

# DIVERSITY AMONG ANIMALS

## \* PARAZOA

Phylum Porifera

## \* METAZOA

Phylum coelentrata to Phylum chordata

## \* DIPLOBLASTIC

Phylum Coelentrata

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## \* TRIPLOBLASTIC

Phylum Platyhelminthes to Phylum chordata

### 1. Acoelomates:

Phylum Platyhelminthes

### 2. Pseudo coelomates:

Phylum Aschelminthes

### 3. Coelomates:

Phylum Annelida to Phylum Chordata

#### a) Protostomes:

Mollusks, Annelids, Arthropods

#### b) Deuterostomes:

Echinoderms, chordates

# PHYLUM PORIFERA

\* Wording : Latin Porous → minute holes  
ferra → to bear

\* Level of organization: cellular

\* pores → ostia

\* Most primitive metazoans

\* Sponges

\* Habitat : Aquatic , mostly marine

\* Body shape : Tubular

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\* Support : Internal

spongin → collagen protein

spicules → crystalline spikes

\* osculum : a large aperture in a sponge through which water is expelled

\* spongocoel → cavity

\* Tubular walls :

outer layer → pinacoderm made of flattened cells called pinacocytes

Inner layer → choanoderm made of flattened collar cells called choanocytes

\* Muscular : None

\* Circulatory : None

\* Respiratory : Diffusion through choanocytes

\* Flagellated cells

\* Amoebocytes : → nutritive

→ produce ova and sperm

\* Digestion: No digestive cavity

1. Intracellular digestion → in collar cells (phagocytosis)
2. Extracellular digestion → in spongocoel

\* Characteristic Feature: Canal system

\* Food of Porifera: Phytoplankton, zooplankton, protozoans, crustacea and other small organisms.

But 80% → Dead Decaying Organic Matter

\* Locomotion: No locomotory organ hence sessile

\* Reproduction:

Asexual → Budding and Gemmule formation

Sexual → Formation of eggs and sperms

Excretion: Through Diffusion

Nervous System: Absent

→ presence of neurosensory cells and neurons

Skeletal support: present except in class mykospingida

Skeleton forms:

1. spicules → carbonates of lime or silica
2. Spongin → collagen protein (fibrous protein)

\* Classes

1. Class Mykospingida (lacking skeleton)

2. Family Cladorhizidae (Predatory sponges)

Examples

Marine: 1. Sycon

2. Leucoselenia

3. Euplectella or Venus flower basket

Freshwater: 4. Spongilla

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# PHYLUM COELENTRATA (CNIDARIA)

✧ Wording : Greek kolios → hollow  
enteron → intestine  
(hollow, sac like intestine)

✧ characteristic feature : specialized cells, cnidocytes which give rise to nematocyst (special stinging cells)

✧ habitat: Aquatic (both marine + freshwater)

✧ Level of organization: tissue and organ

✧ Germ Layers :

Ectoderm → protection + give rise to nematocyst

Endoderm → specialized for digestion

✧ Digestive System: Incomplete

→ Gastrovascular cavity or enteron

→ food is digested in gastrovascular cavity by action of enzyme released by glandular cells of endoderm.

✧ Polymorphism: zooids

1. Polyps (tube like body)

2. Medusae (umbrella like body)

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✧ special feeding zooids: called gastrozooids → only perform function of nutrition for whole colony (found in obelia and order Siphonophora)

✧ Alternation of Generation or Metagenesis:

e.g in Obelia

Polyp form called blastostyle → Asexual Generation

Medusae → saucer shaped → Sexual Generation

Asexual Generation alternates with sexual generation

✗ Nutrition : Carnivorous

→ zooplanktons , crustaceans , insect larva , small fish

✗ Locomotion : Many colonial forms are sessile e.g obelia , corals etc

A large number move actively

✗ Jet-propulsion method : in Jelly fishes

\* *Physalia pelagica* → Portuguese man of war have swim rate 12.1 cm/sec

✗ Respiration : Diffusion

\* Excretion : Diffusion

✗ Reproduction :

Asexual → Budding , Regeneration , Fragmentation

Sexual → eggs and sperms found in ovaries and testes

Mostly , sexes are separate

✗ Order : Siphonophora

✗ Examples :

Hydra , Obelia , Jelly Fish , Sea Anemone , Corals

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# PHYLUM PLATYHELMINTHES

- \* Wording : Greek      Platys → Flat  
   Helminthes → worms
- \* Segmentation : Absent  
    Either unsegmented or superficially segmented
- \* Cilia : In free living forms → Present  
          In Parasitic Forms → Absent
- \* Cuticle : Present in parasitic forms
- \* Organs of attachment : Hooks or suckers
- \* Digestive System :  
    In free living Form → Developed  
    In Parasitic Forms :  
        Class Trematoda → Poorly Developed  
        Class Cestoda → Absent
- \* Circulatory System : Absent
- \* Respiratory System : Absent
- \* Excretory System : Few flame cells attached with ducts  
    which open at excretory pore
- \* Nervous System : A pair of anterior cerebral ganglia and  
    a ventral ganglion connected by nerve ring and one or  
    three nerve cords.
- \* Muscular Layer : well developed in free living forms and help  
    in locomotion
- \* Reproductive System : well developed  
    → gonads, ducts and copulatory organs  
    → Eggs are large in number and small with yolk  
    → Both self and cross fertilization  
    → Fertilization is always internal

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\* Larvae: Eggs → New individual (as in Planaria and Tape worm)  
Eggs → Larvae → Adult (as in Liver fluke)

\* Regeneration:

Class Turbellaria → Present

Class Trematoda and Cestoda → Absent

\* Species Diversity: 15,000 species

\* Size: Planaria → 10mm

Tape worm → 16 ft (5 meters)

\* Classes:

1. Class Turbellaria → free living eg Planaria

Parasitic:

Class Trematoda → e.g liver flukes

Class Cestoda → e.g Tape worm

\* Examples:

1. Planaria (Dugesia)
2. Liver fluke (*Fasciola hepatica*)
3. Tape worm (*Taenia solium*)
4. Human Tape worm (*Taenia saginata*)
5. Schistosoma (Blood fluke)

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# PHYLUM ASCHELMINTHES

\* Classification by Hegner and Engemann

1. Class Gastrotricha
2. Class Rotifera
3. Class Kinorhyncha (spiny, marine, microscopic)
4. Class Nematoda (largest class)
5. Class Nematomorpha (resemble Nematoda)

## PHYLUM NEMATODA (ROUND WORMS)

\* Naming: Greek Nematoda → Thread

\* Segmentation: Absent

\* Cilia: Absent

\* Cuticle: Present for protection

\* Respiratory System: Absent

\* Circulatory System: Absent

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Fluid in body cavity → Performs function of blood

\* Digestive System:

well developed alimentary canal

Anterior Opening → mouth

Posterior Opening → Anus

\* Excretory System: consist of two longitudinal canals on each side which open on the ventral side by a small excretory pore close behind the mouth

\* Nervous System: Nerve ring which encircles the pharynx and sends its branches to different parts of the body.

\* Muscular System:

Muscles: Four longitudinal bands

Circular Muscles → Absent

show whipping movements



\* Sexes: Generally separate

Males smaller than females

\* Regeneration: Absent

\* Colour: Mostly white or cream colored

*Ascaris lumbricoides* → reddish tinge due to Hb

\* Reproduction: sexual

Male: Testes → long, coiled thread with seminal vesicle which posteriorly opens into rectum by short ejaculatory duct

Female: very much coiled ovaries → uterus → two uteri combine to form vagina

\* Habitat: Aquatic (Fresh + Marine), Terrestrial (soil)

\* Examples:

1. *Ascaris lumbricoides*

2. Pin worm (*Enterobius vermicularis*)

1. *Ascaris lumbricoides*

→ most common animal of Nematoda

→ endoparasite in small intestine of man

→ lives in lumen (cavity of small intestine)

→ Female: 8-16 inch

→ Male: 6-12 inch

→ Anterior Part:

Male: Pointed

Female: Pointed

→ Posterior Part:

Male: curved with two spine like structures called penial setae

Female: Not sharply pointed

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\* Eggs :

Total → 27 million eggs

Eggs per day → 200,000

## 2. Enterobius vermicularis (Pin worm)

→ human parasite

→ mostly parasitize children

→ lives in caecum, colon, appendix of host

→ cause severe itching of anus, inflammation of mucus membrane of colon and appendix

→ Sleeplessness (insomnia)

→ loss of appetite

# PHYLUM MOLLUSKA

- \* Naming: Latin Molluscus → soft
- \* soft bodies
- \* Diversity: Second largest phylum
  - More than 80,000 species
  - 35,000 fossil forms
- \* Shell: → calcium carbonate secreted by the mantle
  - one piece or two piece shell
  - may be internal, reduced or even absent
- \* Body Plan: head, dorsal visceral hump, ventral muscular foot
- \* Mantle: tough, fleshy membrane
- \* Mantle Cavity: → space b/w mantle and body
  - Here kidneys and anus open
  - Gills present in mantle cavity
- \* Radula: Rasping tongue
- \* Respiration: through gills
- \* Digestive System: well developed
- \* Circulatory System: Blood vascular system
  - single heart (1 ventricle, 2 auricles)
  - arteries, veins
  - haemocoelic chambers
  - No respiratory pigment
  - colorless blood
  - sometimes blue-colored pigment hemocyanin is present.  
Hemocyanin can transport 3 times more  $O_2$  than Hb
- \* Nervous System: 3 pairs of orange colored ganglia connected by nerve cords. Nerves arise from these ganglia and enter parts of body

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Reproduction: sexual

→ separate sexes

→ Testes : white

→ ovaries : reddish

→ Fertilization is external and performed in gills

Larva: Glochidium larva

Examples:

1. Garden snail (*Helix aspersa*)
2. Slug (*Limax maximus*)
3. Freshwater mussel (*Anodonta grandis*)
4. Marine mussel (*Mytilus edulis*)
5. Oyster (*Ostrea lurida*)
6. Squid (*Loligo pealii*)
7. Cuttle fish (*Sepia officinalis*)
8. Octopus (*Octopus bairdi*)

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# PHYLUM ANNELIDA

- \* First ~~two~~<sup>true</sup> coelomates
- \* Wordings: Greek annelus : little ring
- \* Ring worms
- \* Segmented worms
- \* Body Shape: → cylindrical (earthworms)  
→ dorso-ventrally compressed (Neries)
- \* Segmentation: Present  
Metamerically segmented
- \* Circulatory System: Closed circulatory system  
→ Pseudohearts (4 to 5 pairs of hearts)  
→ Red blood color due to Haemoglobin
- \* Digestive System: well developed esp in free living species  
→ well formed digestive organs
- \* Excretory System: Metamerically arranged nephridia  
→ Nephridiopore (external opening of nephridia)
- \* Protection:
  1. Glandular epidermis: secretes mucous & keeps body moist
  2. Cuticle
- \* Locomotory Organs:
  1. Setae (e.g in earthworms)
  2. Parapodia (e.g in Neries)
- \* Respiration:
  1. Through general surface
  2. Through gills under parapodia (e.g in Neries)
- \* Reproduction: Sexual  
→ hermaphrodite  
→ cross fertilization is common
- \* Larva: Trochophore larva

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\* Habitat: Fresh and marine water, damp soil; some are parasitic

\* Examples:

1. Earthworm (*Pherithema posthuma*)
2. Medicinal leech (*Hirudinaria medicinalis*)
3. Neries

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## PHYLUM ARTHROPODA

\* Naming Greek Arthoros → jointed

podos → limbs or legs

\* Most successful group and largest phylum

\* Segmentation: Present

→ Metameric segmentation

\* Protection: Exoskeleton → thick cuticle made of chitin

↳ for attachment of muscles

\* Body Plan: Head, Thorax, Abdomen

\* Body Cavity: Haemocoel

\* Circulatory System: Open circulatory system

→ No respiratory pigment

→ Blood called haemolymph bcz it doesnot carry oxygen; it only carries food to different tissues of body

\* Respiration: 1. Gills (in aquatic forms)

2. Trachea → air tubes (in terrestrial forms esp. Insects)

3. Book lungs (in Arachnids)

\* Spiracles: An external respiratory organ

→ Trachea communicates with exterior through spiracles

\* Excretion:

1. Malpighian Tubules (e.g in insects)

2. Green gland or coxal gland (e.g in crustaceans)

## \* Reproduction:

- Fertilization is internal
- sexes generally separate
- sexual dimorphism

\* Social Animals: e.g. honeybees, ants, termites etc

\* Nervous System: well developed

- A pair of cerebral ganglia (simple brain) connected to double nerve cord
- Ganglion present in each segment
- Nerves arise from ganglion connect whole body

\* Sensory Organs: Eyes and antenna

\* Metamorphosis: Present

- Ecdysis or Moulting: process of casting off outer cuticle
- stadia: stages
- instar: developmental stage until sexual maturity is reached
- adult or imago: Final instar

a. Ametabola: No metamorphosis

e.g. Collembolan, other primitive wingless insects

b. Hemimetabola: Incomplete metamorphosis

e.g. cockroaches, wasps

c. Holometabola: complete metamorphosis

e.g. flies, butterflies, moths, beetles

\* Classes:

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- Arachnids → scorpion, spider etc

- Crustacean → crabs, lobster, crayfish, shrimps, prawn etc

- Onychophora → most primitive arthropods

- share characteristics with both annelids and arthropods
- 70 species, 10 genera

## GRASS HOPPER (FROM DIAGRAM)

1. Tympanum: sound detection organ
2. palps: Each of a pair of elongated segmented appendage near mouth of an arthropod, usually concerned with sense of touch and taste.
3. Crop and Gizzard:  
Crop → store food
4. seminal receptacle: storage organ for male gametes inside the female
5. gastric caeca: serve to increase the surface area of midgut; thus increasing its ability to secrete digestive enzymes and extract useful products from partially digested food

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# PHYLUM ECHINODERMATA

\* Naming : Greek echinos → spine  
derm → skin

(spiny skin)

\* Symmetry : Larval stage → Bilateral symmetry  
Adult stage → Radial symmetry

\* Habitat : exclusively marine

\* Body Form : star-shaped, spherical or cylindrical  
→ usually 5 arms are present

\* Spines and Pedicellariae

spines → form spiny skeleton made of calcareous plates  
pedicellariae → keep the body surface clear of debris and  
minute organisms

\* Body Wall :

1. Epidermis → single-layered and ciliated
2. Dermis → middle layer
3. Inner Lining of peritoneum

\* Digestive System

1. Alimentary Canal → short coiled tube
2. Digestive Glands → Pyloric caecae (ten pairs)

\* Circulatory System

- Haemal system
- No respiratory pigment
- No heart

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\* Nutrition : carnivorous

Food : mollusks such as oysters, clams, mussels, fish,  
crab and small animals

- \* Tube Feet: → help to capture prey
  - principal sense organs
  - helps in locomotion
  - exchange of gases

#### \* Excretory System:

- lack specialized organs
- Nitrogenous wastes, chiefly in the form of ammonia, diffuse out through respiratory surfaces

#### \* Respiration:

1. Papule → skin gills (in starfish)
2. Peristomeal Gills (in sea urchin)
3. Genital bursae (brittle star)
4. cloacal respiratory tract (sea cucumber)
5. Tube feet

#### \* Reproduction:

- sexes usually separate (with few exceptions)
- sexual reproduction
- Fertilization is external
- some are viviparous (give birth to young)

#### \* Regeneration: well developed

- A single arm with part of central disc regenerates into a new animal

#### \* Development: Bipinnaria larva

#### \* Amoeboid cells or amoebocytes:

- Found in coelomic fluid
- Absorb waste material
- moves out through wall of rectal caecae
- constantly produced in body

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## \* Nervous System

- primitive
- Radial ganglia containing nerve cords
- No central brain
- sense organs poorly developed
- Nerve cells in epidermal cells
- Radial nerve cord run along ambulacral groove and unite with nerve ring encircling the mouth
- eye : pigmented mass, light perceiving organ

## \* Unique Features:

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1. spines and pedicellariae
2. Ambulacral system (water vascular system)
3. Haemal system
4. Mesodermal endoskeleton of calcareous plates
5. Bilateral symmetry in larva  
Radial symmetry in adults

## \* Water Vascular System (Ambulacral system)

- A hydraulic system used for locomotion, food and waste transportation and respiration
- The system is composed of canals connecting numerous tube feet
- Madreporite : sieve-like opening of water vascular system on upper side of animal

## \* Examples

1. Star Fish (*Asterias rubens*)
2. Brittle star (*Ophiothrix fragilis*)
3. Sea urchin (*Arbacia punctulata*)
4. Sea cucumber (*Thyone briareus*)

### \* Resemblance with Hemichordates:

1. Trochophore larva of *Velvetoglossus* and veliger larva of echinoderms are similar
2. Pattern of cleavage of fertilized egg is similar.
3. Formation of mesoderm, anus, mouth and coelom is similar

### \* Resemblance with chordates

Creatin phosphate in the muscles of both echinoderms and chordates are similar which produce energy for muscular activity.

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# CLASS HEMI CHORDATA

\* worm-like animals

\* Habitat: shallow ocean bottom

\* deuterostomes

\* Body Plan:

1. Anterior protosome (proboscis)

2. Middle mesosome (collar)

3. Posterior metasome (trunk)

Every region is with coelomic compartment

\* Body Wall:

→ unicellular epidermis

→ mucous secreting cells

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\* Digestive Tract: Developed

\* Circulatory System: dorsal and ventral vessel

\* Respiration: Gill slits

\* Excretory System: single glomerulus connected to blood vessel

\* Nervous System:

→ Brain in mesosome

→ main nerve tracts present in mid dorsal and mid ventral line.

→ Notochord: Absent

\* Cleavage: Holoblastic and radial

\* Development: Tornaria Larva

→ Many make colonies

\* Examples:

1. Saccoglossus kowalevskii (acron worm)

2. Balanoglossus sp. etc

# PHYLUM CHORDATA

1. Notochord : In lower chordates → Retained  
In higher chordates (vertebrates) → Replaced by vertebral column.

2. Central, dorsal hollow nervous system

3. Gill slits → perforated pharynx

→ Always present (at least in embryonic stage)

→ In some chordates : non functional

→ Functional in fish and amphioxus

\* Division : 1. Protochordata or Acraniata  
2. Craniata

\* Protochordata : 1. Urochordata  
2. Cephalochordata

1. Urochordate :

Notochord : Free swimming larva → Present  
Adults → Absent

Also called Tunicates :

→ Body covered by tunic

→ Tunic made of tunicin

→ Tunicin, substance related to cellulose

Locomotion :

Larva → Free swimming

Adults → sessile

Examples :

1. *Ciona intestinalis*

2. *Molgula*

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## \* CEPHALOCHORDATA

Notochord: well developed in adults

Body Form: long, pointed rod

→ called sea lancelet

Locomotion: free-living

→ swim in water

Example:

Amphioxus (Branchiostoma)

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# CLASS PISCES

\* Habitat: Aquatic

\* Locomotion: Fins (paired appendages)

\* Respiration: Gills

→ Varying from 5 to 7 on each side

\* Diversity:

→ Largest group of vertebrates

→ 48% of total vertebrates

→ No. of living species : more than 29,000

\* Scales :

→ Body covered by dermal scales

→ Provide protection

→ Arise from dermis layer hence are deep seated

→ class cyclostomata lack scales

\* Circulation:

→ Two chambered heart

→ one auricle, one ventricle

→ single circulation of blood

\* Skeleton :

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→ internal skeleton

→ either bony or cartilagenous

\* Cold-Blooded : Poikilothermous

\* Classes :

1. Class cyclostomata or Agnatha

2. Class Chondrichthyes (cartilagenous fish)

3. Class Osteichthyes (Bony fish)



# 1. CLASS CYCLOSTOMATA OR AGNATHA (JAWLESS FISH)

\* Scales : Absent

\* Paired fins: Absent

\* Gills : 7 pairs

→ not covered by operculum

\* Skeleton: fibrous cartilage

\* Ectoparasites:

→ lack stomach

→ mouth adapted for sucking

→ circular mouth

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\* Examples:

1. Lamprey (*Petromyzon marinus*)

2. Hag fish (*Maxine glutinosa*)

3. Eels

# 2. CLASS CHONDRICTHYES (CARTILAGENOUS FISH)

\* Skeleton : cartilage

\* Body Plan: streamlined bodies

\* Habitat : Marine

\* Mouth : ventral

\* Scales : small and numerous placoid scales

→ give skin touch of sandy paper

\* Circulatory system: many pairs of aortic arches

\* tails : heterocercal

→ dorsal lobe is longer than ventral lobe

- \* Respiration: 5-7 pairs of gills
- \* operculum: Absent
- \* nutrition: carnivorous
- \* Swim bladder: Absent
- \* sexes are separate
- \* many of them are viviparous
- \* Examples:
  - sharks, rays, skates, chimaeras

### 3. CLASS OSTEICHTHYES (BONY FISH)

- \* skeleton: bony
- \* Fins: Median fins → dorsal fin, anal fin, caudal fin  
Paired fins → pectoral and pelvic fins
- \* swim bladder: Present
- \* Respiration: Through gills
- \* Operculum: present
- \* Jaws: with or without teeth
- \* Brain: developed with 10 pairs of cranial nerves
- \* Heart: 1 auricle, 1 ventricle
- \* Blood: Red due to haemoglobin
- \* Sexes separate except a few species
- \* Fertilization is external
- \* Majority are oviparous but some are ovo-viviparous and viviparous.

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## \* LUNG FISH :

- Fish of class Dipnoi
- only 3 species left in world
- In dry months these fish aestivate in the holes dug in the mud and respire through extremely vascularized swim bladder which act as lung
- In rainy season, they start their normal life and respire through gills

## \* CLASS AMPHIBIA

- both aquatic and terrestrial animals
- evolved from class Dipnoi of fish in Devonian period
- poikilothermic (cold blooded)
- sexes are separate
- external fertilization
- breed in water
- Tadpole larva : lives in water, respire through gills swim with laterally flattened tail
- Metamorphosis takes place
- Neotenus retain gills throughout life
- tetrapods : 2 pectoral limbs  
2 pelvic limbs
- caecilians : legless amphibians
- webbed feet
- fingers have no claws
- skin is pigmented, smooth and glandular

→ Heart : 3 chambered

→ mixing of oxygenated and deoxygenated blood in ventricle

→ most amphibians hibernate during winter

### EXAMPLES :

i) Frog }  
ii) Toad } Tailless

iii) Salamander }  
iv) Newt } Tailed  
v) Necturus }

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### 3. Class Reptilia

Reptiles are true land vertebrates. Their bodies are bilaterally symmetrical and can be divided into four regions; head, neck, trunk and tail. They are poikilothermic, pentadactyle (having five fingers) tetrapods. They are terrestrial but some species secondarily has adopted aquatic life like aquatic snakes and turtles. They are lowest amniotes, i.e. their embryos are surrounded by a protective covering amnion. Other protective membranes called extra embryonic membranes i.e. yolk sac, chorion, and allantois are also found.

Sexes are separate and fertilization is internal. They are oviparous and lay shelled eggs with considerable amount of yolk which provide all the nutritional required by the developing embryo within the egg, hence there is no larval stage and the young ones hatch out fully formed from the egg. Their skin is thick, scaly and devoid of glands. This is why skin is very dry and impervious to water.

Exoskeleton is present in the form of nails and epidermal scales and digits are with claws. Teeth are present on the jaws except in turtle and tortoise. All reptiles are carnivorous. Heart is four chambered with two auricles, a completely or partially divided ventricle and a pair of systemic arches. Colour of the blood is red due to the presence of haemoglobin as respiratory pigment. Respiration takes place through lungs which have spongy texture. Gill slits appear during embryonic stages but gills

### Tidbit

Most of the Lizards never take water in their life. They survive with conserving the water present in their food.



never develop in reptiles. Excretory organs are **metanephric kidneys**. Being adapted to live on land they are **uricotelic** i.e. excrete uric acid crystals to conserve water. Most of the modern reptiles live in temperate and tropical areas of the world.

It is believed that those amphibia which had totally departed from their aquatic environment were the ancestors of the reptiles. Reptiles were once the most dominant group on the land and that time in geological history is termed as **age of reptiles**.

Reptiles flourished in **Mesozoic period** (225- 65 million years back). Modern reptiles are the descendents of the Dinosaurs of **Jurassic period** (195- 136 million years back and **Cretaceous period** (136- 65 million years back). At the end of Mesozoic period change in climatic conditions and environmental hazards caused the reptiles to become extinct. Those who could survive and are found today include **lizards, snakes, tortoises, turtles** and the **Tuatara (*Sphenodon punctatum*)** of New Zealand, a species also called living fossil.

#### 4. Class Aves

All the birds are included in this class. Birds are unique among vertebrates in having **feathers** on their bodies. Both birds and mammals are considered to be evolved from reptilian

ancestors. Scales on the legs and claws are the reptilian characters which are still very prominent in birds. Evolutionary history of birds is very interesting. In 1861 from the rocks of Jurassic period, fossil of a bird was found which was given the name of

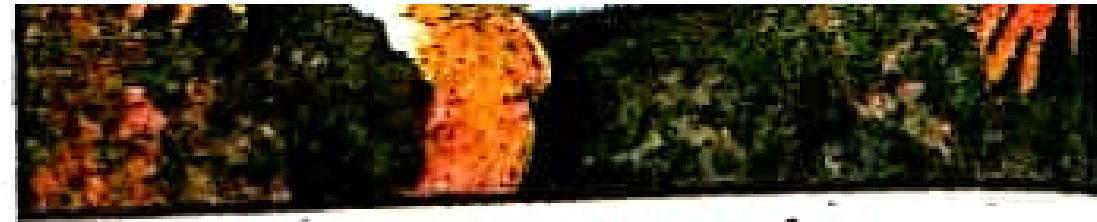


Fig: 9.29 Lizards, snakes, tortoises, turtles and Tuatara

**Archaeopteryx**, the lizard tailed bird. It is of the size of a crow. Interesting about it is that it has characters of both reptiles and birds so can be considered a transition species between the two groups.

Some of the **birds like characters** of archaeopteryx are

Well developed contour and flight feathers covering the body.

Forelimbs modified in to flying wings.

Tail with two rows of feathers.

Skull large with a single occipital condyle.

Jaws elongated to form a beak.

### **Reptilian characters of archaeopteryx**

Presence of scales on the legs.

Bones solid and heavy without air spaces.

Jaws with teeth present in sockets.

A long, tapering lizard like tail consists of **20 caudal vertebrae**.

Nine to ten **cervical vertebrae**.

No fusion of trunk and **sacral vertebrae**.

Sternum not keeled. Free cervical and abdominal ribs are also present.

Simple brain with cylindrical cerebral hemisphere and unexpanded cerebellum.

Fore limbs with three clawed fingers.

The above evidences prove that archaeopteryx was a **connecting link** between reptiles and birds. Birds gradually evolved and became one of the most successful group of vertebrates

## Tidbit

One specimen of archaeopteryx is present in Berlin museum and the other in British museum



→ contour feathers



## Distinguishing Characteristics of Birds

They are **homiothermic i.e. warm blooded animals** because they maintain their body temperature. The body is covered by different coloured feathers which are epidermal exoskeleton. Body is fusiform (streamlined) to allow better movement in air with less resistance. Fore limbs are modified into wings for flight. They have adapted a bipedal life and hind limbs are used for walking on land. Terrestrial aquatic birds possess webbed feet. Skin is without epidermal glands except **urophygial gland** present at the base of tail.

**Bones** of the birds are hollow having air spaces which make them lightweight. **Sternum** is well developed into a keel which not only helps in cutting the air during flight but also provides additional area for the attachment of muscles. Jaws are without teeth and are modified in the form of a **beak**. Digestive system has a **crop** to store the food and a **gizzard** to grind it.

**Heart is four chambered** with two auricles and two ventricles. A **single aortic arch** is present which curves to the right side. Blood is red due to **haemoglobin** contained in **oval, nucleated RBCs**.

Vocal cords are not present in larynx but a special sound box **syrinx** is present at the junction of trachea and bronchi. Lungs are provided with extra **air sacs**. These sacs are extended into viscera.

Eyes are provided with a third eyelid, the **nictitating membrane** which can be drawn across the eye. A rudimentary **pinna** is present outside the external auditory opening.

Excretory organs are **metanephric kidneys**. Ureters open in common **cloaca** and nitrogenous wastes are excreted in the form of semisolid urates.

Sexes are separate and **sexual dimorphism** is found in many birds. Fertilization is internal. Females have only left ovary and oviduct is well developed. Females have **shell secreting glands**. Birds are **oviparous** and have eggs with considerable amount of yolk covered with a hard calcareous shell. Birds are **amniotes** and have all the **extra embryonic membranes i.e. amnion, chorion, yolk sac and allantois**. In many birds **parental care** is very developed.

## Types of Birds

Birds are of two types:

- Flightless Birds
- Flying Birds

**Flightless Birds** are those which do not fly in the air. They are called running birds as instead of flying they secondarily has adapted a running mode of life. Their bones are not hollow and sternum is not keeled. Tail feathers are irregularly arranged e.g. ostrich, emu, kiwi, cassowary, penguin etc.



a. ostrich

b. emu

c. cassowary

Fig: 9.30 Flightless Birds

**Flying Birds** are the birds with strong wings for flight and keeled sternum. Their bones are hollow. Tail feathers are well developed and are used for steering the bird in air during flight. e.g. pigeon, sparrow, parrot, eagle, owl etc.

## 5. Class Mammalia

Mammals are the animals in which females nourish their babies with milk produced by **mammary glands**. The development of brain and nervous system in mammals is the most remarkable character which has placed them at the top of the evolutionary tree.

Because of possessing **solid and hard bones** and being the most recently evolved forms, the fossil record of mammals is more continuous and complete. Mammals are believed to be evolved from reptiles. Ancestors of mammals lived simultaneously with reptiles in Jurassic period and are called mammal like reptiles. A **fossils animal (named varanope)** has been recovered from Texas which has 50% mammalian characters. The ancestors of mammals were of the size of mice and lived on trees. **Mammals became dominant in Cenozoic period.** Today we are living in the

## Age of mammals.

Following are general characteristics of mammals:

Mammals are warm blooded, air breathing, tetrapods which are mostly terrestrial. Their body is covered with hairs which insulate the body and help in maintaining temperature. Mammals have two pairs of pentadactyle limbs which are adapted for walking, running, climbing, burrowing, swimming, gliding. In aquatic orders hind limbs are absent. Skin is glandular with sweat glands and sebaceous glands and mammary glands in females for secreting milk. Brain is well developed with two large cerebral hemispheres and 12 pairs of cranial nerves. Sense organs are well developed. Eyes are protected by movable eyelids. Ears have an external pinna for collection of sound waves. Internal ear contains a set of three bones viz. incus, malleus and stapes which are the smallest bones of the body. Sense of smell, taste and touch are also well developed.

Respiration takes place through lungs which are spongy in texture due to the presence of air sacs. Larynx is well developed with vocal cords. Heart is four chambered and a complete separation of oxygenated and deoxygenated blood is maintained. Only left aortic arch is present. Colour of the blood is red due to the presence of haemoglobin in biconcave, non nucleated RBCs. Nitrogenous wastes are filtered by highly glomerular kidneys and are excreted in the form of urine. Teeth are present in jaws which have their roots in the jaws. Canine, incisors, premolar and molar type teeth are found in varying numbers in mammals.

Sexes are separate and sexual dimorphism is prominent in most mammals. Testes of male mammals lie in scrotal sac outside the body. Males have a copulatory organ penis for depositing sperms deep inside the vagina of the female. Fertilization is internal and they are viviparous. Embryo is kept inside the body of the female for development, the process is called gestation. To absorb nutrition from the body of mother a glandular tissue develops between foetus and uterine wall of the mother called Placenta. Mammals are also amniotes. The extra embryonic membranes help in the formation of placenta. Parental care is highly developed in mammals. Mammals are divided into three sub classes.

- a. Subclass Prototheria or monotremata
- b. Subclass Metatheria or marsupials
- a. Subclass Eutheria or placentalia

### \* Subclass Prototheria or Monotremata

These are the most primitive mammals and are also called as egg laying mammals. They have certain characters of reptiles like they lay eggs but these eggs are

kept in the uterus where they are fertilized and development takes place. In these mammals there is no connection between the body of mother and foetus for transfer of nutrients.

These animals are more rightly be called as **ovo-viviparous**. The youngs are given birth in an immature form and are nourished by the teats present on the ventral side of the body in females until they grow enough to survive and start taking their own food.



Fig: 9.31 Platypus and spiny ant eater

Prototheria are restricted to Australian region and are found in Australia, Tasmania, New Guinea and their neighbouring islands. They are insectivorous, **borrowing, nocturnal animal**. In adults teeth are absent and a **horny beak** is found. Their body temperature varies between **25-28°C**. Example of these mammals are duck billed platypus (*Ornithorhynchus*) and spiny ant eater (*Tachyglossus*).

Subclass **Metatheria** or **Marsupials**

These mammals are also called **pouched mammals**. Females of these animals bear a **pouch or marsupium** on



opossum



koala

kangaroo

Fig: 9.32 Marsupials

the ventral side of the belly in which young ones are kept after hatching as they are born in a very under developed and immature stage. Teats of the mammary glands are present in the pouch from which the babies suckle milk. In these animals placenta is not formed therefore, babies come out of the body earlier in immature form.

**Marsupials are also confined to Australian region with the exception of one species, American opossum.** Their body is covered with hairs. They are terrestrial, burrowing or arboreal (living in trees) in habit. Examples are Kangaroo, Opossum, Koala etc.

### c. Subclass Eutheria or Placentalia

These animals are the true mammals having the highest degree of evolution in brain and body structures. They are also called placental mammals as placenta of different types is formed in these mammals with the help of which the developing embryo gets nourishment and oxygen from the body of mother and removes metabolic wastes. Young ones develop inside the uterus to a relatively mature stage. After birth mother feeds them on her milk produced in the mammary glands with well developed teats. Teeth are present in jaws. Cloaca is absent and urino-genital opening opens independently of rectum. Testes are in scrotum hanging outside the body either throughout life or at least descend to scrotum during breeding season.

**Eutheria are divided into sixteen orders.** Some important orders with examples are mentioned below:

- Insectivora:** Feed on insects, includes moles and shrews.
- Chiroptera:** Flying mammals like bats, flying squirrels.
- Cetacea:** Aquatic mammals e.g. whale, dolphin, porpoises, sea lion etc.
- Carnivora:** Flesh eating like dog, cat, lion, Wolves
- Rodentia:** Cutting habit like rats, mice, squirrel, beavers etc.
- Edentata:** Adults with no or poorly developed molar teeth like Sloth, American anteater, sloths.
- Pholidota:** Body covered with large, overlapping, horny scales e.g. Pangolin
- Proboscidea:** Have a long trunk like elephant.
- Perissodactyla:** Odd-toed hoofed mammals like, horse, zebra etc.
- Artiodactyla:** Even-toed hoofed mammals like cow, goat, deer etc.
- Primates:** Mammals with highest brain development like lemur, monkeys, apes, tarsiers, human beings etc.

# LARVAE

1. Mollusca → Glochidium larvae

2. Annelida → Trochophore larvae

3. Echinoderms → Bipinnaria larva

4. Hemichordata → Tornaria larva

# CIRCULATORY SYSTEM

1. Arthropoda: 3 chambered heart
  - 2 atria, single ventricle
  - open circulatory system
2. Mollusca: open circulatory system
3. Echinoderms: closed circulatory system
4. Pisces: 2 chambered
  - 1 atrium, 1 ventricle
5. Aves: 4 chambered
  - 2 atria, 2 ventricles
6. Amphibians: 3 chambered
  - 2 atria, 1 ventricle
7. Reptiles: 3 chambered
  - 2 atria, 1 ventricle
  - Crocodiles → 4 chambered
8. Platyhelminthes: absent circulatory system
9. Nematoda: Absent
10. Annelida: closed circulatory system
  - aortic arches

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# LOCOMOTION

\* Platyhelminthes → cilia

\* Nematodes → 4 longitudinal bands of muscles

\* Annelida → setae, parapodia

\* Mollusca → muscular foot

\* Echinoderms → tube feet

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\* carapace → A hard upper shell of a tortoise, crustacean or arachnid

\* spinneret → silk-spinning organ of spider

\* 8 walking legs present in Arachnid

\* siphon → A siphon is an anatomical structure which is a part of body of mollusks.

Tube-like structure in which water flows

\* Anthocyanins → water-soluble vacuolar pigments that depending on their pH; may appear red, purple, blue or black. Food plants rich in anthocyanins include blueberry, raspberry etc.

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