Domain/Kingdom, Phylum, Subphylum, Class, Order, Suborder, Family, Genera, Species
Domain Archaea & Bacteria: Prokaryotic: single-celled with no nucleus. Autotrophs and heterotrophs. Some chemosynthetic and capable of handling high pressures and temperatures. Some roles in oceans: base of food chain, converters of nitrogen gas into useful forms for organisms, decomposers. *Cyanobacteria* (*stromatolites*).
Domain Eukarya: Kingdom Protista: Eukaryotic: cells contain a nucleus. Heterotrophs and autotrophs. Mostly single celled, but some autotrophs are colonial and/or multicellular. All autotrophs use chlorphyll *a* as their primary photosynthetic pigment. (Grab bag kingdom: all eukaryotes that aren't fungi, plants, or animals.)
Unclassified: Amoebas and their relatives. Mostly heterotrophs. Move and feed by cellular extensions. *Foraminiferans ($CaCO_3$ shells) and Radiolarians (SiO_2 shells).*
Phylum Haptophyta: Single or multicelled. Mostly autotrophic with brown accessory pigments. All have two flagella and a haptonema structure (a third flagella used to move molecules). *Coccolithophores* (single celled with $CaCO_3$ shells).
Phylum Dinophyta: Mostly single-celled flagellates with two dissimilar flagella. Heterotrophic and autotrophic forms. *Dinoflagellates (including zooxanthellae).*
Phylum Ochrophyta: **Brown algae**. Single or multicelled. Mostly autotrophic with brown accessory pigments. *Diatoms* (single celled, with SiO_2 shells), *Kelps (oakblade kelp, feather boa kelp, giant kelp, bullwhip kelp), sea palms, rockweed.*
Phylum Rhodophyta: **Red algae**. Autotrophic; red accessory pigments. *Encrusting and articulated coralline algae, brillo pad algae, Neptune's washcloth, sea sacs, irridescent algae, nori.*
Phylum Chlorophyta: **Green algae**. Mostly autotrophic with chlorophyll *b, β-carotene, and other carotenid* accessory pigments. *Sea strings, sea lettuce, ocean pin cushion.*
Domain Eukarya: Kingdom Fungi: Eukaryotic. Multicellular heterotrophs. No photosynthesis. Most are decomposers that live embedded in their food source, secreting digestive enzymes and absorbing products. *Mushrooms, fungi, molds, lichen; mostly land, freshwater, or highest supratidal organisms: keep algae moist.*
Domain Eukarya: Kingdom Plantae: Eukaryotic. Photosynthetic multicellular autotrophs that evolved from Green algae. Primarily terrestrial. Roots, leaf-bearing shoots; gas exchange through leaves. Waxy coating on leaves prevents excessive water loss. Hardening of cell walls of woody tissues for support on land. Only division found in marine environment is Anthophyta: **Angiosperms**. Flowering plants; roots, covered seeds. Most species are freshwater or terrestrial. *Marine eelgrass, manatee grass, surfgrass, turtle grass, salt marsh grasses, mangroves.*
Domain Eukarya: Kingdom Animalia: Eukaryotic. Multicellular heterotrophs.
Phylum **Porifera**: *Sponges.* Simplest of all marine animals. Sessile. Porous. Filter feeders. No nervous, digestive, respiratory, or circulatory system. Diffusion of wastes, nutrients, gases in and out cell walls. (Separate holes for in/out.) Water drawn into pores by beating of flagellated cells inside body. Body walls supported by spicules (SiO_2 or $CaCO_3$). Filters 3000x body volume/day.
Phylum **Cnidaria**: Jellyfish and their kin; all equipped with stinging cells. 9,000 species. Radial symmetry. Mouth, the only opening, is shaped like hollow pouch: tentacles line opening. Hollow = digestive cavity. Diffusion moves wastes and gases between mouth and body. No excretory or circulatory system. Reproduce by fission of polyps (sessile; mouth up) usually creating colonies or produce medusae (planktonic; mouth down) forms, which swim away, produce sperm and eggs, which combine to create polyp. (Some species do both.) Carnivores, save rare types with zooxanthellae. Class Hydrozoa: Most alternate and medusa forms. *Port. man-of-war, Hydroids, Siphonophores.* Class Scyphozoa: No (or reduced) polyp stage in life cycle. Free-swimming medusa. *Sea wasps. Jellyfish. Nettles.* Class Anthozoa: Medusa stage absent. Polyps only. *Sea anemones, coral.*
Phylum **Bryozoa**: Most widespread and numerous sessile marine animals. Small, encrusting colonies. Live inside conjoined calcite square boxes/shells. LOPHOPHORES (all have circular structure spirally wound and lined around entire perimeter with ciliated tentacles). U-shaped digestive tract. No head. Filter feeders.
Phylum **Mollusca**: (58,000 marine species). Soft bodied, usually protected by a hard $CaCO_3$ shell. Three parts to body: muscular foot, usually used for movement; visceral mass containing most internal organs; mantle: a fold of tissue that drapes over visceral mass and secretes shell if one present. Many have toothed radula used for digging holes in rocks, removing algae from rocks, etc. Most have gills, anus, and excretory pores. Obvious heads, flow-through digestion, well-developed nervous system. Most have separate sexes with gonads (ovaries or testes). Class Polyplacophora: Shell with eight plates (articulated). Head reduced. *Chitons.* Class **Gastropoda**: Asymmetric body plan, usually with coiled shell. Foot cannot attach to sand or mud. Grazers, suspension feeders, predators, some planktonic. Radula rasped across rocks, kelp stipes, or surfaces. 43,000 sp. *Snails, limpets, abalones, pteropods, sea slugs* (*nudibranchs*; no shells), *sea hares, whelks*. Class **Bivalvia**: Enclosed in twin shells. Head reduced. Filter feeders. Paired gills. Dig with foot. Mantle forms siphons that extend to obtain water and eject waste. 13,000 sp. *Clams, oysters, scallops, mussels.* Class **Cephalopoda**: Head surrounded by foot, divided into tentacles. Stiff adhesion discs on tentacles (suction cups) catch prey. Sharp beaks tear and bite. Shells reduced, absent, or internal. Locomotion by jet propulsion using siphon made from mantle. 450 species. *Squid, octopuses, nautiloids, cuttlefish.*

Phylum **Annelida**: Segmented bilaterally symmetrical worms. Each segment has its own circulatory, excretory, nervous, muscular, and respiratory systems. Some are specialized, such as the head. 5400 species. Primary Class: Polychaetes (many bristles). Brightly colored or irridescent with pairs of bristly projections extending from each segment. Can be herbivores, carnivores, deposit feeders, filter feeders (tube dwellers). *Feather Duster worm.*

Phylum **Arthropoda**: Segmented. Body of two or three parts. Three or more pairs of legs. Jointed appendages (pincers, mouthparts, walking legs, and swimming appendages; and two pairs of sensory antennae). Bilateral symmetry. Exoskeleton. Striated muscles. Head with pair of eyes. Most successful of all animal phyla.

Subphylum **Crustacea**: Jawlike mandibles (30,000 species*). Copepod, barnacles, krill, isopods, amphipods, shrimp, lobsters, crab, euphasiids.*

Subphylum Chelicerata: Clawlike feeding appendages. *Horseshoe crabs, sea spiders, (trilobites).*

Phylum **Echinodermata**: Sessile or slow-moving benthos. Internal and external parts radiate from center, often as five spokes. Thin skin covers endoskeleton of hard calcareous plates. Most prickly from skeletal bumps and spines. Use water-vascular system: a network of hydraulic canals branching into extensions called tube feet that are used to move, feed, and exchange gases. 6000 species. Lack eyes or brain. *Sea stars, Brittle stars, basket stars, sea urchins, sand dollars, sea biscuits, sea cucumbers.*

Phylum **Chordata** (45,000 species); Four structures appear at some point during lifetime: notochord, dorsal, hollow nerve chord, gill slits, muscular, postanal tail.

Subphylum **Urochordata**: *Tunicates (sea squirts)*. Mostly sessile. Filter feeders. Some colonial. Covered by tunic with 2 openings: water in and water out.

Subphylum **Vertebrata**: Retain primitive chordate traits, with specializations. Larger and more active. Backbone; internal skeleton of calcified bone, cartilage or both.

Superclass Agnatha: **Jawless fishes**. 50 species. Cartilaginous skeleton. Rasping tongue. Notochord. No paired appendages to swim. *Lampreys, hagfishes.*

Superclass Gnathostomata: Hinged jaws. Notochord largely or completely replaced by vertebrae in adults. Paired appendages.

Class Chondrichthyes: **Cartilaginous fishes**. Cartilaginous skeleton and jaws with teeth. Respiration through gills. Internal fertilization (eggs or live birth); acute senses including lateral line. Paired fins. No swim bladder. Gill slits instead of operculum. *Sharks, skates, rays, sawfish, chimeras.*

Class Osteichthyes: **Bony fishes**. Hard, strong, light-weight bony skeletons and jaws. Operculum covers gills. Most have external fertilization and lay large numbers of eggs. Respiration through gills. Many have swim bladder. *Salmon, pike, parrot fish, barracuda, tuna, etc.*

Class **Reptilia**: Tetrapods with scaly skin; respiration via lungs; lay amniotic shelled eggs or give live birth. Ectotherms. Special salt glands concentrate and excrete excess salts from body fluids. Except for one turtle, require warm waters. *Sea snakes* (50 species). *Marine crocodile* (1 species): lives in mangrove swamps and reef islands. *Sea turtles*: small streamlines hells without space to retract head or limbs. No predators as adults, save humans.

Class **Aves**: Birds. Tetrapods with feathers. Forelimbs modified as wings. Respiration through lungs. Internal fertilization. Breed on land. Lay eggs on land. Shelled amniotic eggs. Acute vision. Endotherms. *Penguins (*No ability to fly. Use wings to swim. Great maneuverability.) *Gulls*. 115 species. *Pelicans*. // *Albatross, petrels*. *Tubenoses*. (Beak: sense airspeed, smells, and ducting for removing saline water from glands.)

Class **Mammalia**: Tetrapods with young nourished from mammary glands of females. Hair. Diaphragm that ventilates lungs. Endothermic. Amniotic sac. Most give live birth. 4300 marine species (all evolved from land mammals, returning to sea 30-40 Ma).

Order **Cetacea**: 79 species. Fish-shaped bodies; paddle-like forelimbs and no hind limbs. Thick layer of insulating blubber.

Suborder Odontoceti: **Toothed whales**; *Pilot whales, belugas, killer whales, bottlenose dolphins. Porpoise. Sperm whale. Narwhales.*

Suborder Mysticeti: **Baleen whales** *Gray whales*. Short baleen. Can sieve bottom seds. // *Humpback, fin, sei, blue, Bryde's, minke*. Dorsal fins and grooved distensible throats expand like balloons. Swallowers. //*Black right whale, bowheads*. Lack grooved throats and dorsal fins. Largest baleen. Skimmers.//

Order **Sirenia**: Herbivores. Possess finlike forelimbs and no hind limbs. *Manatees, Dugongs*.

Order **Carnivora**: Carnivorous. Possess sharp, pointed canine teeth and molars for shearing. Clawed toes.

Suborder Pinnipedia. Flipper-footed. Can safely come out on land to rest, breed, and give birth. Thick, insulating blubber.

Family Phocidae: True seals; No external ear (hole only). Crawl on land because front flippers are small, and hind flippers cannot rotate forward. Swimming power from large, almost fan-like rear flippers. *Harbor seals, elephant seals*.

Family Otariidae: External ear. Rotatable rear flippers: can walk on land. Swimming power from large front flippers. *Fur seal, sea lion*.

Family Odobenidae: Two long tusks. No external ear. Rotatable rear flippers: can walk on land. Two large air pouches extend from each side of the pharynx; inflate to hold head above water when sleeping, or used as resonance chambers for underwater sounds. *Walrus.*

Suborder Fissipedia: Toe-footed carnivores (usually land animals). No blubber – warmth comes from fur.

Family Mustelidae: Smallest marine mammals. Usually do not inhabit the open ocean. Live among coastal kelp beds, where they dive and hunt for a variety of shellfish and marine invertebrates. Exceptionally thick dark fur; a longer tail; no true flippers. *Sea otters*.

Family Ursidae: Bear family. Only marine species: *Polar bear.* Carnivorous. Depends on the ocean for a majority of food. Large head, heavily built body. Stocky legs terminate in paws, with hairy soles, and five claws. Spend most of the winter asleep in a den living off stored fat reserves.