Unit 24 · Animalia

STUDY NOTES

WHAT NEB'S GRADE 11 EXAM ASKS

- **CDC's grid (2077):** Faunal Diversity (Units 22–26 together): 19 of 75 marks, 1 MCQ, 2 short and 1 long; in one group with Evolutionary Biology, Units 18–21 (28 marks)
- **The paper:** 11 MCQs × 1 · 8 short × 5 · 3 long × 8; 3 hours; 1 mark per expected point
- **MCQ (1 mark)**
  - body plans; acoelomate, pseudocoelomate, diploblastic phyla
  - common names (*Hyalonema*, sea mouse, feather star, tusk shell, freshwater polyp)
  - the larva of a phylum; excretory or locomotory organs of a phylum
  - polymorphism, metagenesis, nematocysts, nerve net
  - largest phylum; living fossil; molting; ommatidia; terrestrial crustacean
  - radula, mantle, hemocyanin, water vascular system
  - jawless vertebrate; cranial nerves; kidney type; dicondylic skull; syrinx; left ovary; diaphragm; crocodile's heart
- **Short and long (in parts)**
  - *Hydra* vs *Sycon*
  - unique features and classes of Porifera; of the phylum with metagenesis
  - male vs female *Ascaris*
  - mouthparts, cephalothorax, features of Arthropoda; spider vs prawn; millipede vs centipede
  - classes of Mollusca with characters and examples; identify *Pila* and *Octopus*
  - three main features of Chordata; why the hagfish isn't a true fish
  - complete a table: coelom, gut, segmentation, excretion
  - echinoderms are unique; features of Aves; pigeon vs bat
  - Osteichthyes vs Chondrichthyes

Key terms

Cellular · tissue · organ-system level: sponges · coelenterates · Platyhelminthes to Chordata.

Blind sac plan: gut with one opening (coelenterates, flatworms); **tube within tube**: mouth and anus (roundworms to chordates).

Protostome: blastopore → mouth; **deuterostome**: blastopore → anus (echinoderms, chordates).

Diploblastic: two germ layers with mesoglea between (Porifera, Coelenterata); **triploblastic**: three.

Acoelomate · pseudocoelomate · coelomate: no cavity · cavity from the blastocoel, mesoderm only outside · cavity inside mesoderm, lined on both sides.

Schizocoel: coelom from split mesoderm; **enterocoel**: from gut pouches; **hemocoel**: blood-filled cavity.

Metameric segmentation: true segments, alike, of one age; **pseudosegmentation**: proglottids budded off, of different ages.

Polymorphism: two or more body forms (polyp, medusa); **metagenesis**: polyp and medusa alternate.

Ammonotelic · ureotelic · uricotelic · aminotelic: ammonia · urea · uric acid · amino acids.

Protandry: male organs ripen first (earthworm); **protogyny**: female first.

Oviparous · viviparous · ovoviviparous: lays eggs · born after growing fed by the mother · eggs hatch inside, young born alive.

Retrogressive metamorphosis: larva more advanced than adult (*Herdmania*).

Terms used to describe animals

Body plan

- **cell aggregate**: no gut; water through the **spongocoel** (Porifera)
- **blind sac**: mouth only; can't eat while emptying (*Hydra*, *Planaria*, *Fasciola*)
- **tube within tube**: one-way gut, parts specialize (roundworms to chordates)

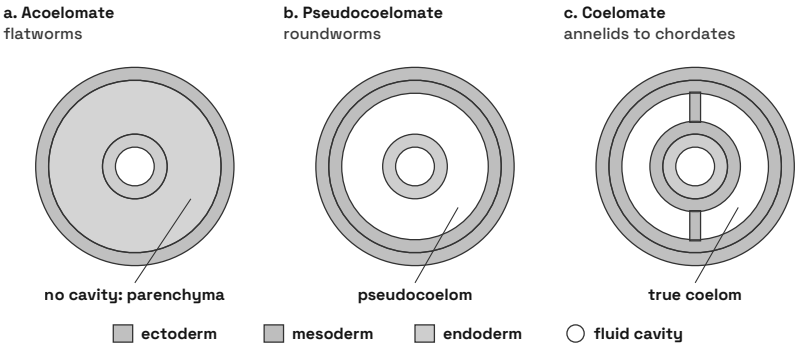
Symmetry

- **asymmetrical**: most sponges, snails (torsion), *Amoeba*
- **spherical**: any plane through the center (*Volvox*); hardly an animal
- **radial**: several planes through the oral–aboral axis (coelenterates, adult echinoderms)
- **bilateral**: one median (sagittal) plane (Platyhelminthes to Chordata)
- **biradial**: two planes (comb jellies; sea anemones with two siphonoglyphs)
- radial: meets the world from every side; bilateral: moves head first → **cephalization**

Body cavity (coelom)

- uses: gut moves freely, room for organs, **hydrostatic skeleton**, transport
- **acoelomate**: **parenchyma** fills the space (flatworms; also sponges, coelenterates)
- **pseudocoelomate**: from the **blastocoel**; mesoderm outside, endoderm (gut) inside (Aschelminthes)

- **coelomate**: **parietal** layer (body wall) + **visceral** layer (gut)
  - **schizocoel**: annelids, arthropods, mollusks (vertebrates too)
  - **enterocoel**: echinoderms, hemichordates, protochordates
  - **hemocoel**: arthropods, mollusks, leeches



Acoelomate, pseudocoelomate and coelomate in cross-section.

Segmentation

- **unsegmented**: sponges, coelenterates, roundworms, mollusks (except *Neopilina*), echinoderms
- **metameric**: **metameres** (somites), repeated outside and in; formed together; none lives alone (annelids, arthropods, chordates)
- **pseudosegmentation**: tapeworm's **proglottids** bud behind the head (**strobilization**): **immature** → **mature** → **gravid**

Words to know

- **directions**: anterior/posterior; dorsal/ventral; lateral; mid-dorsal/mid-ventral
- **habitat**: lentic (standing) / lotic (running); pelagic (open water) / benthic (bottom); sessile; gregarious (groups) vs colonial (joined)
- **homeothermic** (birds, mammals) / **poikilothermic** (fish, frogs, reptiles)
- **locomotion**: flagellum, cilia, pseudopodia, **setae** (earthworm), **parapodia** (*Nereis*), muscular foot (mollusks), **tube feet** (echinoderms), fins, limbs
- **respiration**: tracheae (insects), **book lungs** (spiders), pulmonary sac (land snails)
- **open** circulation (sinuses; arthropods, most mollusks) / **closed** (annelids, cephalopods, vertebrates)
- **myogenic heart** (vertebrates) / **neurogenic** (many arthropods)

Excretory organ	Animal
flame cells (protonephridia)	flatworms
nephridia	annelids
Malpighian tubules	insects, spiders
green glands / coxal glands	crustaceans / *Limulus*, spiders
organ of Bojanus	bivalves (*Unio*)

Waste	Examples
ammonia	freshwater bony fish, tadpoles
urea	adult frogs, mammals, sharks
uric acid	birds, land reptiles, insects
amino acids	*Unio*, starfish

- **sexual dimorphism**: peacock; male *Ascaris* smaller, curved tail
- **direct** development (no larva) / **indirect** (larva, metamorphosis)

The invertebrate phyla

Porifera (Grant, 1836; animals: Ellis, 1765; sponges, **Parazoa**)

- aquatic, mostly marine (*Spongilla* fresh water); **sessile**
- **cellular grade**; asymmetrical or radial; **diploblastic**
- **pinacoderm** outside, **choanoderm** inside, **mesenchyme** (amoebocytes) between
- **water canal system**: in by **ostia**, out by **osculum**; food, oxygen, wastes
- **spongocoel** lined by **choanocytes** (collar cells)
- skeleton: **spicules** (calcareous, siliceous) or **spongin**
- no gut: **intracellular** digestion; no respiratory, excretory, nervous systems
- hermaphrodite, cross-fertilized; **gemmules**, budding, regeneration
- larva: **parenchymula** or **amphiblastula**

Class	Skeleton	Examples
Calcarea	calcareous spicules; shallow sea	*Sycon*, *Grantia*, *Leucosolenia*
Hexactinellida (glass sponges)	**six-rayed** siliceous; deep sea	*Euplectella* (Venus's flower basket), *Hyalonema* (glass rope)
Demospongiae	spongin, or spicules (never six-rayed); largest	*Euspongia* (bath), *Spongilla* (freshwater), *Cliona*

Coelenterata (Leuckart, 1847) or **Cnidaria** (Hatschek, 1888)

- aquatic, mostly marine (*Hydra* fresh water)
- **tissue grade**; diploblastic, **mesoglea**; acoelomate; radial or biradial
- **cnidoblasts** with **nematocysts**: catch prey, defense
- tentacles round the mouth
- **polymorphism**: **polyp** (fixed, asexual) and **medusa** (free, sexual); **metagenesis** (*Obelia*)

- **coelenteron** (gastrovascular cavity): one opening, gut incomplete
- carnivores; digestion extracellular then intracellular
- **nerve net**, no brain; ocelli, statocysts
- larva: **planula**; some build **coral** ($CaCO_3$)

Class	Forms	Examples
Hydrozoa	polyp, or both; non-cellular mesoglea	*Hydra*, *Obelia*, *Physalia*
Scyphozoa (jellyfish)	medusa main; no corals	*Aurelia*, *Rhizostoma*
Anthozoa	polyps only; septa; reef builders	*Metridium* (sea anemone), *Gorgonia*, *Tubipora*

Platyhelminthes (Gegenbaur, 1859): flatworms

- mostly **parasites**; **dorso-ventrally flat**; bilateral
- **first triploblastic**; first **organ-system** grade; **acoelomate** (parenchyma)
- **tegument** in parasites; hooks, **suckers**, spines
- gut incomplete, branched, or **absent** (tapeworms)
- excretion: **flame cells**
- nerves: **ladder** of cords and cerebral ganglia
- mostly **hermaphrodite** (*Schistosoma* unisexual); parthenogenesis, polyembryony

Class	Features	Examples
Turbellaria	free-living; ciliated; no suckers; regeneration	*Planaria*, *Bipalium*
Trematoda (flukes)	leaf-shaped; suckers; branched gut	*Fasciola* (liver fluke), *Schistosoma*
Cestoda (tapeworms)	pseudosegmented; **scolex**; no gut; **onchosphere**	*Taenia solium* (pork), *T. saginata* (beef), *Echinococcus*

- *T. solium*: pork cysts → **taeniasis**; eggs → **cysticercosis** (brain, epilepsy)

Aschelminthes (Grobben; Nemathelminthes): roundworms

- round in section, unsegmented, pointed ends
- **pseudocoelomate**; **first complete gut**
- **cuticle**, molted 4 times; **longitudinal muscles only**
- no circulatory, respiratory organs; gut parasites **anaerobic**
- excretion: **renette cells** (H-shaped canals)
- **nerve ring**; amphids, **phasmids**
- unisexual; male **smaller**, **curved tail**; no asexual reproduction; no larva

Class	Features	Examples
Phasmida	phasmids; renette canals	*Ascaris*, *Wuchereria* (elephantiasis), *Ancylostoma*
Aphasmida	no phasmids; free-living	*Trichinella*, *Mermis*

Annelida (Lamarck): segmented worms

- **metameric** segments; **septa** inside
- **schizocoel** (true coelom), **hydrostatic skeleton**
- **setae**, **parapodia** or **suckers**
- **closed** circulation; hemoglobin **in the plasma**
- excretion: **nephridia**
- nerve ring and double **ventral nerve cord**, a ganglion per segment
- larva (unisexual ones): **trochophore**

Class	Features	Examples
Polychaeta	head, palps; **parapodia**; no clitellum; trochophore	*Nereis*, *Aphrodite* (sea mouse), *Arenicola*
Oligochaeta	no head; few setae; **clitellum**; hermaphrodite; direct	*Pheretima*, *Tubifex*, *Lumbricus*
Hirudinea (leeches)	**sucker at each end**; no setae; ~33 segments, many **annuli**	*Hirudinaria*, *Hirudo*, *Haemadipsa*
Archiannelida	marine; faint segments; no parapodia, setae	*Polygordius*, *Protodrilus*

Arthropoda: largest phylum (>1 million, 80%+ of animals)

- **jointed appendages**; metameric; **hemocoel**
- **chitin** exoskeleton, **molting** (ecdysis)
- head, thorax, abdomen, or **cephalothorax** + abdomen
- muscles in bundles: quick movements
- gills, **tracheae**, **book lungs**
- **mouthparts**: biting–chewing, piercing–sucking, sponging, siphoning
- **open** circulation: dorsal heart, sinuses; no veins or capillaries
- **compound eyes** of **ommatidia** (detect movement)
- unisexual; parthenogenesis (aphids, drones)
- size kept small: molting, tracheae; biggest, Japanese spider crab (3.7 m)

Subphylum · class	Features	Examples
Chelicerata: **Merostomata**	book gills; telson; marine	*Limulus*, **living fossil**
Chelicerata: **Arachnida**	chelicerae, pedipalps, **4 pairs of legs**; no antennae	spider, scorpion, ticks
Mandibulata: **Crustacea**	**carapace**; **2 pairs of antennae**; green glands	prawn, crab, *Daphnia*, *Oniscus* (woodlouse, on land)
Mandibulata: **Myriapoda**	head + long trunk, many legs	*Julus*, *Scolopendra*
Mandibulata: **Insecta**	head, thorax, abdomen; 3 pairs of legs; wings	cockroach, honey bee, housefly

- Trilobitomorpha: extinct
- insect metamorphosis: **complete** (larva, pupa: butterfly) or **incomplete** (**nymphs**: cockroach)

Millipede	Centipede
round in section	flat
2 pairs of legs per ring	**1 pair** per segment
no poison claws	**poison claws**
eats rotting leaves	predator

Spider	Prawn
Arachnida; on land	Crustacea; in water
no antennae	2 pairs of antennae
4 pairs of legs	5 pairs of walking legs
book lungs, tracheae	gills
simple eyes	compound eyes

Mollusca (*mollis*, soft; Aristotle's "soft ones"): second largest, ~85,000

- soft, **unsegmented**; asymmetrical in snails
- **calcareous shell**: outside, inside (squid) or none (slug, octopus)
- **head, muscular foot, mantle, visceral mass**
- **mantle** (pallium) secretes the shell; **mantle cavity** holds gills
- **radula** rasps food
- **open** circulation (closed in **cephalopods**); **hemocyanin** (copper, blue)
- **ctenidia** (gills) or **pulmonary sac**; kidneys (**organs of Bojanus**)
- **osphradium** tests water
- larvae: **trochophore**, **veliger**
- *Pila globosa* (घोँगी): gill + pulmonary sac; **operculum**

Class	Features	Examples
Monoplacophora	one shell; repeated organs	*Neopilina* (living fossil, 1952)
Amphineura	**eight plates**	*Chiton*
Scaphopoda	**tusk shell** open at both ends; no gills	*Dentalium*
Gastropoda	**torsion**; coiled univalve shell	*Pila*, *Helix*, *Limax*
Pelecypoda (Bivalvia)	**two valves**; no head, no radula; pearls	*Unio*, *Pinctada*
Cephalopoda	arms with suckers, **siphon**; marine	*Sepia*, *Loligo*, *Octopus*, *Nautilus*

Pila	Octopus
fresh water; coiled shell, operculum	marine; no shell
asymmetrical	bilateral
creeping foot	8 arms, siphon
open circulation	closed circulation

Echinodermata (Klein, 1734; spiny skin)

- all **marine**, **benthic**
- adult **pentamerous radial**; **larva bilateral**
- **enterocoelomate**; no head; oral and aboral surfaces; **ambulacra**
- **pedicellariae** clean the surface
- endoskeleton of **ossicles**, with spines
- **water vascular system**: **madreporite** → canals → **tube feet** (ampulla, podium, sucker)
- **no heart**, **no excretory system**, **no brain**: nerve ring, radial nerves
- great **regeneration**; external fertilization

Class	Features	Larva	Examples
Asteroidea	5 arms, not marked off	bipinnaria, brachiolaria	*Asterias*
Ophiuroidea	thin arms marked off; no suckers	ophiopluteus	*Ophiura*
Echinoidea	no arms; test; **Aristotle's lantern**	echinopluteus	*Echinus*
Holothuroidea	long; tentacles; **respiratory trees**	auricularia	*Holothuria*
Crinoidea (Pelmatozoa)	**stalked**; mouth and anus up	doliolaria	*Antedon* (feather star)

Phylum Chordata (Balfour, 1880)

- three characters, at least in the embryo:
  1. **notochord**: mid-dorsal, below the nerve cord, above the gut; replaced by the **vertebral column**
  2. **dorsal hollow nerve cord** (invertebrates: solid, double, ventral)
  3. **pharyngeal gill slits**
- also a **post-anal tail**
- closed circulation, **ventral** heart; kidneys

Subphylum	Features	Examples
Hemichordata	worm-like; **stomochord**; proboscis, collar, trunk	*Balanoglossus*
Urochordata	notochord in larva's tail only; **test**; retrogressive metamorphosis	*Herdmania*, *Ciona*
Cephalochordata	notochord, nerve cord whole length, for life	*Branchiostoma* (*Amphioxus*)
Vertebrata	**cranium**, **vertebral column**	fishes to mammals

- protochordates = **Acraniata**; vertebrates = **Craniata** (Euchordata)
- hemichordates: today a separate phylum near echinoderms

Agnatha: Cyclostomata (jawless)

- eel-shaped; **unpaired fins** only; no scales
- round **sucking mouth**, no jaws; **single nostril**; gill pores
- two-chambered heart
- *Petromyzon* (lamprey), *Myxine* (hagfish): not true fish

Pisces (Gnathostomata, jawed)

- streamlined; **scales**; **gills**; **paired** (pectoral, pelvic) and unpaired fins
- **two-chambered** heart, deoxygenated blood only
- poikilothermic; mesonephric kidneys; **10** pairs of cranial nerves; **lateral line**

Chondrichthyes	Osteichthyes
cartilage skeleton	bony skeleton
placoid scales	ganoid, cycloid, ctenoid
heterocercal tail	**homocercal** tail
ventral mouth	terminal mouth
5–7 gill slits, **no operculum**	4 pairs, **operculum**
no swim bladder	swim bladder
internal fertilization, **claspers**	mostly external
Scoliodon, *Torpedo*, *Trygon*	rohu, carp, *Hippocampus*, *Tor*

Tetrapoda

	Amphibia	Reptilia	Aves	Mammalia
heart	3	3 (croc. 4)	4	4
condyles	2	1	1	2
kidney	meso-	meta-	meta-	meta-
waste	urea	uric acid	uric acid	urea
cranial nerves	10	12	12	12

- **Amphibia**: double life; moist glandular skin, no scales; breathe by skin, lungs, mouth lining; heart has a **sinus venosus**; eggs in water, **tadpole**; ear ossicle **columella**; *Hoplobatrachus*, *Bufo*, *Ichthyophis*
- **Reptilia**: dry horny **scales**; lungs only; first **true** land vertebrates (shelled egg on land); **Jacobson's organs**; membranes: amnion, chorion, yolk sac, allantois
- **Aves**: **feathers**; **preen gland** the only skin gland; wings; lungs with **air sacs**; toothless **beak**; **pneumatic** bones; **keel**; **crop**, **gizzard**; **syrinx**; only **left ovary**; **no bladder**; migration, nests
- **Mammalia**: **hair**; **sweat, sebaceous, mammary** glands; **diaphragm**; **pinna**, **3 ear ossicles**; teeth **heterodont, thecodont, diphyodont**; RBCs no nucleus; **placenta**; monotremes lay eggs

Pigeon	Bat
feathers	hair
beak	teeth
no pinna	pinna
air sacs	diaphragm
lays eggs	milk, viviparous

The phyla side by side

Phylum	Cavity	Gut	Excretion
Porifera (2 layers)	none	none	surface
Coelenterata (2)	none	blind sac	surface
Platyhelminthes	none	blind, none	flame cells
Aschelminthes	pseudocoel	complete	renette
Annelida	schizocoel	complete	nephridia
Arthropoda	hemocoel	complete	Malpighian
Mollusca	hemocoel	complete	kidneys
Echinodermata	enterocoel	complete	none
Chordata	coelom	complete	kidneys

- Platyhelminthes onward: 3 germ layers
- **metameric** segments: Annelida, Arthropoda, Chordata; **pseudo**: tapeworm (Platyhelminthes); the rest none

COMMON MISTAKES

✗ Pseudocoelom lies between ectoderm and endoderm
✓ **mesoderm** outside, endoderm inside.

✗ Humans show protogyny
✓ humans are unisexual; neither word applies.

✗ Reptiles are the first land vertebrates
✓ first **true** land vertebrates (shelled egg); amphibians came first.

✗ The rhea has a urinary bladder
✓ no bird has one; the **ostrich** stores urine in its cloaca.

✗ A seahorse isn't a fish
✓ bony fish: gills, operculum, fins.

✗ The hagfish is a fish
✓ a jawless **cyclostome**.

✗ *Limulus* is a crab
✓ an arachnid relative (Chelicerata).

✗ Hemichordates have a true notochord
✓ the **stomochord** is a gut pouch.