**Animal Diversity Notes Guide**

Animals are extremely diverse

There are over 1.3 million known animal species. Animals vary greatly in size, habitat, body form, and intelligence.

What makes it an animal?

Animals all have a specific set of features in common:

They have eukaryotic cells that lack cell walls.

Their cells produce an extracellular matrix.

They have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bodies.

They go through a blastula stage of development.

They are heterotrophic, by ingestion.

There are nine main animal phyla

Most animals are invertebrates, which lack backbones. Many fewer animals are vertebrates, which have backbones.

Vertebrates (which include familiar mammals, amphibians, reptiles, and fish) are in phylum Chordata.

Animal life began in water

The first animals arose about 570 million years ago. They probably resembled aquatic protists called choanoflagellates.

Animal features reflect shared ancestry

Animals are grouped by shared features of body \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, developmental characteristics, and DNA.

Animals are classified by having tissues

The first branching point in animal taxonomy distinguishes eumetazoans (animals with true body tissues) from parazoans (animals with no true body tissues).

Most animal phyla have tissues

Animals are classified by symmetry

The second branching point distinguishes radially symmetrical from bilaterally symmetrical animals.

Most eumetazoan phyla have bilateral symmetry

Some animals have no symmetry

Many sponges (phylum Porifera) are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Some animals have radial symmetry

An organism has radial symmetry if any plane passing through the body from the mouth to the opposite end creates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ images.

Some animals have bilateral symmetry

An organism has bilateral symmetry if only one plane can divide the animal into mirror images.

Bilaterally symmetric animals have a head and a tail

This body type correlates with cephalization, which is the tendency to concentrate sensory cells and a brain at the animal’s head.

Typically this is accompanied by greater sensory complexity.

Animals are classified by germ layers

The same branching point also distinguishes animals with two embryonic germ layers from animals with three.

Most eumetazoan phyla have \_\_\_\_\_\_\_\_\_\_ germ layers

The gastrula is an early embryonic structure

In eumetazoans, the embryonic ball of cells called a blastula folds in on itself, forming a gastrula.

Animal embryos develop germ layers

In some animals, the gastrula only develops two tissue layers (endoderm and ectoderm).

In others, a third tissue layer (mesoderm) develops.

The germ layers develop into body parts

Ectoderm develops into the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and nervous system.

Endoderm becomes the digestive tract.

Mesoderm gives rise to the muscles and circulatory system.

Animals are classified by early embryonic development

The third branching point distinguishes animals by how their gastrula develops.

Protostomes are “mouth first”

If the first indention of the gastrula develops into the mouth,

the organism is a protostome.

The anus will develop from the second opening.

Deuterostomes are “anus first”

If the first indention of the gastrula develops into the anus,

the organism is a deuterostome.

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ will develop from the second opening.

Protostomes and deuterostomes are fundamentally different

Animals are classified by body cavity

A coelom is a body cavity surrounded on all sides by mesoderm.

Bilaterally symmetrical animals have different types of body cavities.

Some animals have a true coelom

This sheep’s body cavity is fully surrounded by mesoderm.

This is where the internal organs will grow.

Some animals have a pseudocoelom

This roundworm’s body cavity is surrounded by mesoderm on one side and ectoderm on the other side.

Some animals have no coelom

This flatworm lacks a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cavity.

Animals are classified by digestive tract

Animals have an incomplete digestive tract if the mouth both takes in food and ejects wastes.

Animals have a complete digestive tract if food passes in one direction from mouth to anus.

Animals are classified by segmentation

This millipede’s body is segmented: it is divided into \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ parts.

Segmented bodies are more flexible and have more potential for developing specialized body parts than unsegmented bodies.

Animals are classified by reproduction and development

Animals with direct development resemble adults in their juvenile stage. The baby fish looks like a smaller version of the adult fish.

Some animals reproduce larvae

Animals with indirect development have a larval stage that does not resemble the adult form. The larva undergoes metamorphosis as it matures into an adult.

Each animal phylum has a unique combination of features

Sponges (Porifera) are simple animals

Sponges are aquatic and sessile (anchored to a surface). They do not have true tissues.

They have hollow bodies that are either asymmetric or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ symmetric.

Sponges are filter feeders

Water moves into a sponge’s body through pores in its sides, then out through a hole at the top.

This allows the sponge to trap food and eliminate waste.

Sponges have specialized cells

Collar cells trap food and start to digest it.

Amoebocytes digest food and distribute it to other parts of the body.

Sponges are hermaphrodites

Reproduction can be asexual (by budding) or sexual.

Sperm are released into the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and fertilize eggs retained in the body of the sponge.

Cnidarians are simple eumetazoans

The 4 groups of cnidarians are jellyfish, hydra, coral, and sea anemones.

Cnidarians are aquatic and radially symmetric, with 2 germ layers.

Cnidarians’ unique feature is mesoglea

Mesoglea is a jellylike, noncellular substance found between the 2 cell layers that make up a cnidarian’s body

Cnidarians have stinging cells

In the outer body layer there are cells called cnidocytes, which contain tiny sharp harpoons used to sting predators or prey.

The sting can irritate, paralyze or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ other animals.

Cnidarians reproduce sexually and asexually

Adults release sperm or eggs into the water. When they meet up fertilization occurs to form a zygote.

The zygote develops into a larva and then a polyp, which can form a colony and release new medusae.

Flatworms are simple protostomes

Flatworms (phylum Platyhelminthes) are bilaterally symmetric, with three germ layers.

Planarians, flukes, and tapeworms are three groups of flatworms.

Flatworms have no coelom

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ body shape increases surface area and allows for efficient gas exchange in the absence of a coelom and without a specialized respiratory or circulatory system.

Planarians are free-living flatworms

Flukes and tapeworms are parasitic

Some flatworms are parasitic, such as the blood fluke. They reproduce in the human intestine.

Fluke infects human through skin.

Fluke matures in veins surrounding intestines or bladder.

Eggs are passed with feces or urine.

Egg hatches into swimming larva.

Larvae infect intermediate host.

Larvae leave intermediate host.

Mollusks are soft, unsegmented protostomes

Mollusks are a large, diverse phylum with a true coelom.

Mollusk features:

A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that secretes the shell

A muscular foot used for locomotion

A visceral mass where organs are found

A radula for feeding

Mollusks are a diverse group

Chitons have eight overlapping shells.

Bivalves have hinged shells.

Gastropods have spiral shells.

Cephalopods have internal or absent shells.

Mollusks have several organ systems

All mollusks have an open circulatory system and reproduce sexually.

Cephalopods have particularly well-developed nervous systems including a large brain, eyes, excellent sense of touch, and impressive problem-solving abilities.

Mollusks have a complete digestive tract

In this bivalve, the radula contains teeth made of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Food moves into the body through the mouth, and excretion occurs through the anus.

Annelids are segmented worms

Each body segment functions the same as the others

Annelids inhabit different environments

Annelids have several organ systems

This earthworm has a complete digestive system, a closed circulatory system with aortic arches, and a nervous system that includes a brain and ventral nerve cord.

Each body segment contains excretory organs.

The saddlelike thickening area holds the eggs in a specialized cocoon.

Nematodes are unsegmented worms

Phylum Nematoda is comprised of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Although they look wormlike, the closest evolutionary relatives of roundworms are the arthropods.

Some roundworms cause disease

Parasitic roundworms such as pinworms, heartworms, and hookworms infect the intestines, muscles, blood, and lungs of humans and other animals. Others such as C. elegans are free-living.

Nematodes have few organ systems

Fluid in the pseudocoelom distributes nutrients, oxygen, and carbon dioxide.

This roundworm’s nervous system includes a brain and nerve cords. Roundworms lack specialized circulatory and respiratory organs.

Arthropods have jointed appendages

Phylum Arthropoda is the largest, most diverse phylum of animals. Their legs, antennae, mouthparts, and other organs are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Trilobites

Chelicerates

Myriapods

Crustaceans

Insects

Over 1,000,000 species of arthropods exist!

Arthropods have an exoskeleton

All arthropods produce a tough outer exoskeleton made of chitin that supports and protects the body.

As their bodies grow, they molt and grow a new exoskeleton.

Arthropods have specialized body segments

In many arthropods, the segments group together into three major regions: head, thorax, and abdomen. Segments in each region develop specialized functions.

Arthropods have complex organ systems

Arthropods have a respiratory system made up of holes called spiracles for letting in air, and tubes called tracheae and book lungs for gas exchange.

The typical arthropod has a well-developed nervous system, open circulatory system, and complete digestive system.

Arthropods are the most diverse animals

Arthropods are divided into five subphyla.

These trilobites are an extinct marine phylum.

Arthropods are grouped by their mouthparts

The other four subphyla of arthropods are divided into:

Chelicerates with grasping clawlike \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mandibulates with chewing, jawlike mouthparts

Chelicerates are spiders and their relatives

Chelicerates include horseshoe crabs, mites, ticks, spiders, and scorpions.

Myriapods are mandibulates

Millipedes and centipedes (myriapods) make up one group of mandibulates. The head has jaws and antennae; the rest of the body has pairs of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Crustaceans are mandibulates

Crustaceans include crabs, shrimp and lobsters. Their bodies vary, but all have two pairs of antennae

Insects are mandibulates

There are millions of insect species. They each have one pair of antennae, six legs, and (usually) two pairs of wings.

Echinoderms are marine deuterostomes

Echinoderms include sea urchins, sea stars, and sea cucumbers.

They are most closely related to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Echinoderm adults have radial symmetry

Larval echinoderms are bilaterally symmetric.

After metamorphosis, they develop into adults with five-part radial symmetry.

Special features include regeneration and tissues that switch between soft and hard.

Echinoderms have a water vascular system and tube feet

The water vascular system is versatile, fulfilling the functions of a complex circulatory, respiratory, and excretory systems.

Tube feet pump out water and act as locomotion and sensory systems.

Chordata is the ninth animal phylum

Phylum Chordata is made up of chordates.

All chordates share four features

Every chordate expresses each feature at some point during its life, since they are inherited from a common ancestor.

Some chordates are invertebrates

Tunicates, lancelets, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are invertebrate chordates.

Some chordates have a cranium

Vertebrates and hagfishes have a cranium, a bony or cartilage-rich case that protects the brain.

Some chordates have vertebrae

Vertebrates have a series of small structures making up a backbone to protect the spinal column.

Some chordates have jaws

Fishes, amphibians, reptiles, and mammals have hinged jaws that frame the mouth entrance.

Some chordates have limbs and lungs

Most fishes have gills; amphibians, reptiles, and mammals have lungs for gas exchange.

Some chordates have an amnion

Reptiles and mammals have several membranes that surround, protect, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ their developing embryos

Other features reveal chordate evolution

Body coverings, thermoregulation, and heart chambers are also used to classify chordates.

Tunicates and lancelets resemble ancestral chordates

Tunicates and lancelets are chordate subphyla that lack a cranium and vertebrae.

Tunicate and lancelet anatomy is distinct

Tunicate larvae are free swimming; adults are sessile.

Lancelets \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-feed with their tails buried in the sediment.

Hagfishes and lampreys are craniates without jaws

A hagfish is a marine invertebrate with a cranium. Hagfishes secrete sticky slime, which helps them slide their bodies out of danger.

Lampreys have cartilage around their nerve cord, so they are the \_\_\_\_\_\_\_\_\_\_\_ animals to evolve vertebrae.

Hagfishes and lampreys have long, slender bodies

How did jaws develop?

Jaws can include teeth or a beak, and greatly expand the ways vertebrates can eat. In very early fishes, the skeletal elements that supported gill slits near the mouth may have developed into jaws.

Fishes are aquatic vertebrates with jaws

Fishes originated about 500 MYA from an ancestor that had jaws, gills, and paired fins.

Fishes are the most diverse and abundant vertebrates.

Some fishes are cartilaginous

The most ancient fishes have skeletons made of cartilage.

Sharks, rays, and skates are examples.

Along their sides, they have sense organs called lateral lines for detecting \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Bony fishes have skeletons of bony tissue

Unique features of bony fishes include hinged gill coverings and a swim bladder they use to adjust their buoyancy.

Like cartilaginous fishes, bony fishes have a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ line system.

Bony fishes include two main lineages

Ray-finned fishes are the most familiar fishes – trout, tuna, eels, etc.

Lobe-finned fishes are most closely related to tetrapods (animals with \_\_\_\_\_\_\_\_\_\_\_\_\_\_ limbs).

Fishes changed vertebrate evolution

Adaptations for surviving on land first arose in lobe-finned fishes.

Lungs developed from the swim bladder in a few species known as lungfish.

Strong pectoral and pelvic fin bones are the precursors for limb bones.

Amphibians were the first tetrapods

Lungs and limbs facilitated amphibians’ move to land. Their eggs must remain moist, so amphibians retain

a strong link to water.

Amphibians are adapted to live on land and in water

Improved lungs coupled with porous skin used for breathing

Closed circulatory systems with a three-chambered heart

Denser, stronger \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Amphibians include three main lineages

Most amphibians are frogs: either smooth-skinned “true” frogs or warty-skinned toads.

Salamanders and newts resemble lizards.

Caecilians are amphibians that lack limbs and resemble giant earthworms.

Amniotes include reptiles and mammals

An amniotic egg has a leathery or hard outer layer surrounding a yolk that nourishes the developing embryo. Similar structures surround a mammal’s embryo.

The amniotic egg broke the tie to water

The amnion allows reptiles and mammals to breed in dry habitats.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are considered a clade of reptiles, although they used to be thought of as a separate group.

Reptiles were the first vertebrates to thrive on land

Reptiles evolved about 310 MYA. Many reptiles that once dominated the planet are now extinct.

Reptiles are adapted to retain water inside their bodies, and reproduce outside of it.

There are five main groups of reptiles

Turtles and tortoises have a tough shell

Turtles are aquatic whereas tortoises live on land. Their shells are fused with the vertebrae, making it an integral component of the skeleton.

Birds are warm, feathered reptiles adapted to flight

Feathers provide lift

Hollow bones keep the body lightweight

Specialized flight muscles attach to the breastbone

Mammals are warm, furry milk-drinkers

Mammals evolved about 200 MYA.

They are amniotes with hair and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-secreting mammary glands.

Monotremes are mammals that lay eggs

These animals have distinctive anatomy that is similar to reptiles – the digestive, urinary, and reproductive tracts share a single opening to the outside of the body.

Mammals and reptiles share a common ancestor

Unique mammal traits arose after mammals and reptiles diverged.

Mammary glands

Hair

Three middle ear bones

Four types of teeth

Four chambered hearts

Muscular diaphragm for breathing

Large brains

Marsupials are mammals that bear live young

Babies are very tiny at birth and spend additional time developing in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (pocket).

Eutherians are mammals that bear live young

Babies develop inside a uterus before birth. The placenta connects the maternal and fetal circulatory systems, nourishes, and removes waste from the developing offspring.