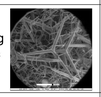
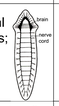
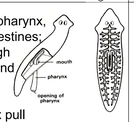
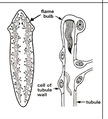
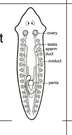
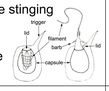
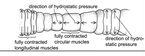
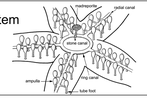
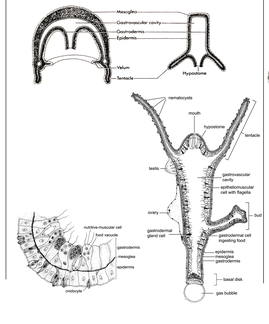
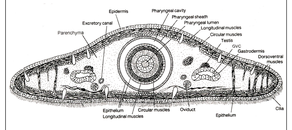
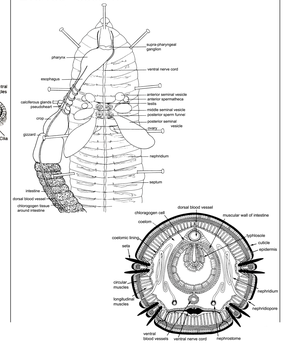
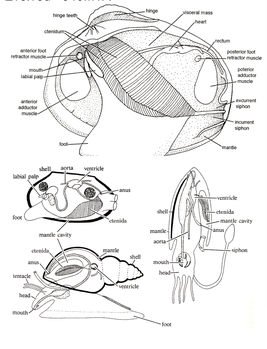
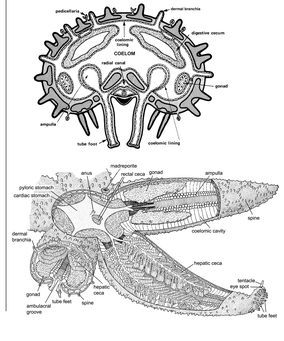
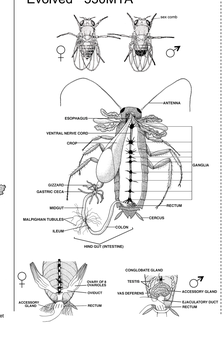
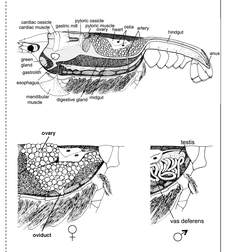
Phylum	PORIFERA	CNIDARIA	PLATYHELMINTHES	ANNELIDA	MOLLUSCA	ECHINODERMATA	ARTHROPODA		CHORDATA
Groups (organisms studied in detail in Bio1AL are underlined)	**Hexactinellida** -- glass (siliceous) sponges **Demospongia** -- spongin or siliceous sponges **Calcarea** -- calcareous sponges **Scleropongiae** -- coralline or tropical reef sponges	**Anthozoa** -- corals and sea anemones **Hydrazoa** -- hydras, some corals **Cubozoa** -- box jellyfish, sea wasps **Scyphozoa** -- jellyfish, sea nettles	**Turbellaria** -- free-living or symbiotic flatworms (*Dugusia*) **Trematoda** -- flukes (parasitic) **Cestoda** -- tapeworms (parasitic) **Monogenea** -- parasitic flatworms	**Polychaetes** -- segmented bristleworms **Oligochaetes** -- earthworms (*Lumbricus*) **Hirudinea** -- leeches	**Gastopods** -- snails and slugs **Bivalves** -- clams, scallops, mussels **Cephalopods** -- squid, octopus, nautilus **Polyplacophora** -- chitons	**Asteroidea** -- starfish **Echinoidea** -- sea urchins, sand dollars **Holothuroidea** -- sea cucumbers **Ophiuroidea** -- brittle stars **Crinoidea** -- sea lily, feather stars	**Trilobitomorpha** -- tribolites (extinct) **Chelicerata** **Arachnida** -- spiders, scorpions **Xiphosura** -- horseshoe crabs **Mandibulata** **Crustacea** -- crustaceans (shrimp, crayfish **Hexapoda** -- insects (cockroach, fruit fly) **Myriapoda** **Chilopoda** -- centipedes **Diplopoda** -- millipedes		**Urochordata** -- tunicates **Cephalochordata** -- lancelets **Mixini** -- hagfish **Petromyzontida** -- lamprey **Chondrichtyes** -- sharks, skates **Actinipterygia** -- ray-finned fish **Sarcopterygia** -- lobed-finned fish **Amphibia** (frog, newt) **Reptilia** (snake, turtle) **Aves** (chicken, hummingbird) **Mammalia** (human, rat)
							Hexapoda	**Crustacea**	
Symmetry	Asymmetrical or radial	Radial, about the axis of the mouth surface	Bilateral	Bilateral	Bilateral	Radial; but larvae bilateral	Bilateral	Bilateral	Bilateral
Coelom and Body Organization	No Coelom Specialized cells (including chaonocytes and amoebocytes), but lack true tissues Canal system of pores	No Coelom Specialized cells organized into tissues Lack organs	No Coelom Have true organs, with solid mass of mesodermal parenchyma cells surrounding organs	True coelom Metamerism - repetition of body parts (hearts, nephridia, reproductive organs) Septa separate segments (somites)	Well-developed coelom	Well-developed coelom	Well-developed coelom	Well-developed coelom	Well-developed coelom
Germ Layers and Development	No true germ layers Two cell layers: Pinacocytes form outer cells of epidermis Chaonocytes line inner cavities Cell layers separated by gel layer called mesenchyme	Two germ layers: Ectoderm becomes epidermis Endoderm becomes inner gastrodermis Two stages in the life cycle: free-swimming medusa stage and the sessile polyp stage	Three germ layers: ectoderm, mesoderm, endoderm	Three germ layers: ecto-, meso-, endo- Protostome	Three germ layers: ecto-, meso-, endoderm Protostome	Three germ layers: ecto-, meso-, endoderm Deuterostome	Three germ layers: ecto-, meso-, endoderm Protostome Can be hemimetabolous (like cockroach) or holometabolous (like fruit fly)	Three germ layers: ecto-, meso-, endoderm Protostome	Three germ layers: ecto-, meso-, endoderm Deuterostome
Respiratory system	Diffusion	Diffusion	Diffusion	Use hemoglobin as respiratory pigment dissolved in blood (no red blood cells)	Sinuses collect hemolymph and transport to ctenidia for gas exchange	Gases diffuse via dermal branchiae; soluble wastes released by simple diffusion across surface epithelium	Air enters lateral spiracles, through trachea, into tracheoles throughout body; no respiratory pigment	Gills; use blood to transport O_2 and CO_2; respiratory pigment in plasma is hemocyanin	Gills, functionally replaced by lungs in higher vertebrates; use blood to transport O_2 and CO_2; respiratory pigment is hemoglobin
Circulatory system	Specialized cells called chaonocytes contain flagella that produce a current moving water through pores in body	Gastrovascular cavity (GVC) Cilia lining cavity move fluid and food	Gastrovascular cavity (GVC)	Closed circulatory system (blood contained within vessels); dorsal blood vessel and ring-like hearts contract rhythmically	Open circulatory system; hemocyanin dissolved in plasma; lymphocytes present; a few bivalves and gastropods use hemoglobin and have erythrocytes; dorsal heart beats rhythmically to create pressure; hemolymph forced into aorta and carried into tissues by open vessels	Open circulatory system; poorly-defined channels in coelomic cavity; lack heart; cilia associated with water vascular system circulate coelomic fluid	Open circulatory system; dorsal vessel carries hemolymph anteriorly, into cavities surrounding organs, then flows posteriorly and back into dorsal vessel	Open circulatory system; heart → arteries →tissue sinuses →gills → pericardial sinus →return to heart	Closed circulatory system (except cephalo- and uro-); ventral two- to four-chambered heart (except cephalo- and uro-); respiratory pigment is hemocyanin (cephalo- and uro-) or hemoglobin
Skeletal system	Diverse skeletal elements depending on type, including calcareous laminae, organic filaments, and siliceous and calcium carbonate spicules 	Mesoglea: space between epidermis and gastrodermis; filled with extracellular matrix. Functions like endoskeleton, but is not considered cellular layer	Hydraulic skeleton - gastrovascular fluid; longitudinal and circular muscles	Hydraulic skeleton - coelomic cavity filled with fluid	Hard exoskeleton; outer organic layer rests on layers of calcium carbonate; exoskeleton reduced or absent in most cephalopods	Calcareous endoskeleton made up of small plates joined by connective tissue	Chitinous exoskeleton secreted by underlying epidermis; limits growth; requires molting	Chitinous exoskeleton (with some calcium carbonate) secreted by underlying epidermis; limits growth; requires molting	Bony or cartilaginous endoskeleton
Nervous system	No cephalization or specialized sensory cells	Primitive; forms irregular net Responds to stimuli in a coordinated fashion (outer tentacle engulf while inner tentacles contract Limited sensory capabilities; no cephalization	Organized like a ladder with two lateral cords connected by transverse cords; some cephalization with sensory, association, and motor neurons; pigmented eyespots but no imaging 	Cephalization; suprapharyngeal ganglia (in somite 3) connects to ventral nerve cord; nerves branch out to adjacent tissues	Limited cephalization, except cephalopods, which have giant nerve cells, complex sensory system with image forming eyes and complex behavior	No cephalization; nerves distributed throughout arms and central disk; no special sense organs (except starfish and brittle stars have light-sensing “eyes” on end of each arm	Extensive cephalization; flattened, double, ventral nerve cord; ganglia along length of cord have strand-like nerves branching outward	Extensive cephalization; double, ventral nerve cord; ganglia along length of cord	Extensive cephalization; dorsal, hollow nerve cord; often protected by vertebrae
Digestive system	Suspension feeders Specialized cells called chaonocytes contain flagella that produce a current through pores in body; chaonocytes ingest food by phagocytosis Specialized amoebocytes distribute food throughout body	Tentacles used to gather food GVC functions in food distribution and digestion; gastrodermis lines cavity and has glands that secrete proteases Nutritive muscular cells form pseudopods that engulf partially digested food and transport them to vacuoles where final digestion takes place	GVC consists of mouth, pharynx, and three branched intestines; pharynx extends through mouth during feeding and secrete digestive enzymes; muscular contractions of pharynx pull food into mouth 	Complete (both mouth and anus); includes pharynx, esophagus with calciferous glands, crop, gizzard, and intestine	Complete; specialized for filtering small food particles from water Cilia lining ctenidia draw water into mantle cavity through incurrent siphon; from mantle, labial palps direct food to mouth; esophagus, stomach, digestive glands; waste exits anus into excurrent siphon	Mouth on oral surface leads to cardiac stomach (everted during feeding), then to pyloric stomach with hepatic (digestive, pyloric) ceca extending into each arm; short intestine with out-branching rectal ceca leads from pyloric stomach to anus on aboral surface	Complete; including crop and gizzard (with chitinized teeth) in foregut, digestive (gastric) ceca in midgut, ileum, colon, rectum in hindgut	Short esophagus; large, two-chambered stomach: anterior cardiac chamber with gastric mill (with chitinized teeth), and pyloric chamber; large digestive glands beneath stomach release enzymes into gut	Complete; including in rat: pharynx with three regions, esophagus, stomach, small intestine with three regions, liver, pancreas, cecum, large intestine
Excretory system	Diffusion and out pores	Diffusion	Nitrogenous waste diffuses into surrounding environment; protonephridia regulate ion balance; cilia line blind tubes open to outside; undigested food expelled out mouth 	Pair of nephridia (primitive kidneys) within each somite; opens into coelom by a ventral ciliated funnel and empties into exterior by pore in ventral wall	Nitrogenous wastes excreted into excurrent siphon by pair of kidneys; some ammonia eliminated by ctenidia	Lack excretory organs	Malpigian tubules at junction of mid- and hind-gut function in removal of nitrogenous wastes from hemolymph in coelom for transfer to hindgut for excretion	Green gland filters nitrogenous wastes from hemolymph and excretes near base of antenna	Nitrogenous waste filtered by pair of kidneys
Reproduction	Most are monoecious (hermaphroditic); sperm released into water current with internal fertilization Some also asexual (mitotic cell divisions produce a bud that is pinched off from parent)	Most both sexual and asexual (mitotic cell divisions produce a bud that is pinched off from parent); Hydra can be either dioecious or hermaphroditic	Both Asexual, via regeneration when cut Sexual; most hermaphroditic with cross-fertilization 	Hermaphroditic with cross-fertilization Clitellum secretes mucus for reproductive processes	Sexual; dioecious Pair of gonads empties gametes into excurrent siphon	Sexual; dioecious Gonads near base of each arm under hepatic ceca Some starfish can reproduce asexually by regeneration	in cockroach: Sexual; dioecious Male has pair of testes, vas deferens, accessory gland Female has pair of ovaries with 8 ovarioles, accessory glands	in crayfish: Sexual; dioecious Male has pair of three-lobed testes, vas deferens, modified swimmerets Female has pair of ovaries, oviduct	Sexual; dioecious (except urochordates are monoecious)
Defense	Many secrete toxins	Tentacles contain specialized cells called cnidocytes, which have stinging organelles called nematocysts, which discharge harpoon-like projections with toxins 			Burrowing with muscular foot; hard exoskeleton (shell-reduced in cephalopods) Ink used by some cephalopods	Spines	Exoskeleton	Exoskeleton; pincers	Various
Locomotion	Sessile (motile larval phase)	Tentacles and body contract and release for swimming in medusa stage In polyp stage, nematocysts help attaching to substratum	Ventral surface covered in cilia Thin strands of dorsiventral muscles pass through parenchyma Outer circular and inner longitudinal muscle layers beneath epidermis	Localized, coordinated muscle contractions (longitudinal vs. circular) Anchoring by setae 	Muscular foot	Water-vascular system 	Jointed legs, wings	Jointed legs, swimmerets	Various, including fins, legs, and wings
Notes	~6,000 species Mostly marine, but some freshwater Can live independently or in colonies Evolved ~600 MYA	~10,000 species, mostly marine Hydra are freshwater, and have no medusa stage Evolved ~580MYA 	~15,000 species 80% are internal parasites Evolved ~550MYA 	~15,000 species Evolved ~530MYA 	~100,000 species; second largest phylum of invertebrates Evolved ~540MYA 	~7,000 living species; exclusively marine Evolved ~600MYA 	Most diverse phylum; over 1,000,000 species; 90% of animals species are in this phylum Evolved ~530MYA 		~45,000 living species Evolved ~530MYA