Bio 20 Marine Biology – Exam 3 Outline

Marine Fishes (Chapter 8)

I. Classification of Fishes

Vertebrates have the 4 basic characteristics of chordates:

Plus vertebrate characteristics:

II. Fish Facts
- Fishes were the 1st vertebrates (appeared > 500 mil. years ago).
- Evolved from invertebrates particularly lancelets or tadpole larvae of sea squirt.
- Most abundant vertebrates in both species & individuals.
- About 58 % of species are marine.

III. Types of Fishes – 3 major groups (fig. 8.1)

A. Class Agnatha (jawless fishes) – most primitive fishes living today
   Ex. Hagfish (slime eels), lampreys

B. Class Chondrichthyes (cartilaginous fishes)
   Ex. Sharks, rays, skates, ratfishes
1. Sharks – “living fossils” similar to species that swam the seas over 100 mil years ago

2. Rays & Skates

3. Ratfishes (chimaeras)

C. Class Osteichthyes (bony fishes) – 96 % of fishes

IV. Biology of Fishes
   A. Body Shape – (fig. 8.9)
B. Coloration

Read “Coloration” pp. 160-161 and define the following coloration patterns and state what habitat fish with each pattern tend to be found:

1. Warning coloration

2. Cryptic coloration

3. Disruptive coloration

4. Countershading

C. Locomotion & Buoyancy – different betw. sharks & bony fish (fig. 8.12)

D. Getting Oxygen

1. Dissolved oxygen diffuses into capillaries of gill filaments to oxygenate blood.

2. Countercurrent flow system – (fig. 8.17) blood in the gills flows in the opposite direction to the water passing over them. When water has passed over gill and has given up much of is oxygen, it meets blood that has just come from the body and is hungry for the remaining oxygen in the water.
E. Regulating Internal Environment (diff. betw. cartilaginous & bony fish) (fig. 8.18). Cartilaginous and bony fishes are osmoregulators meaning that they keep a constant internal environment. Read “Regulation of Internal Environment” p. 166 and describe how bony fishes osmoregulate and describe how cartilaginous fish osmoregulate.

F. Sensory Organs (fig. 8.19): Can fish smell, taste, hear and feel?
1. Smell:

2. Taste:

3. Hearing:

4. Lateral line:

5. Ampullae of Lorenzini
Read the online article “The Shark’s Electric Sense” and answer the following:
1. What does electroreception help sharks and some fish do and under what conditions is it especially useful?

2. It was determined that the ampullae of Lorenzini probably do not detect weak forms of bioelectricity like brain waves and heart muscle contraction. What electric fields do they detect and what produces these electric fields?

3. Briefly describe what inventors and scientists are developing in order to save sharks from being unintentionally caught by fishers.

4. Briefly describe what shark senses are employed when a shark is 1) at a great distance from prey, 2) closer to its prey, and 3) less than a meter from its prey.

G. Behavior of Fishes
Read “Schooling” and “Migrations” pp. 168-172 and state why fish school and migrate. Also define how anadromous and catadromous fishes migrate:
1. Schools (fig. 8.21) - well coordinated groups of fish
   a. Why school?

2. Migrations – mass movements from one place to another (can be once a day, a year, a lifetime) (fig. 8.22)
   a. Why migrate?
b. Anadromous – (ex. Sturgeon, salmon, lamprey, smelt)

c. Catadromous – (ex. Freshwater eels)

H. Reproduction & Life History
1. Reproductive System Strategies
   a. Separate sexes
   b. Hermaphrodites
   c. Sequential hermaphrodites

2. Fertilization Strategies
   a. External fertilization (spawning)
   b. Internal fertilization

3. Early Development Strategies
   1. Oviparous
   2. Ovoviviparous
   3. Viviparous
Read “A Fish Called *Latimeria*” p. 173 and watch the course website videos and answer the following:

1. What is the common name of *Latimeria*?

2. *Latimeria* belongs to a group of fishes that might have given rise to what group of animals?

3. What structures cause this fish to be so unique?

### Table 8.1 Most Important Characteristics of Marine Fishes

<table>
<thead>
<tr>
<th>Group</th>
<th>Distinguishing Features</th>
<th>Skeleton</th>
<th>Feeding</th>
<th>Reproduction</th>
<th>Significance in the Marine Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hagfishes</td>
<td>No paired fins, no scales, exposed gill slits, marine</td>
<td>Cartilaginous skull, no vertebrae, no jaws</td>
<td>Suction by round, muscular mouth with teeth</td>
<td>Oviparous</td>
<td>Predators of dead or dying fishes and bottom invertebrates</td>
</tr>
<tr>
<td>Lampreys</td>
<td>Two dorsal fins only, no scales, exposed gill slits, fresh water or anadromous</td>
<td>Cartilaginous skull, no vertebrae, no jaws</td>
<td>Suction by round, muscular mouth with teeth</td>
<td>Oviparous</td>
<td>Suckers of fish blood or predators of bottom invertebrates</td>
</tr>
<tr>
<td>Rays, skates</td>
<td>Paired fins, placoid scales, pectoral fins greatly expanded, five ventral gill slits, mostly marine</td>
<td>Cartilaginous</td>
<td>Grinding plates to feed on bottom animals or gill rakers to filter plankton</td>
<td>Oviparous, viviparous</td>
<td>Predators of bottom animals or filter feeders</td>
</tr>
<tr>
<td>Sharks</td>
<td>Paired fins, placoid scales, 5–7 exposed and lateral gill slits, mostly marine</td>
<td>Cartilaginous</td>
<td>Teeth in jaws to capture prey or gill rakers to filter plankton</td>
<td>Oviparous, ovoviviparous, viviparous</td>
<td>Predators or filter feeders</td>
</tr>
<tr>
<td>Ratfishes</td>
<td>Paired fins, placoid scales, one pair of gill slits covered by flap of tissue, deep water</td>
<td>Cartilaginous</td>
<td>Grinding plates to feed on bottom invertebrates</td>
<td>Oviparous</td>
<td>Predators of bottom invertebrates</td>
</tr>
<tr>
<td>Coelocanths</td>
<td>Paired fins, large scales, gills covered by operculum, deep water</td>
<td>Bony</td>
<td>Teeth in jaws to capture prey</td>
<td>Ovoviviparous</td>
<td>Predators</td>
</tr>
<tr>
<td>Bony fishes</td>
<td>Paired fins, cycloid or ctenoid scales (absent in some), gills covered by operculum, marine and fresh water</td>
<td>Bony</td>
<td>Teeth in jaws to capture prey or graze or gill rakers to filter plankton</td>
<td>Oviparous, ovoviviparous, viviparous</td>
<td>Predators, grazers, or filter feeders</td>
</tr>
</tbody>
</table>
I. Land dwelling vertebrates (tetrapods) had to adapt to harsher environment on land. What did they evolve in order to do this?

Some land dwelling vertebrates went back to ocean (marine tetrapods)

<table>
<thead>
<tr>
<th><strong>CLASS MAMMALIA</strong></th>
<th><strong>CLASS REPTILIA</strong></th>
<th><strong>CLASS AVES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td>Reptiles</td>
<td>Birds</td>
</tr>
<tr>
<td>Order Carnivora</td>
<td></td>
<td></td>
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<tr>
<td>Sea otter, polar bear</td>
<td></td>
<td></td>
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<tr>
<td>Order Cetacea</td>
<td></td>
<td></td>
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<tr>
<td>Baleen whales</td>
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<tr>
<td>Suborder Odontoceti</td>
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<tr>
<td>Toothed whales</td>
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<tr>
<td>Order Carnivora</td>
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<td>Baleen whales</td>
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<tr>
<td>Suborder Odontoceti</td>
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<tr>
<td>Toothed whales</td>
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<tr>
<td>Order Squamata</td>
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<td></td>
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<tr>
<td>Sea snakes, marine iguana</td>
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<tr>
<td>Order Crocodilia</td>
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<tr>
<td>Saltwater crocodile</td>
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<tr>
<td>Order Chelonia</td>
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<tr>
<td>Sea turtles</td>
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<tr>
<td>Order Sphenisciformes</td>
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<tr>
<td>Penguins</td>
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<tr>
<td>Order Procellariiformes</td>
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<tr>
<td>Tubanosi</td>
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<tr>
<td>Order Anseriformes</td>
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<tr>
<td>Ducks</td>
<td></td>
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<tr>
<td>Order Charadriiformes</td>
<td></td>
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<tr>
<td>Gulls and related birds, shorebirds</td>
<td></td>
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<tr>
<td>Order Ciconiiformes</td>
<td></td>
<td></td>
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<tr>
<td>Herons</td>
<td></td>
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<tr>
<td>Order Gruiformes</td>
<td></td>
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<tr>
<td>Rails, coots</td>
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<tr>
<td>Order Pelecaniformes</td>
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<td></td>
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<tr>
<td>Pelicans and related birds</td>
<td></td>
<td></td>
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<tr>
<td>Order Gaviiformes</td>
<td></td>
<td></td>
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<tr>
<td>Loons</td>
<td></td>
<td></td>
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<tr>
<td>Order Podicipediformes</td>
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<tr>
<td>Grebes</td>
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</tbody>
</table>

A. Class Reptilia

1. Marine Reptiles - sea turtles, sea snakes, marine iguanas, salt water crocodiles
   How are these marine reptiles different from their land dwelling relatives?

Read “The Endangered Sea Turtles” p. 182 and answer the following:

1. List the reasons why sea turtle populations are so low in numbers.

2. How many species of sea turtles are classified as threatened worldwide?
B. Class Aves

2 types of marine birds: (How are these marine birds different from their land dwelling relatives?)
1. Seabirds - ex. penquins, albatross, pelicans, gulls

2. Shorebirds - ex. herons, egrets, ducks

C. Class Mammalia

Marine Mammals: (How are these marine mammals different from their land dwelling relatives?)
1. Order Pinnipedia - ex. Seals, sea lions, walrus

a. Sea Lions vs. Seals (fig. 9.9)
2. Order Carnivora – sea otters & polar bears

3. Order Sirenia – sea cows (manatees & sea dugongs)

Read the online article “Sleek? Well, No. Complex? Yes, Indeed” and answer the following:
1. Describe the general size of the manatee’s brain and discuss why scientists believe that its brain size may have little to do with its intelligence.

2. Describe how the surface of the manatee’s brain differs from other mammals and discuss why manatee brains may still be rather complex even given this difference.

3. Describe how manatees are related to land mammals and state the manatee’s closest living relatives.

4. State the sensory activity and structures that manatees rely on the most and describe why they rely on this activity the most.
4. Order Cetacea – largest group of marine mammals, whales, dolphins & porpoises

   a. 2 groups of cetaceans:
      - Toothless (baleen) whales
      - Toothed whales – dolphins & porpoises, sperm whale, orca
Read “The Whales That Walked To Sea” p. 193 and answer the following:

1. Briefly describe what the oldest known fossil whale, Pakicetus, was like (i.e. how is it similar to a modern cetacean and how is it different?)

2. Briefly describe what Ambulocetus was like (i.e. how is it similar to a modern cetacean and how is it different?)

3. Briefly describe what Basilosaurus was like (i.e. how is it similar to a modern cetaceans and how is it different?)

4. Fossils link early cetaceans with what group of animals?

II. Biology of Marine Mammals
   A. Diving Adaptations
      Read “Diving” p. 201-203 and list the specific adaptations that diving marine mammals have.
B. Echolocation – sensory system based on hearing (nature's version of sonar)

1. Emit sound waves (clicks) which travel 5 times faster in water than in air and listen for echoes that are reflected back from surrounding objects. The time it takes the echoes to return tells the animal how far away the object is, what size it is etc.

C. Behavior – very complex

D. Migrations
   Why migrate?

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Table 9.3 Most Important Characteristics of the Marine Reptiles, Seabirds, and Marine Mammals

<table>
<thead>
<tr>
<th>Group</th>
<th>Distinguishing Features</th>
<th>Temperature Regulation</th>
<th>Feeding</th>
<th>Reproduction</th>
<th>Significance in the Marine Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea turtles</td>
<td>Body covered by shell,</td>
<td>Endothermic, ectotherms</td>
<td>Toothless jaws, adapted for crushing hard</td>
<td>Ovoviviparous, laying eggs on</td>
<td>Predators of jellyfish and bottom invertibrates,</td>
</tr>
<tr>
<td></td>
<td>scales on exposed parts of body, limbs modified as flippers, found mostly in tropical seas</td>
<td></td>
<td>invertebrates or for picking soft invertebrates</td>
<td>sandy beaches</td>
<td>grazers of seaweeds</td>
</tr>
<tr>
<td>Sea snakes</td>
<td>Skin with scales, no legs, laterally flattened for swimming, venomous, found only in tropical Indian and Pacific oceans</td>
<td>Ectothermic, ectotherms</td>
<td>Small teeth adapted for capturing small prey</td>
<td>Ovoviviparous, giving birth at sea or oviparous, laying eggs on land</td>
<td>Predators of bottom fishes, some feed mostly on fish eggs</td>
</tr>
<tr>
<td>Marine iguana</td>
<td>Skin with scales, tail laterally flattened for swimming, found only in the Galapagos Islands</td>
<td>Ectothermic, ectotherms</td>
<td>Three-toed teeth adapted for grasping</td>
<td>Ovoviviparous, laying eggs in nest on land</td>
<td>Grazers of seaweeds</td>
</tr>
<tr>
<td>Saltwater crocodile</td>
<td>Skin with scales, massive jaws and tail found in coastal regions in Australia, Southeast Asia, and some western Pacific islands</td>
<td>Ectothermic, ectotherms</td>
<td>Heavily toothed jaws for capturing wide range of prey</td>
<td>Ovoviviparous, laying eggs in nest on land</td>
<td>Predators of wide variety of coastal animals, including fishes, seabirds, sea turtles, crocodiles</td>
</tr>
<tr>
<td>Seabirds</td>
<td>Feathers for insulation, webbed feet, light bones as adaptations for flight, found in all coastal regions</td>
<td>Endothermic, endotherms</td>
<td>Bills adapted for capturing wide range of prey, including planktonic organisms</td>
<td>Ovoviviparous, laying eggs in nest on land</td>
<td>Predators of fish, and many groups of surface-dwelling and shelled-water invertibrates, including planktonic organisms</td>
</tr>
<tr>
<td>Pinnipeds</td>
<td>Seals, sea lions, walruses, toothless, flippers, found mostly in temperate and polar waters</td>
<td>Endothermic, endotherms</td>
<td>Teeth for capturing and eating prey</td>
<td>Ovoviviparous, giving birth on land</td>
<td>Predators of mostly fish, cold-water seal livers for krill, leopards and seals, mostly seabirds, whales, feeds on clams and bottom invertibrates</td>
</tr>
<tr>
<td>Sea otter</td>
<td>Dense, dark fur, dorsoventrally flattened tail, flattened hind feet, found only in northern and northwestern Pacific Ocean</td>
<td>Endothermic, endotherms</td>
<td>Flattened teeth for capturing and crushing prey</td>
<td>Ovoviviparous, giving birth at sea or on land</td>
<td>Predators of sea urchins and wide range of bottom invertibrates and fishes in kelp forest</td>
</tr>
<tr>
<td>Polar bear</td>
<td>Dense, white fur, found in Arctic region, mostly on drifting ice</td>
<td>Endothermic, endotherms</td>
<td>Powerful jaws and teeth for capturing and eating prey</td>
<td>Ovoviviparous, giving birth on land</td>
<td>Predators of seals</td>
</tr>
<tr>
<td>Sirenians</td>
<td>Mammals, dugongs, stellate ridges, front flippers, paddle-shaped tail, shaped to swim (some species only in fresh water)</td>
<td>Endothermic, endotherms</td>
<td>Teeth as thick ridge pads for crushing vegetation</td>
<td>Ovoviviparous, giving birth at sea</td>
<td>Grazers of scavengers and other coastal vegetation</td>
</tr>
<tr>
<td>Baleen whales</td>
<td>Blubbery streamlined body, reduced back, front flippers, paddle-shaped tail, shaped to swim</td>
<td>Endothermic, endotherms</td>
<td>Baleen on upper jaw for filtering small plankton</td>
<td>Ovoviviparous, giving birth at sea in warm waters</td>
<td>Filter feeders of plankton and small fish, mostly in polar waters, grey whale feeds on small animals (mostly amphipods) in soft bottoms</td>
</tr>
<tr>
<td>Toothed whales</td>
<td>Blubbery streamlined body, reduced back, front flippers, tail flukes, mostly found in all seas (some oliphiens live in fresh water)</td>
<td>Endothermic, endotherms</td>
<td>Conical teeth for capturing prey</td>
<td>Ovoviviparous, giving birth at sea</td>
<td>Predators of fish, squid and other marine mammals, and some large bottom invertibrates such as lobsters</td>
</tr>
</tbody>
</table>
Ecology

Levels of biological organization (Table 4.1)
1. Species – a group of similar organisms whose members interbreed and produce viable offspring.
2. Population - members of the same species that live together in the same area at the same time
3. Community – all the populations of different species that live and interact together within an area at the same time
4. Ecosystem – a community together with its physical (abiotic) environment

I. Populations
   A. How Populations Change in Size
      1. Growth rate (r)

   B. Types of Population Growth
      1. Exponential population growth (J curve) – (fig. 10.2)
      2. Logistic population growth (S curve) – (fig. 10.4)

      a. Carrying capacity (K)
B. Reproductive Strategies of Populations
Organisms must be able to balance the amount of energy allocated to reproduction and to individual survival (growth, body size, etc.). If they allocate all of their energy for reproduction, none is available for the survival of the individual. If they allocate all of their energy for individual survival, none is left for reproduction or for further generations. Organisms deal with this tradeoff differently.

1. 2 main types of reproductive strategies (some have combination of both)
   a. r-selected species (opportunistic species)
   b. K-selected species

II. Communities
A. How Organisms Interact Within a Community
   3 main types of interactions:
   1. Predator/Prey Interactions
      a. How do these interactions affect fitness (evolution)?
      b. How do these interactions affect abundances?
      c. How do these interactions affect species diversity?

Example of predator and their cascading effects in a(n):
   Intertidal (tide pool) community:

   Kelp forest community:
2. Symbiosis “living together”

Read “Symbiosis” p. 220-221 and define the following types of symbioses and state an example of each type.

a. Commensalism

b. Parasitism

c. Mutualism

3. Competition

a. The outcomes of competition:
   - Competitive exclusion
   - Resource partitioning

III. Ecosystems

A. Energy Flow – how energy passes through the ecosystem (one way flow) (Fig. 10.13)

1. Producers – use simple inorganic molecules to make complex organic molecules (ex. photosynthesize)

2. Consumers – eat producers and others to gain energy, cannot gain energy just from simple inorganics

3. Decomposers – break down dead material to make energy

What type of energy is being given off at each level?
B. Food chains and food webs
   1. Food chains (fig. 10.13)

   2. Food webs (fig. 10.14)

   3. Trophic Levels – each step in the food chain through which energy has traveled (fig. 10.15)

C. Trophic Pyramids – represent relative energy at each trophic level (fig. 10.16)

   1. Why is there a stepwise decline of energy as you go up the levels?

   2. Why more lower level consumers (ex. zebras) than higher level consumers (ex. lions)? Why more krill than orcas?

   3. What type of consumer is more “expensive” for an ecosystem to support? Why?

   4. Why can certain animals at lower trophic levels be much larger in size than carnivores?