

``KINGDOM ANIMALIA

What is an animal?

I. Characteristics

- A. multicellular with membrane-bound organelles (EUKARYOTIC)
- B. feed on other organisms (HETEROTROPH)
- C. Have movement in some stage of life (MOBILE)
 - 1. Some animals move to find food ex. lizards, birds, people
 - 2. Some stay in place and bring food to them ex. barnacles, sponges
 - 3. the more advanced the animal, the more complicated its movement
- D. Break down food for use as energy (HETEROTROPHS)
 - 1. Some have an internal cavity for digestion
 - 2. In less complex animals, digestion takes place in individual cells
 - 3. Less complex- one opening in the digestive tract ex. food enters and wastes leave through the same opening.
 - 4. more complex – two openings = one direction of movement
ex. earthworm food enters and exits through different openings.
- E. no cell walls; cell adaptations for different jobs

II. Development of Animals

- A. Division of the egg
 - 1. single-celled zygote divides into a hollow ball of cells around fluid-filled space = blastula – 10 hours
 - 2. GASTRULA –
 - a. Two layers formed by cells folding inward
 - b. Ectoderm – outer surface - forms skin and nervous tissue
 - c. Endoderm – inner surface – forms lining of digestive tract
 - d. All animal embryos except sponges form a gastrula
 - 3. PROTOSTOMES AND DEUTEROSTOMES
 - a. Protostomes –
 - 1) Opening of gastrula becomes mouth
 - 2) includes earthworms and insects
 - b. Deuterostomes –
 - 1) Opening of gastrula becomes anus
 - 2) includes fish, birds, and HUMANS!

III. BODY PLANS AND ADAPTATIONS

- A. Symmetry-
 - 1. balance in body proportions
 - 2. enables the animal to move and find food in different ways
- B. Types of Symmetry
 - 1. Asymmetry (w/out symmetry) – sponges
 - 2. Radial Symmetry (can be divided along any plane through a central axis) – starfish
 - 3. Bilateral symmetry (can be divided into right and left halves that form mirror images) – flatworms, insects, birds, mammals
 - a. Anterior (head) and posterior (tail)
 - b. Dorsal (back) and ventral (belly)
 - c. allows more efficient movement because of muscular control

IV. BILATERAL SYMMETRY AND BODY PLANS

- A. bilateral body plan allows development of body cavities (spaces = “coeloms”) for internal organs. These are called the COELOM
- B. This allowed animals to -
 - 1. Grow larger

2. Move and feed more efficiently
- C. w/out a body cavity – animals rely on diffusion to take in food and eliminate waste
- D. if animals have a mesoderm (middle layer of cells) and internal organs, they can be -
 1. Acoelomate – w/out a coelom – ex. flatworms – flat, solid, compact bodies-
 2. Pseudocoelomate – fluid-filled body cavity partly lined with mesoderm – provides a rigid space for muscle attachment – ex. roundworms
 3. Coelomate – body cavity completely surrounded and attached to mesoderm – ex. humans, fishes – internal organs suspended in fluid-filled cavity – allows for larger size.

V. ANIMAL PROTECTION AND SUPPORT

- A. Exoskeleton – support on outside of body
 1. prevents water loss
 2. provides protection
 3. Invertebrate – animal w/out backbone – ex. crabs, spiders, beetles have exoskeletons
- B. Endoskeleton – support on inside of body
 1. protects internal organs
 2. provides an internal brace for muscles
 3. Vertebrates – animals with backbones

INVERTEBRATE ANIMALS I

SPONGES, CNIDARIANS, FLATWORMS, ROUNDWORMS, MOLLUSKS, AND SEGMENTED WORMS

I. SPONGES (Phylum – Porifera)

- A. Ocean and freshwater habitats
- B. Sessile
- C. Feeding method → filter feeding
- D. No tissues, organs, or organ systems
- E. Reproduction – both sexual and asexual
 1. Hermaphrodites – an individual can produce both eggs and sperm
 2. Produce free-swimming larvae that attach to surface
- F. Importance of sponges
 1. Used for cleaning and bathing
 2. Give off toxic chemicals that may be used to treat cancer
 3. anti-fungal properties
 4. sponge Superglue → used to repair human tissues

II. CNIDARIANS

- A. Corals, jellyfishes, sea anemones
- B. Marine
- C. Radial symmetry
- D. One body opening, two cell layers
- E. Simple nervous systems
- F. Body Forms
 1. Polyp – tube-shaped body with mouth surrounded by tentacles
 2. Medusa – umbrella-shaped with tentacles hanging down
- G. Feeding adaptations – NEMATOCYSTS – stinging cells
- H. Reproduce sexually (during medusa stage) and asexually (budding during polyp stage)
- I. Importance of Cnidarians –
 1. Marine ecosystem
 2. Many people get stung – some can kill (Australian box jelly)
 3. Coral- form reefs that serve as food sources and shelter many other animals

III. FLATWORMS (PLATYHELMENTHES)

- A. Acoelomate
- B. Include parasitic and disease-causing tapeworms, flukes; lab animal- *Planaria*
- C. Possess primitive brain (mad, glad, eat, poop)
- D. Reproduce – sexual (hermaphrodite) and asexual (fission, regeneration)
- E. Adaptations as parasites
 - 1. Get food from inside the bodies of hosts
 - 2. Mouthparts have hooks to hold on
 - 3. Less nervous, muscular tissue
 - 4. Tapeworm – can grow to 10 m (30 feet); live in intestines; have body sections (proglottids) can break off and contain eggs

IV. ROUNDWORMS (NEMATODA)

- A. Live in soil, animals, and freshwater and saltwater
- B. Free-living or parasitic
- C. Pseudocoelom and tube like digestive system
- D. First group with 2 body openings – mouth and anus
- E. Some have sense organs (eyespot)
- F. Economic importance – common human and animal parasites – e.g. Heartworm, hookworm, pinworm

V. MOLLUSKS

- A. Members of phylum mollusca
- B. General characteristics
 - 1. Bilateral Symmetry
 - 2. Coelom
 - 3. Two body openings
 - 4. A muscular foot for movement
 - 5. Mantle
 - a. Thin membrane that surrounds the internal organs
 - b. Secretes the shell
- C. Habitats
 - 1. Marine
 - 2. Freshwater
 - 3. Land
 - 4. Sessile or free-moving
- D. Classes of Mollusks
 - 1. Gastropoda
 - a. stomach-footed mollusks
 - b. large foot positioned under body
 - c. may or may not have a shell
 - d. snails, slugs, sea slugs
 - e. adaptations
 - radula – used for feeding
 - nervous system – brain
 - well-developed circulatory system (open)
 - respiratory system – gills and primitive lung for land snails
 - first group to have excretory structures – nephridia
 - hermaphrodites or use external fertilization
 - f. gastropods w/out shells (slugs)
 - protected by thick layer of mucus
 - sea slugs – may be poisonous

2. Bivalves
 - a. two-shelled mollusks
 - b. source of pearls
 - c. clams, oysters, and scallops
 - d. marine or freshwater habitats
 - e. use large muscular foot for digging
 - f. filter feeders
 - cilia draw water in through siphon
 - water moves over gills and out through siphon
 - food and water get trapped inside mucus layer
 - cilia push food to stomach
3. Cephalopods
 - a. head-footed mollusks
 - b. octopus, squid, chambered nautilus
 - c. most complex and recently evolved mollusks
 - d. habitat – all marine
 - e. foot has been modified to tentacles
 - f. radula and beaklike jaw
 - g. circulatory system – closed

VI. SEGMENTED WORMS

- A. Characteristics of Phylum Annelida
 1. 3 classes – 12,000 species
 - a. Oligochaeta - earthworms
 - b. Hirudinae - leeches
 - c. Polychaeta – bristleworms (marine)
 2. Bilateral symmetry
 3. Coelom
 4. Two body openings
 5. Anterior and posterior ends
 6. Segmented body – looks like tiny rings (roundworms do not have these)
 - Internally – each segment is separated from the others by a partition
 - Provides an important advantage – each segment has own muscles, allowing for shortening and lengthening of body for movement
 - Allows for specialization – each segment has excretory organs and nerve; some segments have digestive and reproductive organs
- B. The Earthworm
 1. Lives in soil, important as food source and for loosening, aerating, and fertilizing the soil.
 2. Nocturnal – moves about at night
 3. Receives oxygen by diffusion through skin
 4. Parts of earthworm (see also diagram)
 - a. Mouth/anus
 - b. Crop – holds soil before it moves to gizzard
 - c. Gizzard – has muscular walls that grinds soil.
 - d. Intestine – runs length of body
 - e. Nervous system

- nerve fibers in each segment
 - Simple brain above mouth
 - Ventral nerve cord
 - f. Circulatory System –
 - closed – blood in vessels
 - heart – 5 pairs of enlarged vessels at anterior end
 - g. Excretory System
 - nephridia – found in each segment
 - eliminate wastes
 - h. External structures – setae → tine bristles that anchor their bodies in soil and allow muscles to move them along
5. Reproduction
- a. Hermaphrodites – but must mate with another worm
 - b. Clitellum – external bandlike structure that is important for reproduction
 - c. During mating – both worms exchange sperm
 - d. Each forms a capsule where fertilization occurs
 - e. Capsule slips off worm into soil, where eggs hatch.

C. LEECHES

1. Segmented worms with flattened bodies and no bristles
2. Most live in freshwater
3. Parasites – live off blood/body fluids
5. Their saliva contains anesthetic and anticlotting agents
6. Medicinal uses – draw excess fluid off wounds

INVERTEBRATE ANIMALS II

ARTHROPODS, ECHINODERMS, AND INVERTEBRATE CHORDATES

I. ARTHROPODS

GENERAL

- bilateral symmetry
- coelom
- exoskeleton = hard outer body covering
 - made of protein and chitin
 - protects and supports internal tissues
 - provides place for muscle attachment
 - in terrestrial (land) species = protects against water loss
 - molting = shedding of old exoskeleton
 - animal contracts posterior muscles, forces blood forward.
 - anterior swells, causes old exoskeleton to split
- appendages = jointed structures that grow out of the body
 - sensory, walking, feeding, mating
 - allow for more powerful movements
- segmentation into 1 – 3 segments
 - 1 segment = head i.e. tick
 - 2 segments = cephalothorax and abdomen i.e. shrimp
 - 3 segments = head, thorax, and abdomen i.e. beetle
- respiratory structures
 - arthropods have efficient respiratory structures to ensure quick oxygen delivery to cells

- circulation = open circulatory system
 - blood is pumped by one or more hearts
 - vessels carry blood away from hearts and then flows out freely from the vessels over the tissues of the rest of the body
- reproduction = sexual
 - fertilization is usu. internal in terrestrial species, often external in aquatic species
 - some are hermaphrodites
 - some parthenogenesis (develop from unfertilized egg)

A. ARACHNIDS (Class Arachnida)

- ex: spiders, scorpions, mites, ticks
- respiration = book lung
 - air-filled chambers that contain leaflike plates

SPIDERS

- only 2 segments = cephalothorax and abdomen
- 6 pairs of jointed appendages
 - chelicerae = 1ST pair; located near mouth; modified into pincers/fangs
 - pedipalps = 2ND pair; adapted for handling food and sensory
 - male spiders = carry sperm during reproduction
 - remaining 4 pairs are for locomotion
- no antennae
- all spiders spin silk, not all spiders make webs
 - silk glands in abdomen secrete silk; spun into thread by spinnerets

TICKS AND MITES

- only 1 segment
- mites are often too small to be seen with the naked eye
- ticks feed on blood from reptiles, birds, and mammals

SCORPIONS

- many abdominal body segments
- enlarged pincers
- related to horseshoe crabs of Class Merostomata
 - living fossils = haven't changed since Cambrian period

B. CRUSTACEANS (Class Crustacea)

- mostly aquatic
- 2 or 3 body segments
- respiration = gills
 - large surface area, enables large amt. of blood-rich tissue to be exposed to water containing oxygen
 - oxygen and carbon dioxide are exchanged when water passes over gills
- mandibles (jaws) for crushing food
 - open and close from side to side
- 2 pairs of antennae for sensing
- 2 compound eyes, usu. located on moveable stalks
- 5 pr. of walking legs- walking, seizing prey, and self-cleaning

C. CENTIPEDES (Chilopoda) AND MILLIPEDES (Diplopoda)

- respiration = tracheal tubes
 - branching networks of hollow tubes that carry air throughout the body
 - spiracles = openings in the thorax & abdomen where air enters & exits

Centipedes

- carnivorous = eat snails, slugs, worms
- one pair of legs per body segment
- fast moving

Millipede

- eats mostly plants and dead material on forest floor
- do not bite; spray stinky fluid from stink gland
- two pairs of legs per body segment
- slow moving

D. INSECTS (Class Insecta)

- largest group
- reproduction = once or a few times (at most!) throughout life
 - internal fertilization, shells form around them
 - female lays large numbers of eggs
- metamorphosis = series of changes controlled by chemical substances
- complete metamorphosis = 4 stages
 - is an advantage b/c larvae don't compete w/adults for food
 - 1. egg
 - 2. larvae = free-living wormlike stage "caterpillar"
 - 3. pupa = period of reorganization in which the tissues and organs of the larva are broken down & replaced by adult tissues
 - 4. adult = fully formed; emerges from pupa
- incomplete metamorphosis = 3 stages
 - 1. egg
 - 2. nymph = same general appearance as adult; only smaller
 - may lack certain appendages (i.e. wings)
 - cannot reproduce
 - molts several times, develops missing structures
 - 3. adult

II. ECHINODERMS

Echinoderms

- marine; found in all of the oceans
- internal skeleton
- spiny or bumpy endoskeleton covered by a thin epidermis
- radial symmetry
 - can sense food & predators in all directions
 - stationary or move very slowly
- water vascular system
 - hydraulic system
 - movement, exchange gases, capture food, and excrete wastes
- Larvae have bilateral symmetry
- simple nervous system = no brain; have nerve net and nerve ring instead
 - cells that detect light and touch; no sensory organs

Diversity of Echinoderms

A. Starfishes

- most have 5 rays; some have more than 40

B. Brittle stars

- extremely fragile!!
 - helps survive an attack by a predator
 - regeneration = regrowth of missing parts
- use tube feet to pass particles of food into mouth

- slithering motion of flexible rays to propel them
- C. Sea Urchins and Sand Dollars
 - globe- or disk-shaped; covered with spines
 - do not have rays
 - sand dollars live on ocean bottoms
 - sea urchins inhabit rocky areas
- D. Sea Cucumbers
 - leathery covering allows them to be flexible
 - pull themselves along ocean floor using tentacles and tube feet
 - in danger = expel tangled sticky mass of tubes through the anus or they may rupture = releases internal organs
 - predator feeds on expelled mass
- E. Sea Lilies and Feather Stars
 - resemble plants
 - sea lilies = only sessile echinoderms
 - feather stars = sessile in larval form; adult uses feathery arms to swim

III. INVERTEBRATE CHORDATES (Phylum Chordata)

ALL CHORDATES...

- A. have notochords = long semirigid, rodlike structure
 - invertebrates = do not develop a backbone
- B. dorsal nerve cord = bundle of nerves housed in a fluid-filled canal that lies above the notochord
 - adults = posterior portion develops into the spinal chord; anterior portion develops into the brain
- C. gill slits = paired openings located in the pharynx, behind the mouth
- D. muscle blocks = modified body segments that consist of stacked muscle layers
- E. Sea Squirts and Lancelets
 - Subphylum Urochordata (Sea Squirts – “tunicates”)
 - adults retain only gill slits as indication of chordate relationship
 - mostly live attached to objects on seafloor
 - may squirt out jet of water
 - Subphylum Cephalochordata (Lancelets)
 - small & streamlined, usu. about 5 cm. long
 - spend most of life buried in sand with head sticking out
 - retain all chordate features throughout life

VERTEBRATES I (Amphibians – Fishes)

I. GENERAL

- Phylum Chordata
- Subphylum Vertebrata
- notochord
- gill slits
- dorsal nerve chord

II. FISHES

- huge range of habitats and body appearances
- A. Class Agnatha (lampreys and hagfishes)
 - jawless fishes
 - no scales, no fins

- skeletons made of cartilage
 - breathe using gills containing tiny blood vessels
 - reproduce sexually; external fertilization
 - two-chambered heart, like all fish
 - one chamber receives deoxygenated blood from body tissues; 2nd chamber pumps blood directly to the capillaries of the gills; oxygen and carbon dioxide are exchanged in the capillaries
 - hagfish = slit-like toothed mouth; feed on dead or dying fish
 - drill a hole and suck blood and insides from animal
 - lampreys = parasites; attack other fish and attach with sucker-like mouths
 - scrape away flesh, then suck out the prey's blood
- B. Class Chondrichthyes (sharks, skates, and rays)
- composed entirely of cartilage
 - living fossils! = classified in same genera as species that swam 100,000+ years ago
 - paired fins = fan-shaped membranes, supported by stiff spines called rays; used for balance, swimming, and steering
 - jaws evolved; enabled animal to grab and crush prey w/great force
 - sensory systems - fine-tuned sense of smell
 - lateral line system = line of fluid-filled canals running along the sides of a fish that detects movement and vibrations in the water
 - SCALES - thin bony plates formed from the skin
 - age of some species determined by counting annual growth rings on scales
 - different shapes of scales
 - diamond-shaped = primitive bony fishes
 - cone- or round-shaped = bony fishes
 - tooth-shaped = sharks
 - SHARKS - 6-20 rows of teeth; continually replaced; point backward which prevents prey from escaping once caught
 - RAYS – flat bodies and broad pectoral fins on the sides
 - some species have sharp spines with poison glands on the tails, some others have organs that generate electricity to kill prey and predators
 - INTERNAL FERTILIZATION for sharks and rays
- C. Class Osteichthyes (bony fishes)
- most fishes
 - bony skeleton, gills, paired fins, highly developed sense organs
 - bony skeleton (instead of cartilage) -> allowed fishes to adapt to different aquatic environments and eventually land
 - vertebrae = provides flexibility; important in locomotion
 - swim bladder = thin-walled, internal sac found just below the backbone
 - can be filled with mostly oxygen or nitrogen that diffuse out of a fish's blood
 - fish control their depth by regulating the amt of gas in the bladder
 - African lungfish has a structure that allows it to obtain oxygen by gulping air!
 - Reproduction - external fertilization
 - spawning -> produce millions of eggs; only small % survive
 - some are live bearers -> offspring born fully developed (swordtails!)

III. CLASS AMPHIBIA

- "double life" = life on land and water
- most adult amphibians can live on land; nearly all rely on water for breeding
 - lack protective membranes and shells -> must be laid in water to keep them moist
- fertilization is external - need water for transporting sperm

- metamorphosis = (FROG/TOAD) egg, tadpole, adult
 - tadpole – aquatic habitat, fins, gills, 2-chambered heart (like fishes)
 - adult - terrestrial legs, lungs, 3-chambered heart
 - heart helped move to land <- walking requires more oxygen.
 - skin is more important than lungs for gas exchange
 - SALAMANDER - young resemble adults
 - young have gills and tail fin; adults do not
 - breathe through their moist skin or with lungs
- thin moist skin and no claws
- ectotherms = body temp. changes with the temp. of the surroundings
- A. Order Anura (frogs and toads)
 - have vocal cords = sound-producing bands of tissue in the throat
- B. Order Caudata (salamanders)
 - have long, slender body with a neck and tail
- C. Order Apoda (legless caecilians)
 - long & have no limbs; look like worms, but have eyes covered by skin

VERTEBRATES II (Reptiles - Birds)

IV. Class Reptilia

- scaly skin – cannot breathe through scaly skin; rely on lungs
- terrestrial reproduction
 - amniotic egg = provides nourishment to the embryo and contains membranes that protect it while it develops
 - internal fertilization
- legs positioned under the body
- most have a 3-chambered heart; some are 4-chambered
- ectotherms
- A. Order Chelonia (turtles and tortoises)
 - slow moving
 - have shells
 - aquatic or terrestrial (“tortoise”)
 - no teeth; powerful jaws to crush food
- B. Order Crocodylia (crocodiles and alligators)
 - crocodiles = long, slender snout
 - alligators = short, broad snout
 - powerful jaws w/sharp teeth
- C. Order Squamata (snakes and lizards)
 - many vertebrae allow snakes to move quickly even though they don’t have limbs
 - Jacobson’s organ = pit-like sense organ in the roof of a snake’s mouth; picks up airborne chemicals
 - 3 methods of killing prey (snakes)
 1. constriction = wrap around prey
 - ex. boa, python, anaconda
 2. venom = inject prey w/poison from glands
 - ex. rattlesnake, viper, cobra
 3. swallowing whole = no venom or constriction
 - most snakes eat this way

V. Class Aves (birds)

- thecodont = fossil evidence shows origin from small, 2-legged lizard-like animal
- complete evolutionary history is not clear...

- fossil record is incomplete -> bird skeletons are light and delicate; easily destroyed
- clawed toes and scales on their feet
- internal fertilization w/amniotic eggs
- Body adaptations
 - only organism w/feathers = lightweight modified scale; provides insulation and enables flight
 - sternum = breast bone; powerful flight muscles attached
 - thin & hollow bones
 - different beak shapes for different types of food
 - 4-chambered rapidly beating heart
 - endotherm = constant body temperature

VERTEBRATES III (Mammals)

VI. Class Mammalia

- endotherms
- hair = insulation, camouflage, signals, protection
- adaptations for secretion
 - gland = cell or group of cells that secretes fluids
 - ex. saliva, hormones, milk, enzymes, sweat
- diaphragm = sheet of muscle located beneath the lungs
 - separates chest & abdominal cavities
 - allows large amts of oxygen into body
- adaptations for obtaining and consuming food
 - ex. opposable thumbs, digging claws
 - consuming food - different types of teeth
 - teeth = incisors, canines, molars
 - cud-chewing = swallowed plants are brought back up to the mouth and chewed again; further breakdown of cellulose
- nurse young
 - mammary glands = secrete milk; enables mothers to nurture & protect young
 - better chance of survival for young
- intelligence levels are superior
- therapsids = heavy-set animals that had characteristics of reptiles and mammals
- grouped by methods of reproduction
 - Placental = carries young inside uterus until completely developed
 - gestation = time in which placental mammals develop inside the uterus
 - uterus = hollow, muscular organ; development of offspring happens
 - placenta = nourishes young inside the uterus
 - Marsupial = young have a short period of development w/in the mother's body
 - then finish development in pouch made of skin and hair found on outside of mother's body
 - Monotreme = lays eggs
 - only 3 species living today
 - platypus & 2 types of anteaters

