Unit 27 · Animal Adaptation

STUDY NOTES

WHAT NEB'S GRADE 11 EXAM ASKS

- **CDC's grid (2077):** Biota and Environment (Units 27–29 together): 6 of 75 marks, 1 short; in one group with Units 1–3, 11–12, 17, 30–31 (21 marks)
- **The paper:** 11 MCQs × 1 · 8 short × 5 · 3 long × 8; 3 hours; 1 mark per expected point
- **MCQ (1 mark)**
  - fishes: primary aquatic; swim bladder (bony fishes); neuromasts; a true statement on whales
  - cursorial animals; digitigrade (cats); unguligrade (goat)
  - identify a fossorial animal; what isn't fossorial
  - arboreal; autotomy; gibbon; patagium (bat); perching; flying fish's pectoral fins
- **Short and long (in parts)**
  - secondary aquatic adaptation, with examples
  - rahu: primary aquatic features
  - arboreal animals and their features; the wall lizard
  - cursorial features
  - primary vs secondary aquatic; volant vs cursorial
  - flight in bats and birds
  - gliding: four examples and their features

Key terms

Adaptation: the fitting of an organism to its habitat, by which it survives and reproduces; **inherited**, built by **natural selection**.

Structural · behavioral · physiological: body parts · what it does · how the body works.

Primary aquatic: ancestors always in water (fishes).

Secondary aquatic: ancestors on land, back to water (whales, seals, turtles).

Cursorial: running; **fossorial**: digging; **arboreal** (**scansorial**): climbing; **volant**: flying or gliding.

Plantigrade · digitigrade · unguligrade: whole sole · toes · hoof tips.

Autotomy: breaking off its own tail; **regeneration**: growing it back.

Patagium: skin flap used as a wing.

Perching: toes lock round a branch by tendons.

Adaptation

- each habitat sets problems: water dense, low oxygen; open ground; dark soil; falling; air
- three kinds:
  - **structural**: fins, flippers, wings, patagia, webbed feet
  - **behavioral**: hibernation, migration, pack hunting
  - **physiological**: steady temperature, **osmoregulation**, a seal slowing its heart
- by habitat: **aquatic**, **terrestrial**, **aerial** (volant)

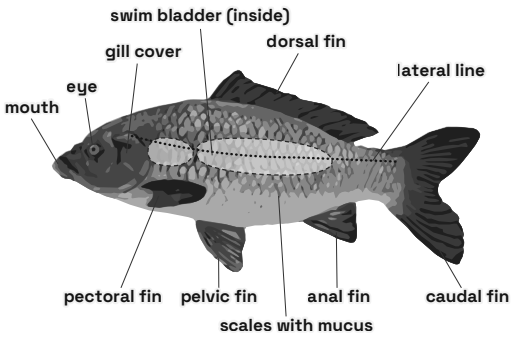
Aquatic adaptation

- water: dense, holds the body up, ~1/30 the oxygen of air, fresh or salty

Primary aquatic (fishes; e.g. rahu, *Labeo rohita*)

1. **streamlined**, laterally compressed; no neck
2. **fins**: paired (pectoral, pelvic) balance, brake, turn; **caudal** drives, steers; dorsal, anal stop rolling
3. **gills** (operculum in bony fishes; open slits in sharks); air-breathing organs: *Anabas*, *Clarias* (magur), *Heteropneustes*
4. **scales**: placoid (sharks), **cycloid** (carps), **ctenoid** (perches)
5. **mucus**: less friction, guards against microbes
6. **swim bladder** (bony fishes): **neutral buoyancy**; sharks use an oily liver

7. **lateral line**: **neuromasts** feel water movement, vibration, pressure (not temperature)
8. no eyelids (some sharks: nictitating membrane)
9. **osmoregulation**:
   - freshwater: little drinking, much dilute urine, gills take salts **in** (**chloride cells**)
   - marine: drinks seawater, little urine, gills pump salt **out**



A carp and its aquatic features.

Secondary aquatic (whales, dolphins, seals, sea turtles, crocodiles, penguins)

- defined by **ancestry** (land), not by living on land and in water
- whales from land mammals ~50 million years ago (nearest: hippos)

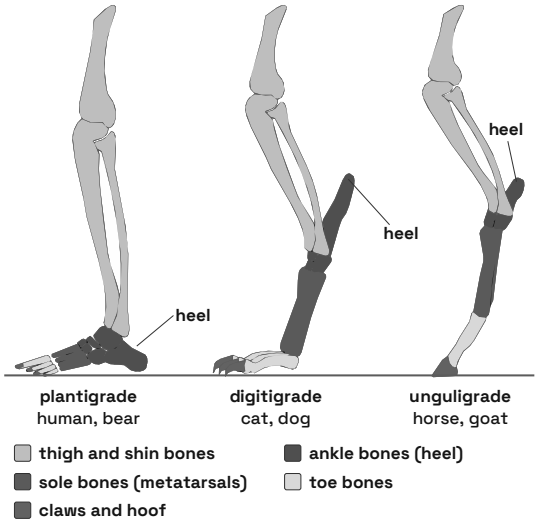
1. streamlined; short neck; **rostrum**
2. forelimbs **flippers** (arm and finger bones inside); hindlimbs lost in whales; **webbed** toes in ducks, frogs
3. **tail fluke** beats **up and down**
4. **blubber** instead of hair; no sweat or oil glands
5. **nostrils on top** (**blowhole**); valves close them
6. **lungs**; oxygen stored in **blood** and **muscle** (**myoglobin**); lungs collapse, heart slows on a dive
7. small eyes, tough **sclera**; **Harderian gland** (oily fluid)
8. no **pinna** (whales, dolphins)
9. testes inside the abdomen; fat-rich milk squirted under water

Primary aquatic	Secondary aquatic
ancestors always in water	ancestors on land
gills	**lungs**; surface to breathe
scales, mucus	blubber, little or no hair
tail beats side to side	fluke beats up and down
swim bladder	oxygen stored in blood, muscle
fishes (rahu)	whale, dolphin, seal, turtle

Terrestrial adaptation

Cursorial (running): cheetah, tiger, horse, deer, blackbuck, dog, ostrich

1. slim, spindle-shaped; head stretched forward; ears back
2. big muscles close to the body (shoulders, thighs)
3. **long legs**: humerus, femur short; radius-ulna, tibia-fibula, foot long (light, fast swing)
4. legs move in **one plane**, like propellers
5. front legs bear weight (~60% in a horse); hind legs push
6. **foot posture**:
   - **plantigrade**: whole sole; bear, human, rat
   - **digitigrade**: toes, heel raised; pads; cat, dog
   - **unguligrade**: hoof tips; horse, cow, goat, deer



Plantigrade, digitigrade and unguligrade legs.

Fossorial (digging): mole, mole-rat, bandicoot, badger, pangolin, echidna, earthworm

1. compact, stout, cylindrical body
2. **conical snout**
3. strong shoulders; short, thick forelimb bones
4. short forelimbs, strong **claws**; mole's **shovel** hands

5. tail short or absent
6. tiny eyes (hidden; nictitating membrane), small or no ear pinnae; touch and smell instead
7. some **hibernate** (marmots); moles stay active

Arboreal (scansorial: climbing)

- rock and wall climbers: geckos (*Hemidactylus*)
- **terrestrio-arboreal**: sloth bear, palm squirrel, rhesus monkey
- **fully arboreal**: gibbon, lemur, sloth, slow loris

1. small, slender, light (or long strong arms: orangutan)
2. movable neck to judge distances
3. horny **scales** in lizards
4. long sticky **tongue** (chameleon)
5. curved ribs; strong **girdles**
6. **claws**; **opposable** thumb (and big toe in apes, monkeys)
7. long **tail** for balance; **prehensile** in American monkeys; scaly-tailed flying squirrels' tail scales grip bark
8. **gecko**: **lamellae** with microscopic **setae** → **van der Waals forces** (not suction)
9. **autotomy**, then **regeneration** (cartilage rod)
10. tree frogs: **adhesive pads**

Wall lizard

- dry horny scales; claws; toe lamellae and setae (grip ceilings); **autotomy** and **regeneration**; sticky tongue

Volant (aerial) adaptation

Active flight: birds, bats, insects

1. **streamlined**, boat-shaped; legs tucked in
2. bat: **patagium** on four very long fingers, arm to body, leg and tail
3. bird: forelimb **wing**, **flight feathers**; hand bones fused
4. **feathers**: contour (shape), quills (lift, steer), down (warmth)
5. **pneumatic bones**: hollow, braced by struts
6. lungs with **air sacs**: one-way air flow
7. **keeled sternum**: **pectoral** muscles (down), supracoracoideus (up); ~1/3 of a pigeon's weight
8. **perching**: bent legs pull tendons; toes lock
9. saving weight: **beak**, no teeth; fused bones; only the **left ovary**; **no urinary bladder**; organs at the center

- bar-headed geese over the Himalaya (one at 7,290 m): air sacs, hemoglobin that grips oxygen tightly

Passive flight (gliding): leaps from a height and sails down; can't climb or stay up

- **flying fish** (*Exocoetus*): huge **pectoral fins**; tail's **lower lobe longer** (hypocercal)
- **flying lizard** (*Draco*): **5–7 long ribs** hold a patagium
- **flying snake** (*Chrysopelea*): spreads its ribs, flattens to a C
- **flying frog** (*Rhacophorus*): long, fully **webbed** toes; **adhesive pads**
- **flying squirrel**, **colugo** (*Cynocephalus*): **patagium** between the limbs

Volant	Cursorial
fly or glide	run on the ground
wings, patagia	long legs, hooves or pads
hollow bones	strong, long distal bones
air sacs (birds)	—
keel for flight muscles	muscles at shoulders, thighs
birds, bats	horse, cheetah, deer

COMMON MISTAKES

✗ Secondary aquatic animals live on land and in water
✓ ancestors lived on **land**; a whale never comes ashore.

✗ The lateral line senses temperature
✓ **water movement**, pressure.

✗ A gecko sticks by suction
✓ **van der Waals forces** on tiny hair tips.

✗ Birds lack the left ovary
✓ only the **left** works; the right stays tiny.

✗ Adaptations are learned in one lifetime
✓ **inherited**, by natural selection.

✗ Bird bones are lighter than a mammal's
✓ denser, stiffer; shaped to save weight.