BIOL 1030 – TOPIC 10 LECTURE NOTES

Topic 10: Introduction to Animals; Porifera and Radiata (Chs. 32, 33)

I. What defines Kingdom Animalia?
   A. multicellular heterotrophs
   B. no cell walls
   C. monophyletic group (evolved from ancestral protist like modern choanoflagellates)

II. What characteristics are associated with animals?
   A. more than 1 million animal species have been described
   B. diversity in form – invertebrates (no backbone; 99% of animals) and vertebrates
   C. sexual reproduction (few exceptions)
      1. no alternation of generations (mostly gametic meiosis – haploid cells do not undergo mitosis)
      2. egg nonmotile, usually much larger than sperm
      3. sperm typically flagellated
   D. most have active movement
   E. cells move within organism during development (and throughout life)
   F. typically complex embryonic development for most animals:
      1. zygote $\rightarrow$ morula (solid ball of cells)
      2. morula $\rightarrow$ blastula (ball becomes hollow)
      3. blastula $\rightarrow$ gastrula (ball folds in to form a hollow sac with one opening, the blastopore)
      4. interior of gastrula eventually forms gut (tube in many)
      5. blastopore becomes mouth or anus

III. How are animals classified?
   A. traditional taxonomic grouping based physical characteristics such as body cavities is on the way out (explored below)
   B. a firm consensus on a new animal classification scheme has not been reached; we will explore some of this on the Tree of Life website in class…

Compiled from the Tree of Life (http://tolweb.org/tree/):
...along with a recent publication from Auburn University faculty member Ken Halanych:

C. even so, the traditional taxonomy is so firmly entrenched that it is worth knowing and will be referenced in this course along with some of the newer classification schemes

D. two subkingdoms: Parazoa and Eumetazoa
   Parazoa: no tissues or organs, asymmetrical
   Eumetazoa: definite shape and symmetry

IV. Subkingdom Parazoa – Phylum Porifera - the sponges
   A. actually appears to be a grade
      1. note Halanych figure above
      2. somewhat controversial – grades aren’t supposed to be phyla!
      3. taxon retained largely due to tradition
   B. asymmetrical
C. cellular level of development – a loose confederation of cells
D. 5150 species, most marine
E. larvae free-swimming (motile)
F. adults sessile
G. filter feeders
1. body has numerous small pores – water comes in through these to the interior spongocoel cavity
2. water leaves the spongocoel through a large pore, the osculum
3. tubes lined with choanocytes (flagellated cells also called collar cells) that move water using their flagellae
   • 1 cm³ of choanocytes can move 20 L of water/day
   • to get an ounce of food, a ton of water has to be filtered!
H. spicules (calcium carbonate or silica) form scaffolding or “skeleton”
I. spongin - a protein - also supports body in some
J. reproduction
1. splitting - remove part and it often will grow into a new sponge
2. some produce eggs, some sperm

V. Subkingdom Eumetazoa
A. rest of the animals; definite shape and symmetry (bilateral or radial) – ~35 living phyla
B. key body plan transition: development of tissues, groups of similar cells organized into a structural and functional unit
C. Eumetazoa –
   1. diploblastic – have two cell layers in embryo
      • ectoderm – outer layer; source of outer covering(epidermis) and nervous system
      • endoderm – inner layer; becomes gut (gastrodermis)
      • found in grade Radiata (radially symmetrical – Phyla Cnidaria and Ctenophora)
   2. triploblastic – have three cell layers in embryo
      • mesoderm – middle layer between ecto- and endoderm; most organs form from mesoderm tissue
      • found in all of clade Bilateria (animals with bilateral symmetry at some point in their life cycle)

VI. Eumetazoa have undergone 4 key transitions in body plan during the course of evolution
A. development of bilateral symmetry
   1. radial symmetry – (found in grade Radiata) any plane through the central axis of the animal will produce two halves that are approximately mirror images of each other
   2. bilateral symmetry – (found in clade Bilateria) body has left and right halves that are approximately mirror images of each other
      • body plan has dorsal and ventral regions (back and front)
• body plan has **anterior** and **posterior** regions (head and rear)

3. bilateral symmetry was a major evolutionary advance
   • bilateral animals move more efficiently
     ▪ able to seek food better
     ▪ able to better avoid predators
   • bilateral animals have a central nerve cord(s)
   • bilateral animals were able to develop a definite head and brain area (**cephalization**)  
     ▪ head is more specialized and efficient
     ▪ head better protects important organs

B. development of the body cavity
   1. evolutionary history unclear; NOT treated as clade-defining synapomorphies anymore
   2. important for allowing development of efficient organ systems
   3. cavity makes room for organs and for efficient support of them (both structurally and for transport of materials to and from them)
   4. **acoelomate** – no cavity
   5. **pseudocoelomate** – have fluid-filled cavity (**pseudocoel**) between mesoderm and endoderm
   6. **coelomate** – have fluid-filled cavity (**coelom**) within mesoderm and surrounded by mesodermal tissue
     • **parietal peritoneum** – epithelium lining outer wall of coelom
     • **visceral peritoneum** – epithelium lining covering organs in coelom; also lines inner wall
   7. body cavities require some form of circulation
      • pseudocoelomates churn fluid in body cavity
      • coelomates have a **circulatory system**
        ▪ circulating fluid = blood
        ▪ open – blood pumps from heart into coelom; used by most invertebrates
        ▪ closed – blood pumps from heart into vessels and back into heart; separation from rest of body fluid allows for greater control of blood contents
   8. Why is a coelom better than a pseudocoelom?
      • endoderm and mesoderm are better able to communicate and coordinate during development because they are in direct contact
      • allows development of a more complex digestive tract

C. development of protostomes and deuterostomes (both appear to make clades)
   1. **protostomes** – “first mouth”; blastopore becomes mouth
   2. **deuterostomes** – “second mouth”; blastopore becomes anus
   3. cell fate is determined from beginning in protostome embryos, not in deuterostome embryos

D. development of a segmented body plan (**segmentation**) in different groups
   1. body develops from blocks or segments that from in embryo
   2. segments initially very similar to each other, but can differentiate
3. advantages:
   • redundancy
   • more flexible locomotion
   • more opportunity for specialization
4. segments may fuse during development
5. found in Phyla Annelida, Arthropoda, and Chordata

VII. grade Radiata
   A. radial symmetry
   B. Phyla Cnidaria and Ctenophora
   C. tissues, but no true organs

VIII. Phylum Cnidaria (clade) – stinging-celled animals: corals, hydras, anemones, and jellyfish
   A. mostly marine, some hydras and jellyfish in freshwater
   B. have distinct tissues, but no organs
   C. simple nerve net
   D. carnivorous, but largely sessile
   E. many are bioluminescent
   F. capture prey with cnidocytes
      1. contain nematocysts - barbed projectiles that penetrate the flesh of prey and inject prey with a toxin
      2. nematocysts are propelled with water pressure - have high internal osmotic pressure (up to 140x standard atmospheric pressure) – one of the fastest and most powerful cellular processes known
      3. if flagellum-like trigger is touched, cell becomes permeable to water, water rushes in and the cell explodes, flinging the nematocyst outward
      4. usually just painful to humans, but the Portuguese man-of-war and some other species produce neurotoxins that are deadly to humans
   G. internal digestion in gut cavity
      1. partial extracellular digestion – can digest larger items than possible with only intracellular digestion
      2. digestive enzymes secreted – mainly proteases
      3. only one opening (mouth/anus from blastopore)
   H. life cycle based on three stages
      1. larval stage called planula
         • multicellular
         • use cilia to swim
         • part of plankton in oceans
      2. polyp (largely sessile) usually develops from planula; most have a holdfast to anchor to the ocean floor
      3. medusa – typically umbrella-shaped and motile (both float and swim)
      4. depending on the species, either the polyp or medusa stage may be dominant or even absent
I. polyps can reproduce asexually, sexually, or produce medusae that reproduce sexually

J. **Class Hydrozoa** (clade) – the hydroids
   1. both polyp and medusa stages
   2. most marine and colonial
   3. *Hydra* - small, freshwater
   4. Portuguese man-of-war - a colonial hydroid

K. **Class Scyphozoa** (clade) – the jellyfish
   1. medusa dominant; polyp small and inconspicuous (sometimes no polyp)
   2. muscular ring of epithelial cells pulse rhythmically to propel animal
   3. separate sexes
   4. larvae are free-swimming **planulae**
   5. planula attaches to substrate and forms a polyp
   6. polyps produce multiple medusae

L. **Class Cubozoa** (clade) – box jellyfish
   1. medusae are box-shaped
   2. tentacle or group of tentacles at each box corner
   3. polyps are inconspicuous, some not known
   4. stings of some fatal to humans

M. **Class Anthozoa** (clade) – sea anemones and corals
   1. *anthos* = flower, *zoa* = animal
   2. largest class of Cnidaria (by number of species)
   3. solitary or colonial
   4. polyp dominant; usually no medusae are formed
   5. most harbor symbiotic algae – mutualism where anthozoan provides protection and algae provides food via photosynthesis
   6. anemones - fairly free-moving, heavily muscularized
   7. corals – hard ones produce calcium carbonate exoskeletons

IX. **Phylum Ctenophora** (clade) – comb jellies or sea walnuts
   A. radially symmetrical, but more complex than Cniderians
   B. have anal pores (two openings – water passes through)
   C. no cnidocytes; some use tentacles to capture prey
   D. move using comb-like plates of fused cilia (largest animals to use cilia for locomotion)
   E. most are bioluminescent