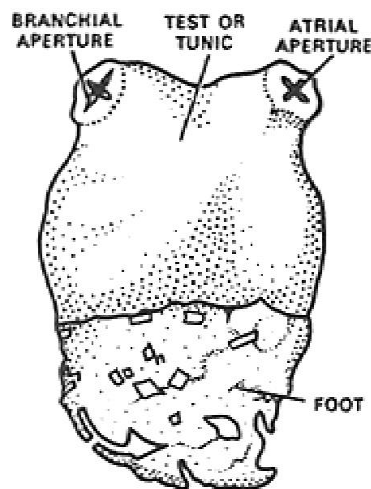
- **Example:** *Branchiostoma lanceolatum* (lancelet or amphioxus)
- **Characteristics**
 - a) Small, fish-like marine animals.
 - b) Notochord extends the length of the body and persists throughout life.
 - c) Lack a distinct head and brain.
 - d) Filter feeders that burrow into the sand.



Ex. Amphioxus

2. Subphylum Urochordata (Tunicata)

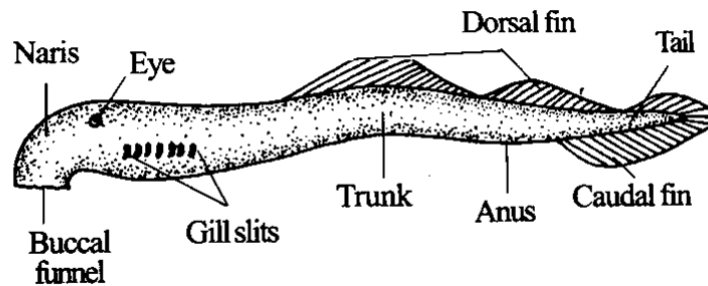
- **Example:** *Herdmania* (a species of sea squirt)
- **Characteristics**
 - a) Sessile as adults, with a tough outer tunic made of cellulose-like substance.
 - b) Larval stage exhibits chordate features (notochord, dorsal nerve cord, pharyngeal slits).
 - c) Adults are filter feeders with incurrent and excurrent siphons.



Ex. Herdmani

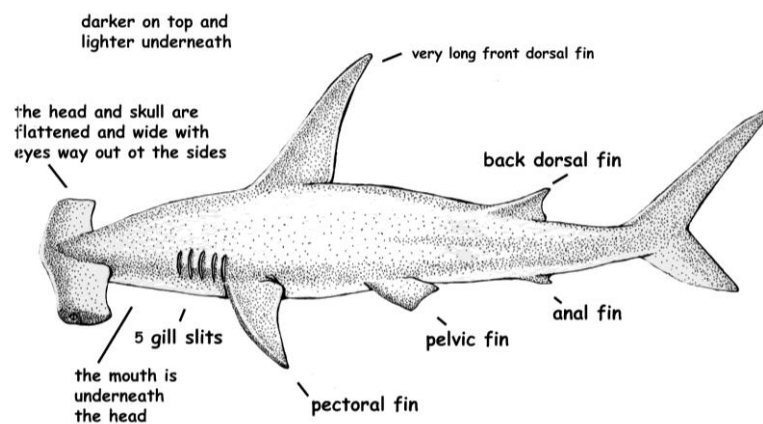
3. Subphylum Vertebrata

- Vertebrates have a well-defined head, a brain protected by a skull, and a segmented spinal column.
- **Class Agnatha (Jawless Fishes)**
- **Example:** *Petromyzon marinus* (sea lamprey)
- **Characteristics:**
 - a) Jawless fish with a circular, sucker-like mouth.
 - b) Lack paired fins.
 - c) Cartilaginous skeleton.
 - d) Parasitic or scavenging lifestyle.



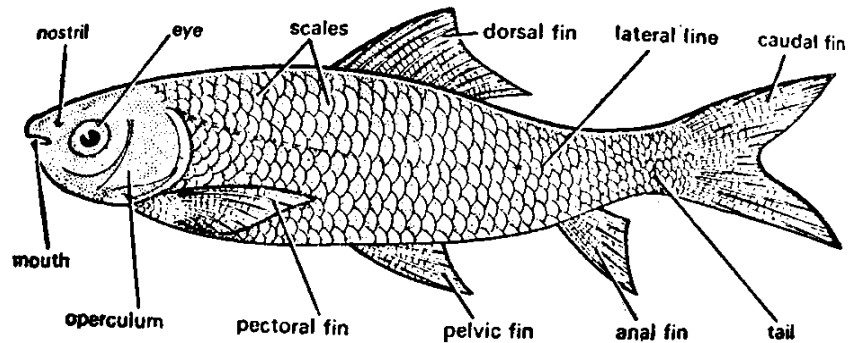
Ex. *Petromyzon*

- **Class Chondrichthyes (Cartilaginous Fishes)**
- **Example:** *Carcharodon carcharias* (great white shark)
- **Characteristics**
 - a) Skeleton made of cartilage.
 - b) Paired fins and jaws with multiple rows of sharp teeth.
 - c) Skin covered with placoid scales (dermal denticles).
 - d) Predominantly marine.



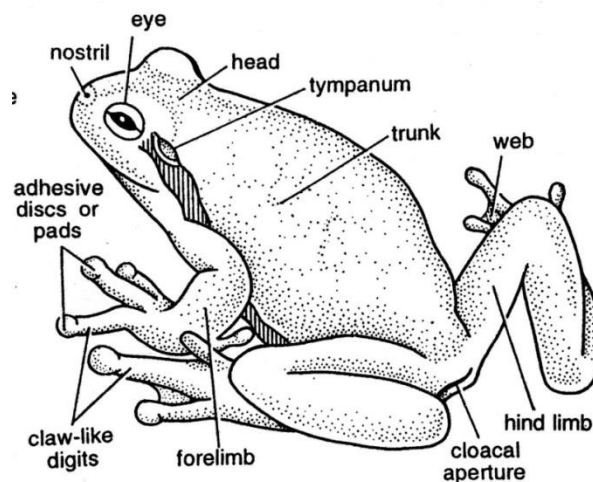
Ex. Hammer Headed Shark

- **Class Osteichthyes (Bony Fishes)**
- **Example:** *Labeo*
- **Characteristics:**
 - a) Skeleton primarily made of bone.
 - b) Operculum covering gills.
 - c) Swim bladder for buoyancy.
 - d) Diverse group including both freshwater and marine species.



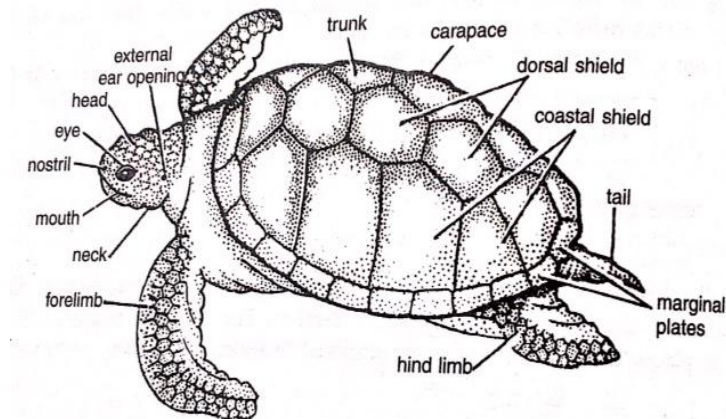
Ex. Labeo

- **Class Amphibia**
- **Example:** *Rana temporaria*, *Hyla*
- **Characteristics**
 - a) Moist, permeable skin used for respiration.
 - b) Life cycle includes aquatic larval stage (tadpole) and terrestrial adult stage.
 - c) Lay eggs in water or moist environments.
 - d) Ectothermic (rely on external sources of heat).



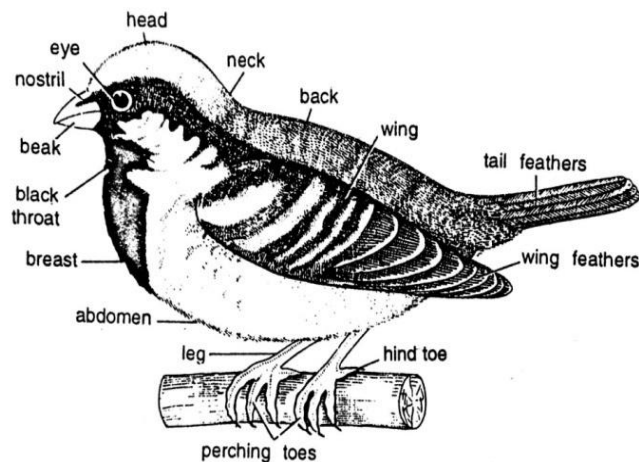
Ex. Hyla

- **Class Reptilia**
- **Example:** *Chelonia mydas* (green sea turtle)
- **Characteristics**
 - a) Dry, scaly skin to prevent water loss.
 - b) Lay amniotic eggs with leathery or hard shells on land.
 - c) Ectothermic.
 - d) Includes turtles, snakes, lizards, and crocodilians.



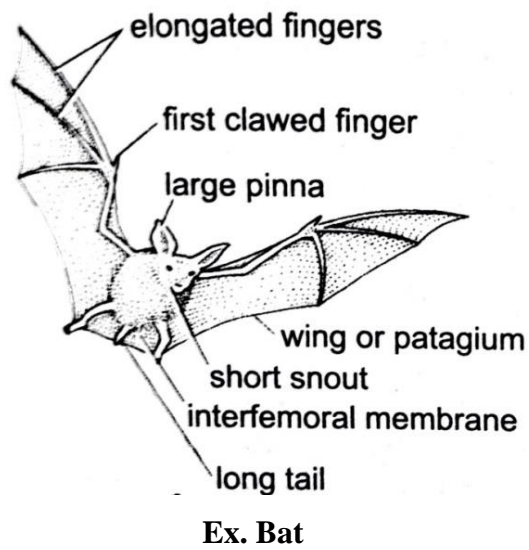
Ex. Turtle

- **Class Aves (Birds)**
- **Example:** *Corvus corax* (common raven)
- **Characteristics:**
 - a) Feathers for flight and insulation.
 - b) Beak without teeth.
 - c) Lay hard-shelled amniotic eggs.
 - d) Endothermic (maintain a constant body temperature).



Ex. Common Sparrow

- **Class Mammalia**
- **Example: Bat**
- **Characteristics**
 - a) Hair or fur covering the body.
 - b) Mammary glands produce milk to feed young.
 - c) Endothermic.
 - d) Differentiated teeth (incisors, canines, molars).
 - e) Highly developed brain and complex social behaviors.



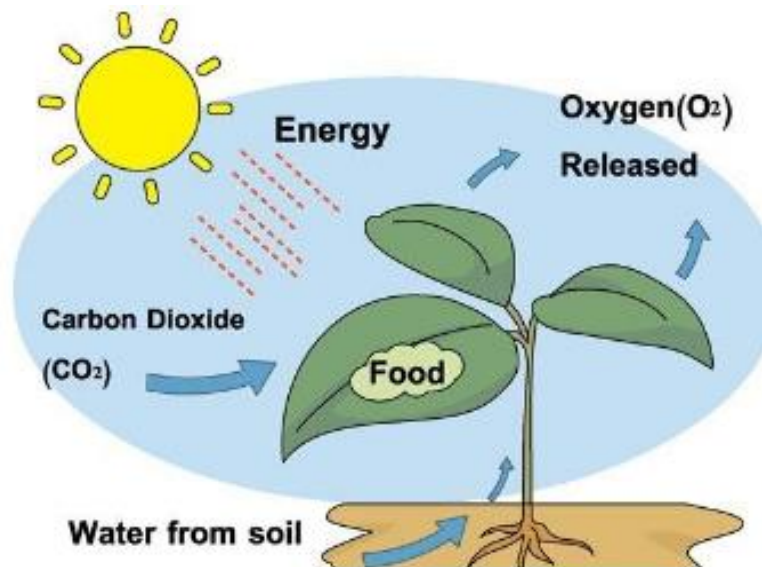
ONE EXAMPLE OF EACH MODE OF NUTRITION

1. Autotrophic Nutrition

Example: Green Plants

Description

- **Mechanism:** Green plants synthesize their own food through the process of photosynthesis.



- **Process**
 - a) Plants absorb sunlight using chlorophyll in their chloroplasts.
 - b) They take in carbon dioxide (CO₂) from the air through stomata.
 - c) They absorb water (H₂O) from the soil through their roots.
 - d) Using the energy from sunlight, they convert CO₂ and H₂O into glucose (C₆H₁₂O₆) and oxygen (O₂).
 - e) The glucose is used for energy and growth, while the oxygen is released into the atmosphere.

Chemical Equation: $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

2. Heterotrophic Nutrition

Example: Humans

Description

- **Mechanism:** Humans obtain their nutrients by consuming other organisms, such as plants and animals.
- **Process:**
 - a) **Ingestion:** Taking in food through the mouth.
 - b) **Digestion:** Breaking down food into smaller molecules in the digestive system using enzymes.
 - c) **Absorption:** Nutrients from the digested food are absorbed into the bloodstream through the walls of the intestines.
 - d) **Assimilation:** The absorbed nutrients are transported to cells where they are used for energy, growth, and repair.
 - e) **Egestion:** The removal of indigestible substances from the body.

Nutrients Involved: Carbohydrates, proteins, fats, vitamins and minerals.

3. Saprotrophic Nutrition

Example: Fungi (e.g., Mushrooms)

Description

- **Mechanism:** Fungi obtain nutrients by decomposing organic matter from dead and decaying organisms.

Saprotrophic Nutrition

Dead plants, dead &
decaying animal bodies

Example

- ★ Yeast
- ★ Mushrooms



- **Process**
 - a) Fungi secrete digestive enzymes into the surrounding environment.
 - b) These enzymes break down complex organic matter into simpler soluble compounds.
 - c) The fungi then absorb these soluble nutrients through their cell walls.

Role in Ecosystem

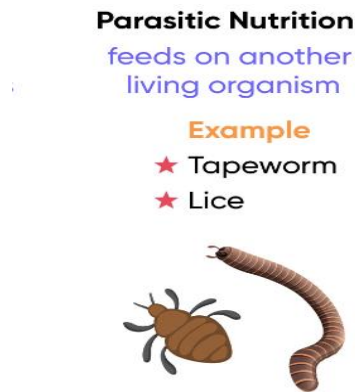
- Fungi play a crucial role in recycling nutrients back into the ecosystem by breaking down dead organic matter.

4. Parasitic Nutrition

Example: Tapeworm (e.g., Taenia)

Description

- **Mechanism:** Tapeworms live in the intestines of their hosts and absorb nutrients directly from the host's digested food.



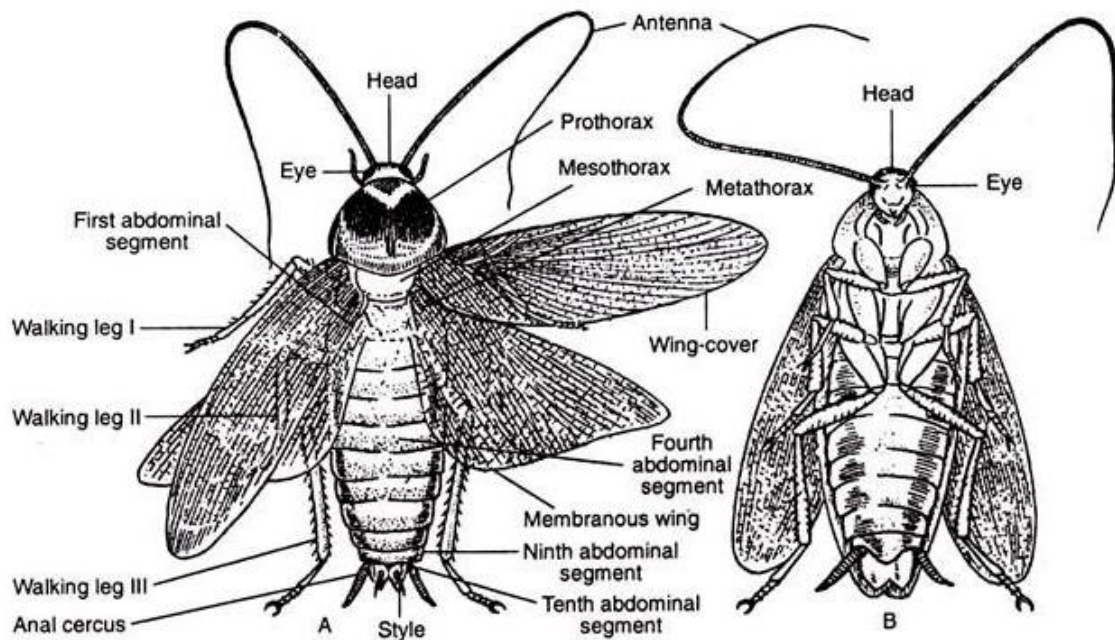
- **Process**
 - a) The tapeworm attaches to the intestinal wall of the host using hooks or suckers.
 - b) It absorbs pre-digested food from the host's intestine through its body surface.
 - c) Tapeworms do not have their own digestive system and rely entirely on the host for nutrition.

Impact on Host

- Parasitic nutrition can weaken the host by depriving it of essential nutrients, leading to malnutrition and other health issues.

These examples illustrate the diversity of nutritional strategies among different organisms, reflecting their adaptation to various environmental niches and modes of survival.

DISSECTION OF COCKROACH DIGESTIVE SYSTEM



A DORSAL VIEW B: VENTRAL VIEW

The dissection of a cockroach's digestive system provides a detailed view of its internal anatomy and helps understand its physiological functions. Here's a step-by-step guide to dissecting the digestive system of a cockroach, along with a description of its major components:

Materials Needed

- Dissecting tray
- Dissecting pins
- Dissecting scissors
- Forceps
- Scalpel
- Needle probe
- Cockroach specimen
- Dissecting microscope (optional)
- Gloves and safety equipment

Steps for Dissection

1. Preparation

- Place the cockroach in a freezer or in a soap solution for a few minutes to immobilize it.

- Lay the cockroach dorsal side up (back facing up) on the dissecting tray and pin the legs to the tray to secure it.

2. Making the Initial Incision

- Use the scissors to carefully cut along the sides of the cockroach's exoskeleton from the posterior end (near the abdomen) to the anterior end (near the head).
- Gently lift the exoskeleton and pin it back to expose the internal organs.

3. Exposing the Digestive System

- Remove any fatty tissue carefully to get a clear view of the digestive organs.
- Identify the main components of the digestive system.

Components of the Cockroach Digestive System

1. Mouthparts

- **Labrum:** Upper lip that helps hold food.
- **Mandibles:** Hard, toothed structures that crush food.
- **Maxillae:** Paired appendages that manipulate food.
- **Labium:** Lower lip that assists in food handling.

2. Foregut

- **Pharynx:** Connects the mouth to the esophagus.
- **Esophagus:** Tube that transports food from the pharynx to the crop.
- **Crop:** A large, expandable storage organ where food is temporarily stored and partially digested.
- **Proventriculus (Gizzard):** Muscular structure that grinds food, aided by internal chitinous teeth.

3. Midgut

- **Stomach (Ventriculus):** Primary site of digestion and absorption. It is lined with digestive enzymes.
- **Gastric Caeca:** Finger-like projections connected to the stomach, increasing the surface area for digestion and absorption. They secrete digestive enzymes and aid in nutrient absorption.

4. Hindgut

- **Ileum:** Short tubular section that connects the midgut to the colon.
- **Colon:** Transports undigested food to the rectum.
- **Rectum:** Absorbs water and salts, forming fecal pellets.
- **Anus:** Opening through which waste is expelled.

5. Malpighian Tubules

- These are excretory structures connected at the junction of the midgut and hindgut. They remove waste products from the hemolymph (insect blood) and release them into the hindgut for excretion.

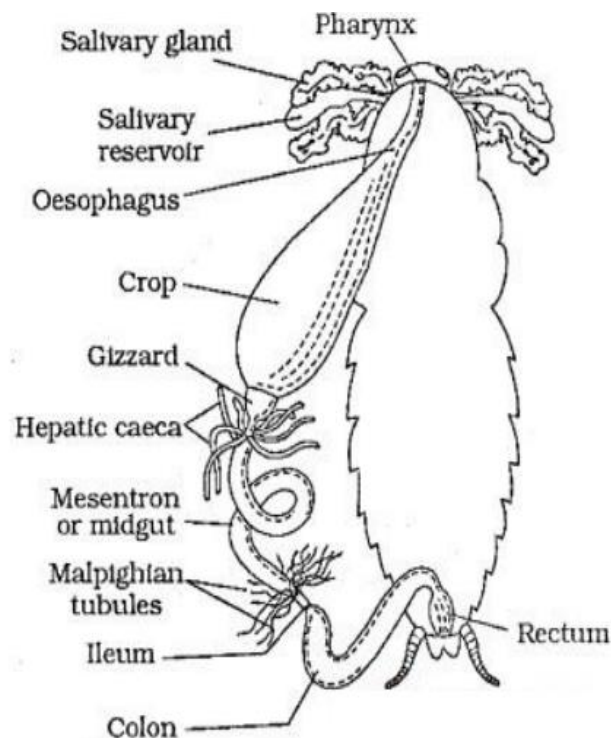
Observations

- Notice the structure and positioning of each organ within the digestive system.
- Observe the texture and color differences among various parts, such as the crop, stomach, and intestines.
- Note the presence of any food particles in the crop or stomach, which can help identify the diet of the cockroach.

Post-Dissection

- Dispose of the specimen according to your lab's guidelines.
- Clean all dissecting tools and work area thoroughly.

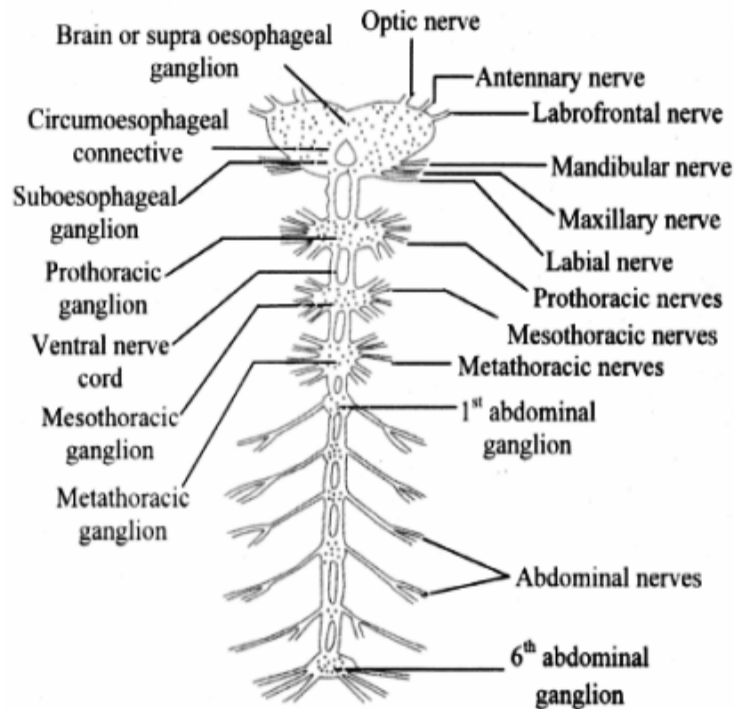
Dissecting the digestive system of a cockroach reveals a highly specialized and efficient system adapted to its omnivorous diet. Each component plays a specific role in the digestion and absorption of nutrients, contributing to the survival and adaptability of the cockroach in various environments.



Digestive System of Cockroach

DISSECTION OF COCKROACH NERVOUS SYSTEM

The dissection of a cockroach's nervous system helps to understand its neural anatomy and function. Here's a step-by-step guide to dissecting the nervous system of a cockroach, along with a description of its major components.



Nervous System of Cockroach

Materials Needed

- Dissecting tray, Dissecting pins
- Dissecting scissors
- Forceps
- Scalpel
- Needle probe
- Cockroach specimen
- Dissecting microscope (optional)
- Gloves and safety equipment

Steps for Dissection

1. Preparation

- Place the cockroach in a freezer or in a soap solution for a few minutes to immobilize it.

- Lay the cockroach ventral side up (belly facing up) on the dissecting tray and pin the legs to the tray to secure it.

2. Making the Initial Incision

- Use the scissors to carefully cut along the sides of the cockroach's exoskeleton from the posterior end (near the abdomen) to the anterior end (near the head).
- Gently lift the exoskeleton and pin it back to expose the internal organs.

3. Exposing the Nervous System

- Remove any fatty tissue and digestive organs carefully to get a clear view of the nervous system.
- Identify the main components of the nervous system.

Components of the Cockroach Nervous System

a) Central Nervous System (CNS)

- **Brain (Supraesophageal Ganglion):** Located in the head, above the esophagus. It controls sensory input and higher functions.
- **Subesophageal Ganglion:** Located below the esophagus. It controls the mouthparts and feeding mechanisms.

b) Ventral Nerve Cord

- Runs along the length of the body on the ventral side.
- Composed of a series of segmental ganglia connected by longitudinal connectives.

c) Segmental Ganglia

- **Thoracic Ganglia:** Three pairs located in the thorax, responsible for controlling the legs and wings.
- **Abdominal Ganglia:** Six pairs located in the abdomen, controlling the abdominal muscles and internal organs.

Dissection Procedure

a. Exposing the Brain

- Carefully remove the head capsule to expose the brain.
- Observe the supraesophageal and subesophageal ganglia.

b. Exposing the Ventral Nerve Cord

- Cut and remove the digestive tract and other organs to expose the ventral nerve cord.
- Follow the nerve cord from the head to the abdomen, identifying the segmental ganglia.

c. Observations

- Note the size and shape of the brain and ganglia.
- Observe the connections between the ganglia and the ventral nerve cord.
- Identify any nerve branches extending to the legs, wings, and other body parts.

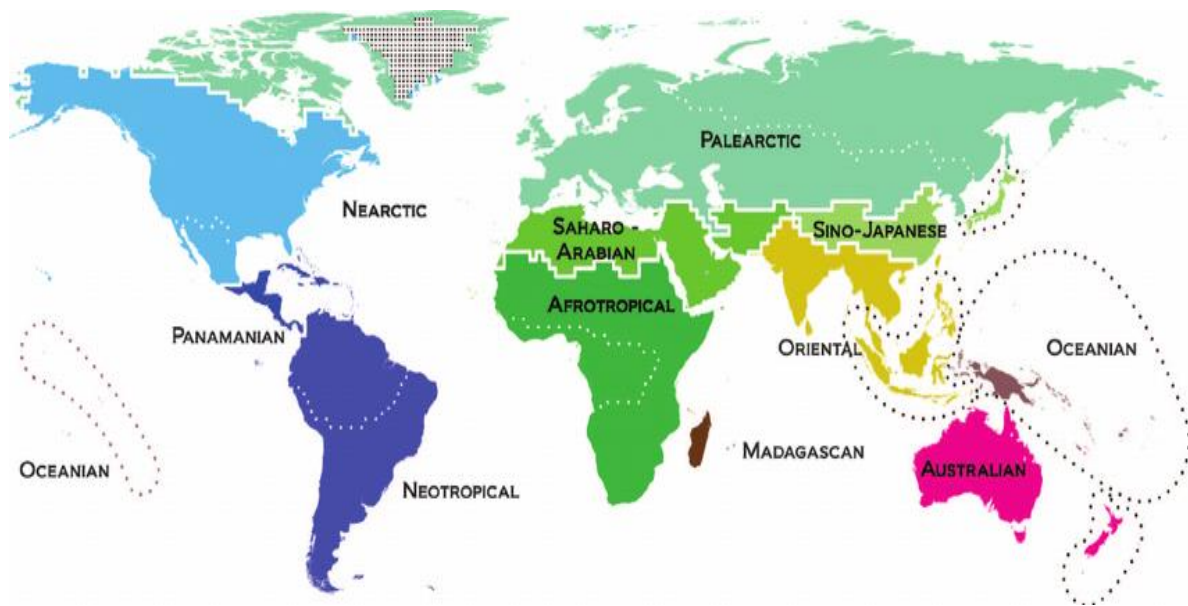
Post-Dissection

- Dispose of the specimen according to your lab's guidelines.
- Clean all dissecting tools and work area thoroughly.

Dissecting the nervous system of a cockroach reveals a relatively simple but efficient neural structure. The brain, composed of the supraesophageal and subesophageal ganglia, controls sensory input and feeding. The ventral nerve cord, with its segmental ganglia, coordinates movement and internal organ function. This decentralized nervous system allows the cockroach to react quickly to environmental changes, contributing to its survival and adaptability.

PLACING THE ANIMALS ON A WORLD MAP ACCORDING TO ZOO- GEOGRAPHICAL DISTRIBUTION

Zoological (or zoogeographical) distribution refers to the geographical distribution of animal species and populations across different regions of the world. Based on Alfred Russel Wallace's classifications, the world can be divided into several zoogeographical regions, each with distinct fauna. Here's how animals can be placed on a world map according to these regions



Zoogeographical Regions and Representative Animals

1. Nearctic Region

- **Location:** North America, including Greenland.
- **Representative Animals**
American Bison (*Bison bison*)
Pronghorn Antelope (*Antilocapra americana*)
Bald Eagle (*Haliaeetus leucocephalus*)

2. Neotropical Region

- **Location:** South America, Central America, the Caribbean, and southern Mexico.
- **Representative Animals**
Jaguar (*Panthera onca*)
Sloth (*Bradypus spp.*)
Macaw (*Ara spp.*)

3. Palearctic Region

- **Location:** Europe, North Africa, and most of Asia north of the Himalayas.

- **Representative Animals**

Brown Bear (*Ursus arctos*)

Siberian Tiger (*Panthera tigris altaica*)

Eurasian Lynx (*Lynx lynx*)

4. Afrotropical Region

- **Location:** Sub-Saharan Africa and Madagascar.

- **Representative Animals**

African Elephant (*Loxodonta africana*)

Lion (*Panthera leo*)

Giraffe (*Giraffa camelopardalis*)

5. Indomalayan Region

- **Location:** South Asia, Southeast Asia, and southern China.

- **Representative Animals**

Bengal Tiger (*Panthera tigris tigris*)

Indian Elephant (*Elephas maximus indicus*)

Orangutan (*Pongo spp.*)

6. Australasian Region

- **Location:** Australia, New Guinea, and neighboring islands.

- **Representative Animals**

Kangaroo (*Macropus spp.*)

Koala (*Phascolarctos cinereus*)

Platypus (*Ornithorhynchus anatinus*)

7. Oceanian Region

- **Location:** Islands of the Pacific Ocean, excluding New Guinea and New Zealand.

- **Representative Animals**

Hawaiian Monk Seal (*Neomonachus schauinslandi*)

Kagu (*Rhynochetos jubatus*) of New Caledonia

Various endemic birds of the Pacific islands

8. Antarctic Region

- **Location:** Antarctica and the surrounding Southern Ocean.
- **Representative Animals**
Emperor Penguin (*Aptenodytes forsteri*)
Weddell Seal (*Leptonychotes weddellii*)
Various species of whales (e.g., Minke Whale)

Placing Animals on a World Map

Here is a general overview of how to place these animals on a world map according to their zoogeographical distribution:

1. Nearctic Region

- Place the American Bison, Pronghorn Antelope, and Bald Eagle across North America, especially in regions like the Great Plains, Western United States and Alaska.

2. Neotropical Region

- Position the Jaguar, Sloth and Macaw throughout South America, especially in the Amazon Rainforest and Central America.

3. Palearctic Region

- Spread the Brown Bear, Siberian Tiger, and Eurasian Lynx across Europe, northern Asia, and parts of North Africa.

4. Afrotropical Region

- Locate the African Elephant, Lion, and Giraffe across sub-Saharan Africa, particularly in savannas and forests.

5. Indomalayan Region

- Place the Bengal Tiger, Indian Elephant, and Orangutan in South Asia and Southeast Asia, especially in India, Indonesia, and Malaysia.

6. Australasian Region

- Position the Kangaroo, Koala, and Platypus throughout Australia, with some extending to New Guinea.

7. Oceanian Region

- Distribute animals like the Hawaiian Monk Seal and Kagu across the Pacific islands, highlighting specific endemic species to each island group.

8. Antarctic Region

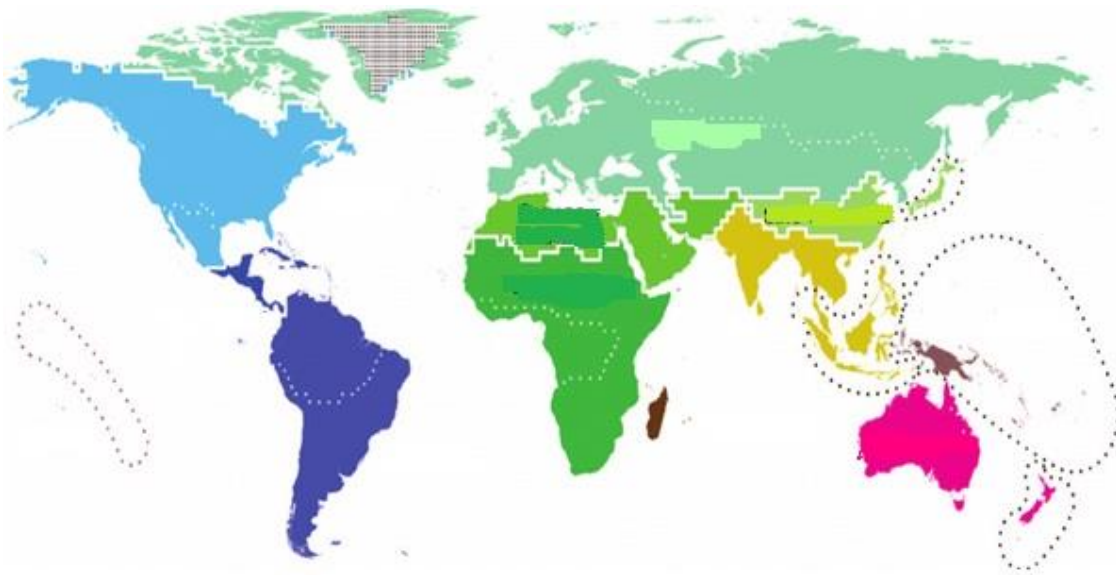
- Place the Emperor Penguin, Weddell Seal, and various whale species around Antarctica and the Southern Ocean.

Visual Representation

To create a visual representation on a world map:

1. **Draw or use a blank world map.**
2. **Mark the boundaries of each zoogeographical region.**
3. **Place icons or drawings of the representative animals in their respective regions.**
For example, draw a bison in North America, a jaguar in the Amazon, a brown bear in Siberia etc.
4. **Label each region and animal for clarity.**

This approach helps visualize the diverse distribution of animal species across different regions of the world based on their zoogeographical classification.



**ONE EXAMPLE OF EACH RARE, ENDANGERED, CRITICALLY ENDANGERED
AND EXTINCT ANIMAL AS PER THE RED DATA BOOK**

The Red Data Book, maintained by the International Union for Conservation of Nature (IUCN), categorizes species based on their risk of extinction. Here's an example of an animal from each category: rare, endangered, critically endangered and extinct.

1. Rare

Animal: Okapi (*Okapia johnstoni*)



The Okapi, also known as the forest giraffe, is a mammal native to the dense rainforests of the Democratic Republic of the Congo. It has distinctive markings, with stripes reminiscent of zebras, but is more closely related to the giraffe. Okapis are rare because they have a limited range and live in secluded habitats, making them difficult to spot in the wild.

2. Endangered

Animal: African Elephant (*Loxodonta africana*)



The African Elephant is the largest land mammal on Earth, found in various habitats across sub-Saharan Africa. It is classified as endangered primarily due to habitat loss, human-wildlife conflict, and poaching for ivory. Conservation efforts are in place to protect these majestic creatures, but they continue to face significant threats.

3. Critically Endangered

Animal: Amur Leopard (*Panthera pardus orientalis*)



The Amur Leopard is one of the rarest big cats in the world, found in the temperate forests of the Russian Far East and northeastern China. With only around 100 individuals left in the wild, it is critically endangered due to habitat loss, poaching, and prey depletion. Intensive conservation efforts are ongoing to prevent its extinction.

4. Extinct

Animal: Passenger Pigeon (*Ectopistes migratorius*)



The Passenger Pigeon was once one of the most numerous bird species in North America, with billions of individuals. They became extinct in the early 20th century due to unregulated hunting and habitat destruction. The last known individual, named Martha, died in captivity in 1914. The extinction of the Passenger Pigeon is a poignant example of how human activities can lead to the rapid decline of a species.

These examples illustrate the various levels of conservation concern and the reasons behind the status of different species as per the Red Data Book.

DIGI STUDIO

DIGI Studio is an innovative digital learning environment designed to enhance the educational experience by integrating various technologies and multimedia resources. It is often used in academic settings to foster interactive and engaging learning opportunities.

DIGI Studio, when applied to the field of zoology, can significantly enhance the teaching, learning and research experiences by integrating advanced digital tools and multimedia resources. Here's how DIGI Studio can be utilized in the context of zoology

Applications of DIGI Studio in Zoology

1. Digital Content Creation

- a) **Virtual Field Trips:** Create immersive virtual field trips to various ecosystems and habitats, allowing students to explore and study wildlife in their natural environments without leaving the classroom.
- b) **Documentaries and Educational Videos:** Produce high-quality documentaries and educational videos that highlight various aspects of animal behavior, physiology, and ecology.

2. Interactive Learning Tools

- a) **3D Models and Animations:** Use 3D models and animations to visualize complex anatomical structures and physiological processes of different animal species.
- b) **Interactive Simulations:** Develop simulations that allow students to experiment with ecological models, study population dynamics, or simulate evolutionary processes.

1. Collaborative Platforms

- a) **Research Collaboration:** Facilitate collaboration between students and researchers through online platforms where they can share data discuss findings and co-author papers.
- b) **Group Projects:** Enable students to work on group projects, such as creating species profiles, conducting virtual dissections, or developing conservation plans.

2. Learning Management System (LMS) Integration

- a) **Course Management:** Organize zoology courses with centralized access to lectures, reading materials, assignments and assessments.
- b) **Progress Tracking:** Monitor student progress in understanding zoological concepts and provide timely feedback on their performance.

3. Resource Libraries

- a) **Digital Specimen Collections:** Access digital libraries of specimen collections from museums and research institutions, allowing students to study various species without physical handling.
- b) **Research Databases:** Provide access to databases containing scientific papers, research articles, and species information for deeper study and research.

4. Assessment and Evaluation

- a) **Interactive Quizzes and Exams:** Develop quizzes and exams that test students' knowledge of zoological principles and species identification.
- b) **Fieldwork Reports:** Allow students to submit digital fieldwork reports, including multimedia elements like photos and videos, to document their observations and findings.

5. Accessibility and Inclusivity

- a) **Adaptive Learning Modules:** Create personalized learning modules that adapt to the learning pace and style of individual students, ensuring everyone can grasp complex zoological concepts.
- b) **Assistive Technologies:** Implement assistive technologies to support students with disabilities in accessing and understanding zoological content.

Benefits of DIGI Studio in Zoology

- a) **Enhanced Visualization:** Helps students visualize and understand complex biological structures and processes that are difficult to grasp through textbooks alone.
- b) **Real-World Experience:** Provides virtual experiences that mimic real-world zoological fieldwork and research, preparing students for careers in the field.
- c) **Increased Engagement:** Keeps students engaged with interactive and multimedia content, making learning more enjoyable and effective.
- d) **Collaboration Opportunities:** Encourages collaboration among students, educators, and researchers, fostering a community of shared knowledge and expertise.
- e) **Flexible Learning:** Offers flexible learning options, accommodating different schedules and learning preferences, which is especially beneficial for field-based studies.

Specific Examples in Zoology

- a) **Virtual Dissections:** Utilize digital dissection tools to study the anatomy of various animals without the ethical concerns and logistical issues associated with traditional dissection.

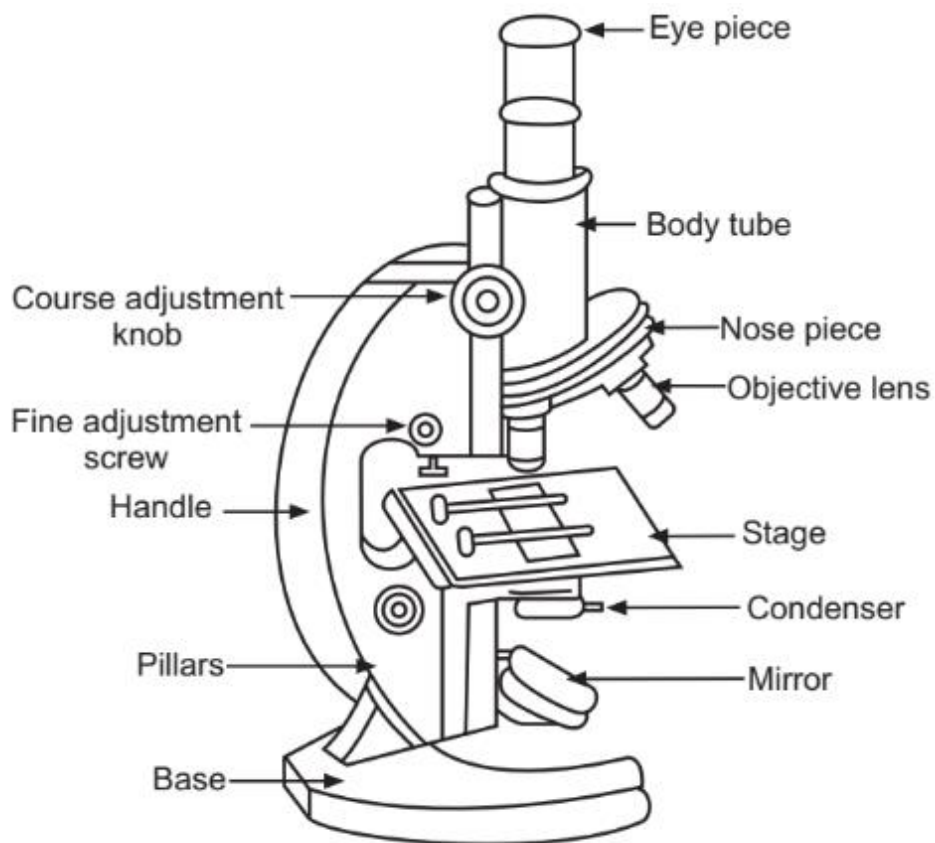
- b) Wildlife Monitoring:** Use real-time data from wildlife monitoring projects to teach students about animal behavior, migration patterns and conservation efforts.
- c) Genetic Studies:** Employ bioinformatics tools to analyze genetic data, helping students understand evolutionary relationships and genetic diversity among species.
- d) Conservation Education:** Develop interactive modules that teach students about conservation strategies, endangered species, and the impact of human activities on wildlife.

By leveraging DIGI Studio in zoology, educators can provide a rich, immersive and flexible learning environment that enhances students' understanding and appreciation of the animal kingdom.

II: PRACTICAL COURSE BASED ON CELL BIOLOGY
STUDY OF LIGHT MICROSCOPE: PRINCIPLES OF MICROSCOPY; STUDY OF
ITS PARTS; FOCUSING OF A SLIDE AT LOW POWER AND HIGH POWER AND
STUDY OF IMAGE FORMATION

Principles of Microscopy

- 1. Magnification:** The process of enlarging the appearance of an object using lenses. A light microscope typically provides a magnification range from 40x to 1000x.
- 2. Resolution:** The ability to distinguish two adjacent points as separate entities. Higher resolution provides clearer and more detailed images. The resolution limit of a light microscope is about 0.2 micrometers.
- 3. Contrast:** The difference in light intensity between the image and the background. Stains and dyes are often used to enhance contrast in biological specimens.



Compound Microscope

Parts of a Light Microscope

- a) **Eyeiece (Ocular lens):** The lens you look through, usually with a magnification of 10x.
- b) **Objective Lenses:** Located on a rotating nosepiece. Common magnifications include 4x (scanning), 10x (low power), 40x (high power), and 100x (oil immersion).
- c) **Stage:** The platform where the slide is placed. It often has clips to hold the slide in place.
- d) **Light Source:** An illuminator located at the base, providing light that passes through the specimen.
- e) **Diaphragm/Iris:** Adjusts the amount of light reaching the specimen.
- f) **Coarse Focus Knob:** Brings the specimen into general focus.
- g) **Fine Focus Knob:** Refines the focus to sharpen the image.
- h) **Arm:** Supports the body tube and connects to the base.
- i) **Base:** The bottom part of the microscope, which provides stability.
- j) **Condenser:** Focuses the light onto the specimen.

FOCUSING A SLIDE

1. Low Power (10x) Focusing

- Place the slide on the stage and secure it with stage clips.
- Using the lowest power objective lens (4x or 10x), bring the lens close to the slide using the coarse focus knob.
- Look through the eyepiece and slowly move the coarse focus knob until the image comes into view.
- Use the fine focus knob to sharpen the image.
- Adjust the diaphragm to enhance contrast if necessary.

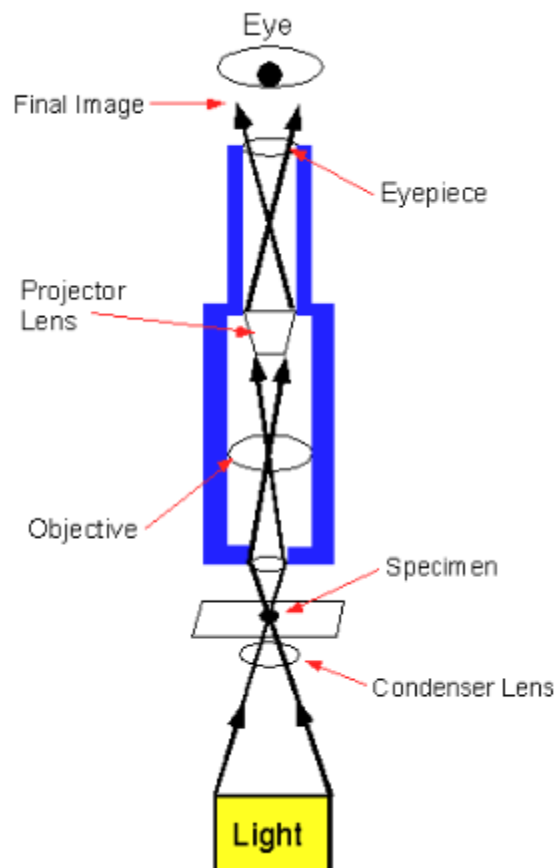
2. High Power (40x or 100x) Focusing

- Once the specimen is focused under low power, rotate the nosepiece to switch to a higher power objective lens (40x).
- Only use the fine focus knob to adjust the image, as the coarse focus can damage the slide or lens at high magnification.
- For the highest power (100x, oil immersion), place a drop of immersion oil on the cover slip and carefully move the 100x objective lens into place.
- Again, use only the fine focus knob to bring the image into sharp focus.

Image Formation

1. **Illumination:** Light from the illuminator passes through the diaphragm and condenser, focusing light on the specimen.
2. **Interaction with Specimen:** Light interacts with the specimen, which can absorb, transmit, or refract the light, creating contrast.
3. **Objective Lens:** The light, modified by the specimen, enters the objective lens, which magnifies the image and projects it up into the body tube.
4. **Eyepiece Lens:** The magnified image from the objective lens is further magnified by the eyepiece lens, forming the final image observed by the eye.

By understanding the principles of magnification, resolution, and contrast, and learning the functions of the various parts of the light microscope, you can effectively focus on and study specimens under low and high power. Proper focusing techniques ensure clear and detailed observation of microscopic details, and the combination of objective and eyepiece lenses plays a crucial role in image formation.



STUDY OF CELLS BY MICROMETRY

Micrometry in cell studies involves measuring the dimensions of cells and their components using microscopes.

Micrometry Techniques

- 1. Eyepiece Micrometer:** A glass disk with a fine scale engraved on it, inserted into the microscope eyepiece.
- 2. Stage Micrometer:** A slide with a finely divided scale, used to calibrate the eyepiece micrometer.

Procedure in Micrometry

1. Preparation

- Ensure that your microscope is correctly set up and clean.
- Insert the eyepiece micrometer into the microscope eyepiece.
- Place the stage micrometer slide on the microscope stage.

2. Calibration

- Focus the microscope on the stage micrometer.
- Align the scale of the eyepiece micrometer with the scale of the stage micrometer.
- Count how many divisions on the eyepiece micrometer correspond to a known length on the stage micrometer.
- Calculate the value of one division of the eyepiece micrometer in micrometers (μm). This can be done using the formula

$$\text{Value of one division of eyepiece micrometer } (\mu\text{m}) = \frac{\text{Known length on stage micrometer } (\mu\text{m})}{\text{Number of divisions on eyepiece micrometer}}$$

For example, if 10 division on the eyepiece micrometer align with 100 μm on the stage micrometer, then one division on the eyepiece micrometer equals:

$$10 \text{ division} = 100 \text{ micrometer}$$

$$1 \text{ division} = \frac{100}{10} \text{ micrometer}$$

$$\text{Therefore } 1 \text{ division} = 10 \text{ micrometer}$$

Measurement

- Replace the stage micrometer with the specimen slide.
- Focus on the cell or structure you wish to measure.
- Align one end of the structure with a division on the eyepiece micrometer.
- Count the number of divisions that span the structure.
- Multiply the number of divisions by the calibration factor (value of one division) to determine the actual size in micrometers.

Example Calculation

Let's say you have calibrated your eyepiece micrometer and found that each division equals 10 μm .

1. Place the specimen slide on the stage and focus on the cell.
2. Align one end of the cell with the zero mark on the eyepiece micrometer.
3. Suppose the cell spans 8 divisions on the eyepiece micrometer.

To calculate the actual size of the cell:

$$\text{Cell Size} = \text{Number Division} \times \text{Value per Division}$$

$$\text{Cell Size} = 8 \text{ Divisions} \times 10 \mu\text{m per division} = 80 \mu\text{m}$$

Summary

1. Calibrate the eyepiece micrometer with the stage micrometer.
2. Measure the specimen using the calibrated eyepiece micrometer.
3. Calculate the size by multiplying the number of divisions by the calibration factor.

This procedure allows for precise measurement of cells and their components, which is crucial for various biological and medical studies.

ISOLATION OF NUCLEUS AND STAINING OF THE NUCLEUS BY ANY NUCLEAR STAIN

Isolation of Nucleus

Isolating nuclei from cells involves breaking open the cells and separating the nuclei from other cellular components. Here's a general protocol for isolating nuclei from tissue or cell cultures:

Materials Needed

- Homogenization buffer (e.g., 0.25 M sucrose, 10 mM Tris-HCl pH 7.4, 1 mM MgCl₂, 1 mM DTT, and protease inhibitors)
- Centrifuge and centrifuge tubes
- Homogenizer (e.g., Dounce homogenizer)
- Micropipettes and tips
- Glass slides and coverslips

Procedure

1. Cell Lysis

- Collect and wash cells or tissue to remove any medium or debris.
- Resuspend the sample in a cold homogenization buffer.
- Homogenize the sample using a Dounce homogenizer to break open the cells. Use gentle strokes to avoid shearing the nuclei.

2. Centrifugation

- Transfer the homogenate to centrifuge tubes.
- Centrifuge at low speed (e.g., 600-800 g for 10 minutes) to pellet intact cells, cell debris, and large organelles. The nuclei will remain in the supernatant.
- Carefully transfer the supernatant to new centrifuge tubes without disturbing the pellet.

3. Nuclei Isolation

- Centrifuge the supernatant at a higher speed (e.g., 2000-3000 g for 10 minutes) to pellet the nuclei.
- Discard the supernatant and gently resuspend the nuclear pellet in a fresh buffer if needed.

4. Purification (optional)

- For further purification, the nuclear pellet can be resuspended in a sucrose gradient and centrifuged to separate the nuclei based on density.

Staining of the Nucleus

Once isolated, nuclei can be stained using a variety of nuclear stains to visualize them under a microscope. Common nuclear stains include Hematoxylin, DAPI and Hoechst stains.

Example Protocol for DAPI Staining

Materials Needed

- DAPI (4',6-diamidino-2-phenylindole)
- Phosphate-buffered saline (PBS)
- Mounting medium (e.g., VECTASHIELD)

Procedure

1. Fixation

- Place the isolated nuclei on a glass slide.
- Fix the nuclei by incubating with 4% paraformaldehyde in PBS for 10 minutes at room temperature.
- Wash the slide with PBS to remove the fixative.

2. Staining

- Incubate the nuclei with DAPI solution (1 $\mu\text{g}/\text{mL}$ in PBS) for 5-10 minutes in the dark.
- Wash the slide with PBS to remove excess stain.

3. Mounting

- Apply a drop of mounting medium to the stained nuclei.
- Place a coverslip over the sample, avoiding air bubbles.
- Seal the edges with nail polish or another sealant if long-term storage is needed.

4. Observation

- Observe the stained nuclei under a fluorescence microscope using the appropriate filter set for DAPI (excitation at ~ 358 nm and emission at ~ 461 nm).

Summary

- 1) **Isolate nuclei** using homogenization and differential centrifugation.
- 2) **Stain the nuclei** with a suitable nuclear stain like DAPI following fixation.
- 3) **Mount and observe** the stained nuclei under a microscope.

These steps ensure effective isolation and visualization of nuclei for further biological analysis.

STUDY OF CONSTITUTIVE HETEROCHROMATIN (BARR BODY)

Constitutive heterochromatin refers to regions of the chromosome that remain highly condensed and transcriptionally inactive throughout the cell cycle. The Barr body is a well-known example of constitutive heterochromatin, representing the inactivated X chromosome in female mammals. Studying Barr bodies can provide insights into epigenetic regulation, chromosomal structure, and X-chromosome inactivation (XCI).

Background

- **Barr Body:** Discovered by Murray Barr and Ewart Bertram in 1949, it is a dense, dark-staining spot found in the nuclei of female cells. It represents an inactivated X chromosome.
- **X-Chromosome Inactivation:** A process where one of the two X chromosomes in female mammals is randomly inactivated to balance the gene dosage between males (XY) and females (XX).

Techniques for Studying Barr Bodies

1. Cytological Techniques

- **Light Microscopy:** Traditional method to identify Barr bodies in interphase nuclei using specific stains.
- **Fluorescence Microscopy:** Modern approach using fluorescent dyes and antibodies to visualize Barr bodies more precisely.

2. Molecular Techniques

- **Fluorescence In Situ Hybridization (FISH):** Allows for the specific detection of X chromosomes using labeled DNA probes.
- **Immunofluorescence:** Uses antibodies against specific histone modifications (e.g., H3K27me3) or proteins (e.g., XIST RNA) associated with the inactivated X chromosome.

Procedure for Identifying Barr Bodies

1. Sample Preparation

- Obtain cells from a female individual, typically from buccal swabs, blood smears or cultured fibroblasts.
- Prepare slides with cell samples and fix them using methanol-acetic acid (3:1) or another suitable fixative.

2. Staining

Classical Staining

- Stain the fixed cells with a nuclear stain such as Giemsa or Toluidine Blue. Barr bodies appear as darkly stained spots in the nucleus.

Fluorescent Staining

- Use DAPI (4',6-diamidino-2-phenylindole) to stain DNA, highlighting the dense heterochromatin of the Barr body.
- Optionally, perform FISH using an X-chromosome specific probe to confirm the identity of the Barr body.

3. Visualization

- Examine the stained slides under a light microscope or fluorescence microscope.
- Identify the Barr body as a dense, dark-staining spot (in classical staining) or a bright spot (in fluorescent staining) near the nuclear membrane.

Procedure for Immunofluorescence Detection

1. Fixation and Permeabilization

- Fix cells on slides with 4% paraformaldehyde for 10 minutes.
- Permeabilize cells with 0.1% Triton X-100 in PBS for 10 minutes.

2. Blocking

- Incubate slides in blocking solution (e.g., 1% BSA in PBS) for 30 minutes to prevent non-specific binding.

3. Primary Antibody Incubation

- Incubate slides with primary antibody against H3K27me3 or XIST RNA overnight at 4°C.

4. Secondary Antibody Incubation

- After washing, incubate slides with a fluorescently labeled secondary antibody for 1 hour at room temperature.

5. Mounting

- Apply a mounting medium with DAPI and cover with a cover slip.

6. Microscopy

- Visualize using a fluorescence microscope, looking for co-localization of DAPI-stained chromatin and specific fluorescence signals indicative of the Barr body.

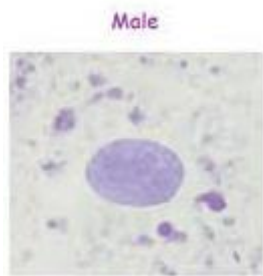
Studying Barr bodies involves

1. **Sample Preparation:** Collect and fix cells.
2. **Staining:** Use classical or fluorescent stains to visualize Barr bodies.
3. **Visualization:** Identify Barr bodies under a microscope.
4. **Immunofluorescence:** Use antibodies to detect specific markers of the inactivated X chromosome.

These methods help researchers understand the structure and function of constitutive heterochromatin and the mechanisms behind X-chromosome inactivation.



An interphase epithelial cell from a human female shows a dark staining Barr-body in the nucleus



An interphase epithelial cell from a human male does not show a Barr-body in the nucleus.

STAINING OF MITOCHONDRIA BY JANUS GREEN B IN ORAL MUCOSA OR ANY SUITABLE TISSUE

Staining of Mitochondria Using Janus Green B

Janus Green B is a vital stain used to specifically stain mitochondria in living cells due to its affinity for these organelles. The following is a detailed procedure for staining mitochondria in oral mucosa or other suitable tissue samples.

Materials Needed

- Janus Green B stain
- Oral mucosa or suitable tissue sample (e.g., cheek cells, liver cells)
- Microscope slides and cover slips
- Phosphate-buffered saline (PBS) or normal saline
- Microscope
- Dropper or pipette

Procedure

1. Collection of Tissue Sample

- For oral mucosa: Gently scrape the inner cheek with a sterile swab or tongue depressor to collect epithelial cells.
- For other tissues: Prepare thin sections of tissue using standard histological techniques.

2. Preparation of the Slide

- Place a small drop of PBS or normal saline on a microscope slide.
- Transfer the collected cells or tissue section onto the drop, ensuring an even spread.
- Cover the sample with a coverslip to avoid air bubbles.

3. Staining with Janus Green B

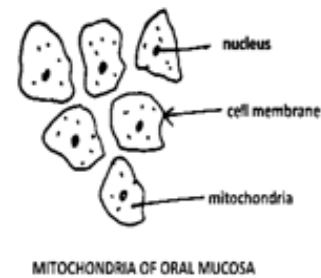
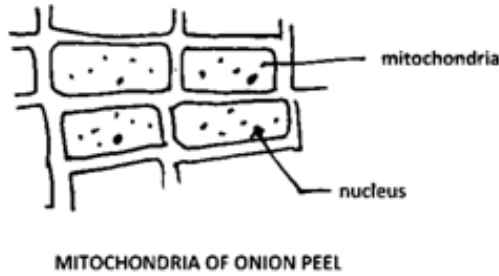
- Add a drop of Janus Green B stain to the edge of the coverslip. The stain will be drawn under the coverslip by capillary action.
- Allow the stain to act for about 1-2 minutes. Janus Green B penetrates living cells and is reduced to a colorless form in the cytoplasm but remains blue-green in the mitochondria.

4. Rinsing

- Gently rinse the slide with a few drops of PBS or normal saline to remove excess stain. Be careful not to wash away the sample.

5. Observation

- Observe the stained cells under a light microscope. Adjust the focus to clearly visualize the mitochondria.
- Mitochondria will appear as blue-green or greenish structures within the cytoplasm of the cells.



Notes and Tips

- **Fresh Stain:** Ensure that the Janus Green B stain is fresh and properly diluted according to the manufacturer's instructions.
- **Live Cells:** Janus Green B is a vital stain and works best with live cells. Ensure the cells are fresh and handled gently to maintain viability.
- **Timing:** Do not over-stain. Prolonged exposure to the stain can kill the cells and affect the staining quality.
- **Microscopy:** Use a microscope with good resolution to distinguish the small mitochondrial structures clearly.

Troubleshooting

- **Weak Staining:** If the mitochondria do not stain well, ensure the stain is fresh and the cells are live. Adjust the staining time if necessary.
- **Excessive Background Staining:** Rinse the slides gently but thoroughly to remove excess stain that can obscure the observation of mitochondria.
- **Cell Viability:** Handle the cells carefully to avoid damaging them, which can impact the uptake and retention of the stain.

The Janus Green B staining technique is a useful method for visualizing mitochondria in live cells from oral mucosa or other tissues. By following this procedure, one can effectively stain and observe mitochondria, gaining insights into their structure and distribution within cells.

STUDY OF OSMOSIS USING SALT SOLUTIONS

Osmosis is the movement of water molecules across a selectively permeable membrane from a region of lower solute concentration to a region of higher solute concentration. This process can be studied using salt solutions and biological materials such as plant cells (e.g., potato or onion) or synthetic materials like dialysis tubing. Below is a detailed procedure for studying osmosis using potato slices and salt solutions.

Materials Needed

- Fresh potato
- Salt (sodium chloride)
- Distilled water
- Beakers or cups
- Knife or scalpel
- Ruler or caliper
- Balance (for measuring mass)
- Paper towels

Procedure

Preparation of Salt Solutions

- Prepare a series of salt solutions with different concentrations (e.g., 0%, 1%, 3%, 5%, and 10% NaCl) using distilled water.
- Label the beakers with the respective concentrations.

Preparation of Potato Slices

- Peel the potato and cut it into uniform slices or cylinders (e.g., 1 cm in diameter and 3 cm in length).
- Measure and record the initial mass and length of each potato piece using a balance and ruler.

Incubation in Salt Solutions

- Place one potato slice into each beaker containing different salt concentrations.
- Ensure that the potato slices are fully submerged in the solutions.
- Allow the potato slices to sit in the solutions for a set period (e.g., 1-2 hours).

Post-Incubation Measurements

- Remove the potato slices from the solutions and gently blot them with paper towels to remove excess solution.
- Measure and record the final mass and length of each potato slice.

Observation and Data Recording

Record the initial and final mass and length of the potato slices for each salt concentration. The data table might look like this

Salt Concentration (%)	Initial Mass (g)	Final Mass (g)	Initial Length (cm)	Final Length (cm)
1%				
3%				
5%				
10%				

Analysis

Change in Mass and Length

- Calculate the change in mass and length for each potato slice by subtracting the initial measurements from the final measurements.
- Plot graphs of change in mass and change in length against salt concentration.

Interpretation

- In distilled water (0% NaCl), potato cells will gain water, becoming turgid due to the higher water potential outside the cells.
- In higher salt concentrations, potato cells will lose water and become flaccid or plasmolyzed due to the lower water potential outside the cells.

Summary

The experiment demonstrates osmosis by showing how potato cells gain or lose water when placed in solutions of varying salt concentrations. This process is driven by differences in water potential, with water moving from regions of higher potential (lower solute concentration) to regions of lower potential (higher solute concentration). By observing and measuring changes in the mass and length of potato slices, one can visually and quantitatively understand the principles of osmosis.

STUDY OF MITOSIS IN ONION ROOT TIPS

Study of Mitosis in Onion Root Tips

Mitosis is a type of cell division that results in two daughter cells each having the same number and kind of chromosomes as the parent nucleus. Studying mitosis in onion root tips is a common laboratory exercise due to the rapid growth and easily visible chromosomes in these cells.

Objectives

- Understand the stages of mitosis.
- Identify and observe the different stages of mitosis in onion root tip cells.

Materials Needed

- Onion root tips
- Microscope slides and cover slips
- Staining solution (e.g., acetocarmine or toluidine blue)
- Microscope
- Scalpel or razor blade
- Forceps
- Dropper
- Fixative solution (e.g., acetic acid or ethanol-acetic acid mixture)

Procedure

1. Preparation of Onion Root Tips

- Grow onions in water for a few days until roots are about 1-2 cm long.
- Cut the root tips (1-2 mm) with a scalpel or razor blade.

2. Fixation

- Place the root tips in a fixative solution for about 10 minutes to preserve the cellular structures.

3. Staining

- Transfer the fixed root tips to a staining solution and leave for 10-15 minutes. This helps in highlighting the chromosomes.

4. Maceration

- Gently macerate (soften) the root tips with a drop of 1 M HCl for 5 minutes. This helps to separate the cells.

• Slide Preparation

- Place the root tip on a clean microscope slide.

- Add a drop of staining solution.
- Cover with a cover slip and gently press to spread the cells into a thin layer. Be careful not to move the cover slip sideways as this can break the cells.

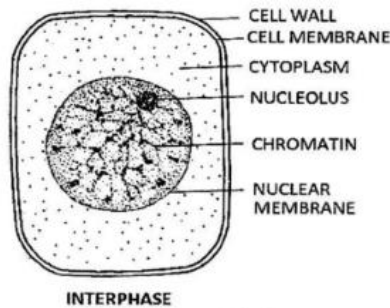
5. Microscope Observation

- Start with the low power objective (10x) to locate the root tip cells.
- Switch to a higher power objective (40x or 100x) to observe the stages of mitosis.

Stages of Mitosis

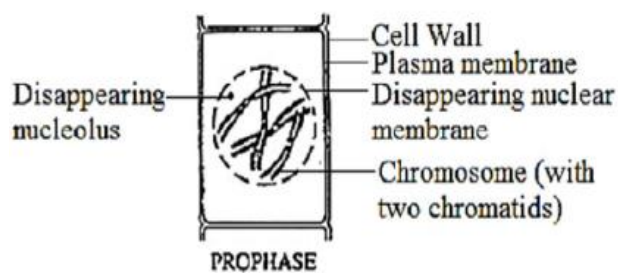
1. Interphase

- The cell is not actively dividing but is preparing for division.
- Chromosomes are not visible as they are in the form of chromatin.
- The nucleolus and nuclear membrane are intact.



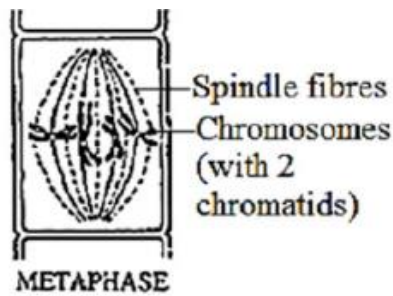
2. Prophase

- Chromosomes condense and become visible as distinct structures.
- The nucleolus disappears and the nuclear membrane starts to disintegrate.
- Spindle fibers begin to form.



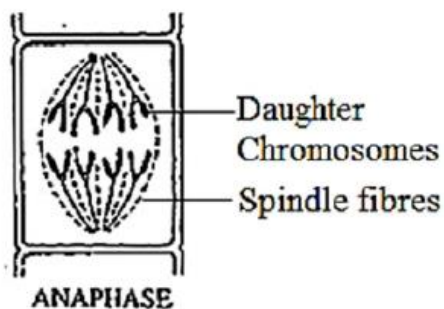
3. Metaphase

- Chromosomes line up along the metaphase plate (equatorial plane) of the cell.
- Spindle fibers attach to the centromeres of the chromosomes.



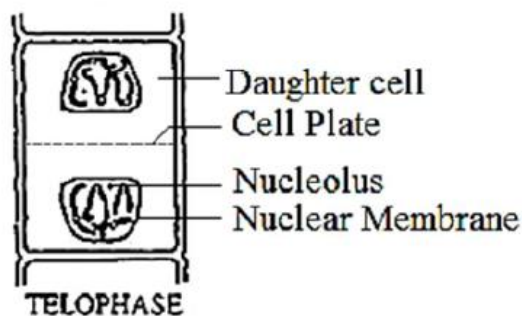
4. Anaphase

- Sister chromatids (identical halves of a chromosome) are pulled apart by the spindle fibers toward opposite poles of the cell.
- The cell elongates.



5. Telophase

- Chromatids reach the opposite poles and begin to decondense back into chromatin.
- The nuclear membrane re-forms around each set of chromosomes, and the nucleolus reappears.
- Cytokinesis (division of the cytoplasm) usually begins, leading to the formation of two daughter cells.



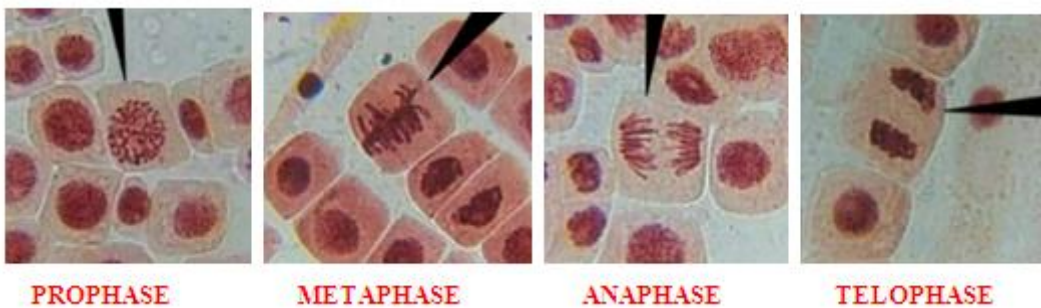
6. Cytokinesis

- The final stage where the cytoplasm divides, resulting in two distinct daughter cells.

Observations and Analysis

- Draw and label each stage of mitosis as observed under the microscope.
- Count the number of cells in each stage to understand the relative duration of each phase.
- Compare the stages with textbook images to confirm accurate identification.

The study of mitosis in onion root tips allows for the observation of the different stages of cell division in a simple and clear manner. By preparing the slides and observing the cells under a microscope, one can gain a better understanding of the process of mitosis and the behavior of chromosomes during cell division.



STUDY OF MEIOSIS – OBSERVATION OF PERMANENT SLIDES

Study of Meiosis – Observation of Permanent Slides

Meiosis is a specialized form of cell division that results in four daughter cells, each with half the number of chromosomes of the parent cell. This process is essential for sexual reproduction and genetic diversity. Studying meiosis using permanent slides allows us to observe the different stages and understand the mechanisms involved.

Objectives

- Understand the stages of meiosis.
- Identify and observe the different stages of meiosis in permanent slides.

Materials Needed

- Permanent slides of meiosis (e.g., slides of lily anthers or grasshopper testes).
- Microscope.
- Textbook or reference images for comparison.

Procedure

1. Preparation

- Obtain permanent slides that show various stages of meiosis.
- Set up your microscope, starting with the low power objective.

2. Slide Observation

- Place the slide on the stage of the microscope.
- Use the low power objective (10x) to locate the cells undergoing meiosis.
- Once located, switch to a higher power objective (40x) to observe the stages in detail.

Stages of Meiosis

Meiosis consists of two consecutive divisions: Meiosis I and Meiosis II. Each has its own stages.

Meiosis I

1. Prophase I

- Chromosomes condense and become visible.
- Homologous chromosomes pair up in a process called synapsis, forming tetrads.
- Crossing over (exchange of genetic material between homologous chromosomes) occurs, leading to genetic recombination.
- The nuclear membrane disintegrates, and spindle fibers begin to form.

2. Metaphase I

- Tetrads line up along the metaphase plate.

- Spindle fibers attach to the centromeres of homologous chromosomes.

3. Anaphase I

- Homologous chromosomes are pulled to opposite poles of the cell by the spindle fibers.
- Sister chromatids remain attached at their centromeres.

4. Telophase I

- Chromosomes reach the poles and may decondense slightly.
- The nuclear membrane may re-form around each set of chromosomes.
- Cytokinesis (division of the cytoplasm) usually occurs, resulting in two daughter cells with half the original chromosome number (haploid).

Meiosis II

1. Prophase II

- Chromosomes condense again if they had decondensed.
- The nuclear membrane disintegrates if it had re-formed.
- Spindle fibers form and attach to chromosomes.

2. Metaphase II

- Chromosomes line up along the metaphase plate in each of the two daughter cells.
- Spindle fibers attach to the centromeres of sister chromatids.

3. Anaphase II

- Sister chromatids are pulled apart to opposite poles of the cells.
- Each chromatid is now an individual chromosome.

4. Telophase II

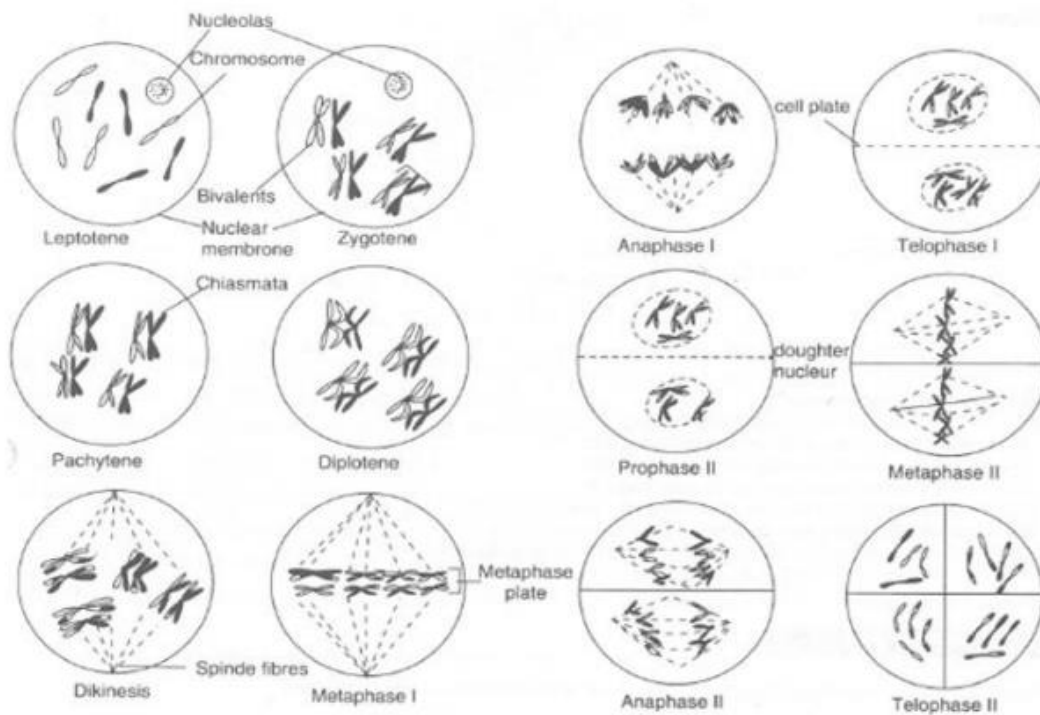
- Chromosomes reach the poles and begin to decondense.
- Nuclear membranes re-form around each set of chromosomes.
- Cytokinesis occurs, resulting in four haploid daughter cells, each with a unique combination of genetic material.

Observations and Analysis

- **Prophase I:** Look for paired homologous chromosomes and possible chiasmata (sites of crossing over).
- **Metaphase I:** Identify the tetrads aligned along the metaphase plate.
- **Anaphase I:** Observe the separation of homologous chromosomes.
- **Telophase I:** Note the formation of two haploid cells.

- **Prophase II to Telophase II:** Identify the stages similar to mitosis but occurring in haploid cells.

By observing permanent slides of meiosis, you can visualize and understand the complex process of meiotic cell division. This exercise helps highlight the differences between meiosis and mitosis, particularly the reductional division in Meiosis I and the equational division in Meiosis II. Understanding meiosis is crucial for comprehending genetic diversity and the fundamentals of sexual reproduction.



STUDY OF ANEMIA AND DIABETIC WOUND AND HISTOLOGY OF CANCEROUS TUMOR

ANEMIA

Anemia is a condition characterized by a deficiency in the number or quality of red blood cells (RBCs) or hemoglobin, leading to reduced oxygen transport in the body. Common causes include nutritional deficiencies (iron, vitamin B12, folate), chronic diseases, genetic disorders and bone marrow problems.

Types of Anemia

- 1. Iron-Deficiency Anemia:** Due to insufficient iron intake or absorption.
- 2. Vitamin-Deficiency Anemia:** Caused by lack of vitamin B12 or foliate.
- 3. Hemolytic Anemia:** Resulting from the premature destruction of RBCs.
- 4. Aplastic Anemia:** A rare condition where the bone marrow doesn't produce enough new RBCs.
- 5. Sickle Cell Anemia:** A genetic disorder causing abnormal hemoglobin, leading to distorted (sickle-shaped) RBCs.

Diagnosis and Treatment

- **Diagnosis:** Complete Blood Count (CBC), blood smear, iron studies, vitamin B12 and folate levels, bone marrow biopsy (if necessary).
- **Treatment:** Depends on the type and cause. Iron supplements for iron-deficiency anemia, vitamin B12 injections for pernicious anemia, medications to treat underlying chronic diseases, and sometimes blood transfusions.

Diabetic Wounds

Diabetic wounds, particularly diabetic foot ulcers, are a common complication in individuals with diabetes. High blood sugar levels can lead to nerve damage (neuropathy) and poor blood circulation, making wounds slow to heal and prone to infection.

Characteristics

- **Neuropathy:** Reduced sensation in extremities, leading to unnoticed injuries.
- **Poor Circulation:** Impaired blood flow, hindering the healing process.
- **Infection Risk:** Elevated due to compromised immune function and poor healing.

Management

- 1. Glycemic Control:** Maintaining optimal blood sugar levels.

- 2. Wound Care:** Regular cleaning, debridement (removal of dead tissue), and dressing changes.
- 3. Infection Control:** Use of antibiotics if infection is present.
- 4. Offloading:** Reducing pressure on the wound through specialized footwear or devices.
- 5. Surgical Interventions:** In severe cases, procedures to improve blood flow or remove infected tissue.

Histology of Cancerous Tumors

Histology is the study of tissues under the microscope. The histological examination of cancerous tumors involves analyzing tissue samples to determine the type, grade and stage of cancer, which is crucial for diagnosis and treatment planning.

Key Histological Features:

- 1. Cellularity:** Density and appearance of cells.
- 2. Cell Morphology:** Size, shape, and structure of cancer cells.
- 3. Mitotic Activity:** Rate of cell division, indicating how quickly the tumor is growing.
- 4. Invasion:** Extent to which cancer cells invade surrounding tissues.
- 5. Differentiation:** How much the cancer cells resemble normal cells, with poorly differentiated cells being more aggressive.

Diagnostic Tools:

- 1. Biopsy:** Removal of a small tissue sample for histological examination.
- 2. Staining Techniques:** Use of dyes and stains to highlight cellular structures (e.g., H&E staining, immunohistochemistry).
- 3. Molecular Testing:** Identifying genetic mutations and markers that can guide targeted therapies.

Implications for Treatment

- **Histological Grade:** Low-grade tumors are less aggressive, while high-grade tumors are more aggressive and likely to spread.
- **Staging:** Determining the extent of cancer spread (localized vs. metastasized).
- **Targeted Therapy:** Based on specific genetic mutations or markers identified in the tumor cells.

Understanding these conditions at a detailed level helps in developing effective treatment strategies and improving patient outcomes. Each area involves multidisciplinary approaches, integrating clinical practice with advanced diagnostic techniques and research.

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SKELETON PAPER FOR PRACTICAL EXAMINATION

B. Sc. Part – I Semester – I

(Major/Minor) ZOOLOGY Practical - I

DSC –Practical -I (Animal Diversity and Cell Biology)

Marks-50

Q. No. 1) Useso as to study it's System	10
Q. No. 2) Cytological experiments	08
Q. No. 3) Cytological Preparation	07
Q. No. 4) Distribution of animals with their zoogeographical regions	05
Q. No. 5) Categorization of animals as per the abundance	05
Q. No. 6) Preparation of stained slide of mitosis and identification of stages	10
Q. No. 7) Journal	

PRACTICAL HANDBOOK OF ZOOLOGY (B. Sc. I)

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