Animals

- **General Characteristics of Animals**
  - **Multicellular**
    - Cells are arranged in varying levels of organization
      - **Cell** - fundamental unit
      - **Tissue** - groups of cells working together
      - **Organ** - groups of tissues working together
  - **Heterotrophic**
    - Cannot make their own food and therefore must eat autotrophs or other heterotrophs in order to gain nutrients
  - **Require Oxygen**
    - Use aerobic respiration to convert compounds into energy
  - **Reproduction**
    - Animals reproduce sexually, and in many cases, asexually
  - **Motility**
    - Most animals are motile during at least part of the life cycle.
  - **Embryonic Development**
    - The life cycle includes stages of embryonic development
    - Embryonic cells give rise to primary tissue layers
      - **Ectoderm** - outer layer
      - **Endoderm** - inner layer
      - **Mesoderm** - middle layer
  - **Invertebrates vs. Vertebrates**
    - **Vertebrates** have a backbone. Invertebrates do not.
  - **Body symmetry and cephalization**
    - Animals are radial or bilateral in symmetry
      - **Radial symmetry** - body parts arranged regularly around a central axis, like the spokes of a bike wheel.
      - **Bilateral symmetry** - right half and left half are mirror images of each other
    - **Cephalization** - tendency for sensory structures to be located in a head region
      - Associated with bilateral symmetry
      - Implies a certain level of behavioral ability
  - **Gut** - tubular, sac-like region in which food is digested and absorbed into the internal environment.
    - **Sac-like guts** - one opening acts as mouth and anus.
    - **Tube-like guts** - two openings, complete with mouth and anus.
  - **Body Cavities** - region between the gut cavity and the epidermis (outer skin).
    - **Coelom** - one type of body cavity that has a unique tissue lining called a peritoneum
      - **Coelomate animals** - have a coelom with a peritoneum
      - **Pseudocoelomate animals** - have a pseudocoel, a body cavity w/o peritoneum
      - **Acoelomate animals** - lack a body cavity
- **Segmentation**
  - Segmented animals have a repeating series of body units that may or may not be similar to one another
    - Earth worms- all the segments are very similar
    - Insects- Segments are very different and are even grouped into body regions: head, thorax and abdomen.

- **Animal Evolution**
  - Most likely evolved from protistans
    - Hypothesis 1
      - Animals evolved from ciliates, like *Paramecium* and had multiple nuclei in a one-celled body.
      - As they evolved, the different nuclei became different cells.
    - Hypothesis 2
      - Evolved from spherical colonies of a number of flagellated cells.
      - Certain cells evolved particular functions

- **Vertebrates vs. Invertebrates**
  - Vertebrates have a backbone. Invertebrates do not.
    - 1.95 million species of invertebrates
      - 50,000 species of vertebrates

- **Invertebrate Phyla**
  - Simplest animal
    - *Trichoplax adhaerens* only known placozoan (‘plate’-‘animal’)
    - Consists of several thousand cells arranged in two layers.
    - Has no symmetry and no mouth
    - Slides along the sea floor and briefly humps up when it gets to food, which it digests externally absorbs food into its cells.
  - Porifera- The Sponges
    - Lack symmetry, tissues and organs
      - Organization is at the cellular level.
    - Mostly marine, though some live in freshwater.
    - Body is stiffened by silica or calcium carbonate spicules
    - Filter feeders
      - Water flows into the sponge body through many microscopic pres and chambers by way of beating collar cells, which have little ‘collars’ that trap food.
    - Reproduction
      - Sexual
        - Release sperm into the water and retain eggs until after fertilization
      - Asexual
        - Somatic embryogenesis- a whole new sponge can grow from fragmented bits of another.
  - Cnidaria- Sea anemones, corals, hydroids and jellyfish
    - Mostly marine, though some are freshwater
    - Radially symmetric
- Cells are arranged into tissue layers
- Feed by using nematocysts - poisonous, stinging cells that are shot out when touched
- Sac-like gut with one opening
- Common body forms are the polyp and medusa
  - Medusae float - think of a jellyfish
  - Polyps attach themselves to the bottom
- Each lining in the body has an epithelium, a tissue having a free surface that faces the environment of some type of fluid inside the body
- They have nerve cells within the epithelia that send signals to the contractile cells that cause the body to move
- Mesoglea - layer of gelatinous secreted material that acts as a gelatinous, hydrostatic skeleton.
  - Hydrostatic skeleton - volume of the body remains the same when contracted and therefore the shape changes.
- **Ctenophora** - Comb Jellies
  - Used to be part of the Cnidaria
  - Instead of using nematocysts, the use coloblasts, which are sticky cells
  - Propel by using cilia, not contracting their bells.
- **Platyhelmenthes** - The Flaworms
  - Bilaterally symmetric
  - Cephalized
  - Have simple organ systems with a sac-like gut
  - Hermaphrodites - both male and female simultaneously
  - Turbellarians
    - Mostly marine
    - Ex: Planaria
    - Reproduce asexually through transverse fission
  - Cestoda
    - Tapeworms
    - Parasitize the intestines of vertebrates
    - Attach by means of a scolex, a structure with suckers, hooks or both
- **Nemertea** - The Ribbon Worms
  - Bilateral
  - Acoelomate
  - Soft-bodied and elongated
  - Mostly marine
  - They have a complete gut, circulatory system and separation of the sexes.
  - Have a proboscis, which is a tubular, prey-piercing, venom-delivering device.
- **Nematoda** - The round Worms
  - Pseudocoelomate
- Bilaterally symmetric
- Covered by a touch cuticle outer covering.
- Simplest animal with a complete digestive system
- Most are free-living, but some are serious parasites
  - Hosts include: humans, cats, dogs, sheep, potatoes, sperm whales and others.

  o **Rotifera** - The Rotifers
    - Bilateral and cephalized
    - Mostly live in freshwater
    - <1mm
    - Have pharynx, esophagus, digestive glands, stomach, intestine and anus
    - Some have ‘eyes’
    - Two ‘toes’ exude substances that attach free-living individuals to substrates at feeding time.
    - Have a crown of cilia on the head that assists in swimming and wafting food toward the mouth.

  - **Coelomate Animals**
    - **Protostomes vs. deuterostomes**
      - **Protostome**
        - In embryos cleavage is oblique to the original body axis
        - First opening to form is the mouth
        - Coelom arises from spaces in the mesoderm
        - Examples
          - Mollusks, annelids and arthropods
      - **Deuterostome**
        - In embryos cleavage is parallel and perpendicular to the original body axis.
        - First opening to form is the anus
        - Coelom arises from the gut wall
        - Examples
          - Echinoderms and Chordates

  o **Mollusca** - Mollusks: Clams, squid, octopus and snails (*molluscus* means soft in latin, referring to their soft bodies)
    - Bilateral, coelomate animals with a complete digestive system
    - Have a mantle, which secretes the calcium carbonate shell found in snails.
    - Most mollusks have a fleshy foot.
    - Many have a radula, a rasping tongue
    - Examples:
      - Chitons:
        - Most ancestral
        - Have 8 plates on their backs
        - Rocky intertidal grazers
      - Bivalves – ‘two’-‘shells’
        - Clams, scallops, oysters and mussels
• Filter feeders with incurrent and excurrent siphons.
• Live buried in sand or wedged between rocks.

• Cephalopods- squid and octopus
  o Have mostly lost their shells, though squid have a remnant piece internally.
  o Very fast and very intelligent
    ▪ Use jet propulsion to move through the water
    ▪ Largest brain-to-body ratio of any mollusk
      • Octopus are smarter than cats.

• Gastropods- ‘Stomach’-‘Foot’: snails and slugs
  o Slugs are snails that have lost their shells
  o Eat with a **radula**
  o Snails have this weird thing, where their intestines have gotten all twisted around because of their shell, and they consequently excrete on their own heads.

• **Annelida**- Means ‘Ringed Forms’- The Segmented Worms, e.g. the earthworm
  ▪ Bilateral symmetry, complete digestive system
  ▪ Hermaphroditic
  ▪ Hydrostatic Skeleton
  ▪ Segmentation has great evolutionary potential
    • Individual parts can undergo modification for specialization of tasks
    • Polychaetes are a great example of this
      o Jaws
      o Tentacles
      o ‘Paddles’
  ▪ Many have bristles on the segments that grip the substrate as the worm pushes its way through.
  ▪ They have a rudimentary brain, with a paired nerve cord
  ▪ System of nephridia, which regulates the composition of internal fluids, much like kidneys.
  ▪ Closed circulatory system

• **Arthropods**- ‘Jointed’-‘feet’
  ▪ Evolutionarily, the most successful of all living organisms
    • Most species, most habitats, exploiting the most different types of food.
  ▪ Bilateral, ceolomates with complete digestive and circulatory systems.
  ▪ Six Important Adaptations
    • Hardened exoskeleton made of chitin
      o Used in defense against predation
      o Evolutionarily, it has been molded into a myriad of different forms. Think of it like nature’s plastic.
- Restricts water loss.
- Arthropods must grow by molting

- Jointed appendages
  - Allows the hardened exoskeleton to move
  - Led to the evolution of things such as antennae, wings, and legs

- Fused and modified segments
  - Ancestral arthropods were similar to annelids
  - The fusing and modification of segments into regions of the head, thorax and abdomen allowed for more morphological diversification.

- Respiratory structures
  - Many aquatic arthropods depend on gills for gas exchange.
  - Land dwellers have tubes that bring oxygen directly to the tissues.

- Specialized sensory structures
  - Intricate eyes and other sensory organs contributed to arthropod success

- Division of Labor
  - The job of surviving is divided amongst different stages of development.
  - Many undergo **metamorphosis**
    - Egg-larva-adult
    - Each stage may be adapted to a specific, and different lifestyle
      - Ex: Caterpillars and moths
      - Dragonfly nymphs and dragonflies

- Major groups of arthropods
  - Chelicerates
    - Marine:
      - Sea spiders, horseshoe crabs, some mites
    - Terrestrial
      - Arachnids
      - Spiders, scorpions, ticks and chiggers
      - Segments fused into a forebody and a hindbody
      - Four pairs of legs, a pair of pedipalps for sensing and a pair of chelicerae that inflict wounds and discharge venom.
      - Hindbody spins out threads for webs and egg cases
      - Open circulatory system
• Crustaceans: called so because they have a flexible, yet hard crust.
  o Mostly marine
    ▪ Shrimp. Crabs, lobster, copepods, barnacles
  o Some terrestrial
    ▪ Millipedes, centipedes, pill bugs
  o Many have 16 or 20 segments
  o In shrimp, crabs and lobsters, the head and thorax are fused into the cephalothorax.

• Insects
  o Head, thorax and abdomen
  o Three pairs of legs and usually two pairs of wings
  o Three part gut
  o Only winged invertebrates
  o Life stages include a nymph and pupal, as well as a larval stage.

  o **Echinodermata** -‘Spiny’ - ‘Skin’: Sea stars, sea urchins, sea cucumbers, sand dollar and brittle stars
    ▪ Number of spines with a rigid calcium carbonate endoskeleton
    ▪ Radially symmetric.
    ▪ No brain, but a decentralized nervous system that responds to information from all directions.
    ▪ Move by using tube feet, which have suckerlike adhesive disks
    ▪ Water vascular system acts as a hydraulically driven musculature
    ▪ Sea stars pry open their prey, insert their stomachs and then digest.