

## Diversity of Marine Animals

### Subphylum Vertebrata

- Within phylum Chordata
- Unlike invertebrate chordates, vertebrates have:
  - Vertebral column
  - Enclosed nerve cord

### Marine Fishes

- Fishes are ~ half of all vertebrate species
- Class Agnatha - jawless fishes
  - Hagfishes and lampreys
  - None in Hawaii
- Class Chondrichthyes - (or cartilaginous fishes) sharks and rays
  - Sharks: most marine, cartilaginous skeleton, paired lateral fins, often heterocercal tail, placoid scales, biting jaws with replaceable teeth, 5-7 gill slits, oil in liver, may be oviparous or ovoviviparous, claspers for internal fert.

### Classification of Fishes (graphic)

#### More Marine Fishes

- Like other vertebrates, salt conc 50% of seawater...osmotic problem
  - Concentrations of urea, and trimethylamine oxide (TMAO) protects proteins from urea
- Class Osteichthyes
  - Bony fishes: bony skeleton, cycloid or ctenoid scales, operculum, flexible fins (spines, rays), many with swim bladder
  - Subclass Crossopterygii - (lobe-finned fishes) coelacanth

### Osmoregulation of Elasmobranchs (graphic)

#### Coelacanth (graphic)

#### Even More Marine Fishes

- Subclass Actinopterygii - (ray-finned fishes)
  - Infraclass Teleostei - about 58% are marine
    - Hypoosmotic to seawater: drink seawater, and excrete salts via kidney and chloride cells in gills
  - Other infraclasses - sturgeons and gars

### Osmoregulation of Bony Fishes (graphic)

#### Ecology of Color

- Warning coloration -beware
- Cryptic coloration – for camouflage
  - Blending with background - ability of chromatophore pigments to constrict/expand
  - Countershading
- Disruptive coloration – for camouflage (stripes) or confusion (eye spot)

### Propulsion (graphic)

#### Behavior

- Complex behavior associated with courtship and reproduction, migration and homing, schooling, territorial maintenance

### **Counter Current Exchange (graphic)**

#### **Reproductive Migration**

- Marine fish moving to freshwater for reproduction – anadromous
  - Salmon, lampreys, smelt, sturgeons
- Freshwater fish moving to salt water for reproduction – catadromous
  - Freshwater eels
  - The larvae of some freshwater gobies (‘O`opu) in Hawaii

#### **Tetrapods**

- Four Legged, air breathing (terrestrial ancestor and must return to surface), period in water variable but usually at least for food
- Class Amphibia - Marine Amphibians
  - Absent

#### **Marine Tetrapods**

#### **Marine Reptiles**

- Class Reptilia –
  - Order Chelonia (turtles) and order Squamata (snakes, and iguana)
  - Oviparous vs. ovoviviparous (sea snakes)
    - Both require internal fertilization
  - Hypoosmotic - nasal glands near eyes secrete salt at twice concentration of seawater and kidneys produce uric acid (almost non-toxic) to conserve water
    - Able to drink seawater due to efficiency

#### **Marine Birds**

- Class Aves
  - Order Procellariiformes (albatrosses, shearwaters, petrels), order Charadriiformes (terns) and order Pelecaniformes (frigate birds)
  - Feathers, flight and feeding adaptations, deal with osmotic problems much like reptiles, oviparous, homeothermic (insulation and countercurrent)
  - Some with little time in marine environment, others a good deal of their life

#### **Marine Mammals**

- Class Mammalia
  - Order Pinnipedia - seals, sea lions, walruses
  - Order Carnivora - sea otters, polar bears
  - Order Cetacea - whales, dolphins, porpoises
    - Toothed (suborder Odontoceti) vs. baleen (suborder Mysticeti) whales
  - Order Sirenia - manatees, dugongs
  - Homeothermic, viviparous, mammary glands, body hair, reproductive tract separate from digestive tract