Biological Diversity: the Kingdoms of Plants and Animals (with a special note for primates)

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The Kingdoms

• Kingdom Plantae
  – Bryophytes and the Tracheophytes

• Kingdom Animalia

Ch. 31: Kingdom Plantae

• Plants – multicellular, autotrophic organisms that have successfully invaded terrestrial environments
• Plants are very dependant on nitrogen fixing bacteria. Nitrogen fixation occurs at the roots.
• Evolution – Bryophytes and the Tracheophytes (vascular plants)
  – Reproduction – old vs new
  – Chitin in land dwelling plants
Bryophytes

- Conquest of land – difficulties, adjustments
  - Light availability greater on land than in oceans, rivers
  - Tradeoff – less water for more sunlight
    - different reproductive and metabolic strategies needed
- Groups:
  - Mosses (2/3 of all Bryophytes)
  - Liverworts
  - Hornworts

Bryophyte lifecycle

Tracheophyte

Bryophyte
Tracheophytes: The Vascular Plants

- Different from bryophytes because...
  - greater adaptiveness to land environments
  - bodies separated into specialized organs – roots, stems, leaves
  - cones or flowers in seed-bearing plants for reproduction

- Seed-bearing Plants
  - Gymnosperm
  - Angiosperm

- Seedless Plants
  - Phylum Lycophyta (club mosses)
  - Phylum Sphenophyta (horsetail)
  - Phylum Pterophyta (fern)

Seedless Vascular Plants

- Lycophyta (club mosses)
  - Gametophyte nonphotosynthetic
  - Symbiosis-dependant on fungi

- Sphenophyta (horsetail)
  - Jointed leaves, hollow stems
  - Cone resembles horsetail

- Pterophyta (fern)
  - Broad-leaved
  - More vascularized

Gymnosperm life cycle

Cone plants
Angiosperm life cycle:

Seed Plants - The Incredible! Edible! Seed.

- The seed
  - Flagellated sperm – past mistake
  - Pollination
  - Structure

History of the seed

- Probably arose independently at different times in the evolution of plants, spermatophytes bearing seed-like structures found from fossil ferns. Today’s spermatophytes are the gymnosperms and angiosperms.
Seed plants – Gymnosperms and Angiosperms

* The Gymnosperms – “naked seed” – earliest form ~400 mya?
  1. Division Cycadophyta – “sago palms” – resemble palms
  2. Division Ginkgophyta – the ginkgo or maidenhair tree
  3. Division Gnetophyta – upright vines (Gnetum), desert shrubs (Ephedra, Welwitschia)
  4. Division Coniferophyta – redwoods (ex sequoias)
  5. Pteridosperms – extinct

* The Angiosperms – “flowering plants”
  – Monocots (in text) & dicots (not in text)

Monocots

- Family Rosaceae – roses, strawberries, cherries, almonds…
- Family Leguminosae – alfalfa, beans, peas, clovers, stock feeds…
- Family Rutaceae – oranges, limes…
- Family Cruciferae – mustard, cabbage, broccoli…
- Family Cucurbitaceae – gourds, pumpkins, squash, cucumbers…
- Family Gramineae – grasses. Wheat, barley, corn, rice…
  – Most important human food group
- Family Bromeliaceae – pineapples
- Family Palmales – date palms

Economic Importance of Plants

- Plants are everywhere! Over 250,000 angiosperm species classified to date, every organ they possess providing food for almost all the members of the animal kingdom.
- Wood – buildings, energy, coal, oil, plastics, rubber, etc.
Herbs - importance

- soft stemmed plants, most being annuals but some biennials and others perennials.
- Medically important.
- Clothing - family Linaceae
- Decoration – businesses, parks, etc

The Green Revolution

- WWII
  - Norman Borlaug w/ Rockefeller Foundation
  - Expansion under Food and Agricultural Organization of the United Nations
- Resulting problems
- Ongoing research

Evolution of the kingdom Plantae
The kingdom Animalia

- Animal – multicellular, eukaryotic organism that eats other living organisms
- Carnivore – animals that prey on other animals
- Herbivore – animals that prey on plants

Ex: lioness (predator, carnivore) stalking a herd of impala (herbivore, prey b/c hunted)

Animals: Classification

- Phylum Chordata
  subphylum Vertebrata
  - backboned animals.
  - 5% of the animal kingdom, figure prominently in the lives of humans.
- Phylum Chordata
  subphylum Invertebrata
  - Insecta, Arachnida, etc.

Evolutionary “tree” of the kingdom Animalia
**Subkingdom Parazoa: Phylum Porifera: The Sponges**

- Sessile, porous
- Less integration and function than other animal groups
  - Individual cells can re-associate once separated
- Used as cleansing swabs, antibiotics (when modified) for cancer chemotherapy

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**Radiata: classification**

- radial (radiata) = possess a central mouth around which the rest of the organs are radially arranged.

**Radiata**

- Phylum Cnidaria (coelenterates)
  - Ex: hydra
- Phylum Ctenophora (comb jellies)
- Both have 2 layers of cells, coelenteron, filter feeding

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**Radiata: Phylum Cnidaria**

![Image: Phylum Cnidaria - Close-up of Nematocysts (present in the entire phylum): Nanobrachia (present in the cnidarians). Nematocysts are stinging cells used for defence and capture of prey.](http://biology.unm.edu/ccouncil/Biology_203/Images/SimpleAnimals/Nematocystspic.jpeg)
Radiata: Phylum Ctenophora

- **Ctenophora**
  - Similar to Cnidaria because...
    - Radial symmetry
    - Are diploblastic
  - Different from Cnidaria because...
    - Lack cnidocytes
    - No alternation of body form during life cycle

Body Symmetry

- **Bilateria** - this type of symmetry involves a similarity of morphology (shape and form) on each side of a longitudinal axis.
- Usually involves a head (anterior end) and a tail (posterior end).
- All bilateral forms are triploblastic, having a third primary germ layer known as mesoderm.

- All **Eumetazoa** above the level of Radiata differ in the terms of the presence or absence of a true coelom (ex: flatworms and proboscis worms are acelomates for the lack of coelom).
- **Pseudocoelomates** have an unlined cavity between endoderm and mesoderm.
  - Include phyla *Rotifera* and *Nematoda* (roundworms).
- **Coelomates** – have a true coelom
• Evolution: The coelomate *Bilateria* diverged into 2 major branches based on differences in the developing embryo (fig 32.1).

• **Branch 1: Deuterostomes** (second mouth)

• **Branch 2: Protostomes** (first mouth)

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**Protostomes and Deuterostomes**

• **Protostomes** - demonstrate spiral, determinate cleavage. Major phyla are *Platyhelminthes*, *Nematoda*, *Mollusca*, *Annelida*, *Arthropoda*.

• **Deuterostomes** - the blastopore forms the anus and the mouth is formed secondarily.
  - Demonstrate radial, indeterminate cleavage.
  - The mesoderm arises from endoderm in the archenteron.
  - The coelom is formed from an outpocketing of the gut.
  - Major phyla showing these developmental patterns are *Echinodermata* and *Chordata*.

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*Protostomes versus deuterostomes (2)*

- Protostomes: coelom forms by a splitting of the mesoderm.
- Deuterostomes: coelom forms by an outpocketing of primitive gut.
• Benefits of the coelom:
  – Movement
    • Peristaltic movements independent of locomotor movement
  – Hydrostatic skeleton
  – Double-layered sheets of support for internal organs

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Acoelomates - Overview

- Phylum Platyhelminthes
  - Class Turbellaria
  - Class Monogenea
  - Class Trematoda
  - Phylum Cestoda
  - Phylum Rhynchocoela

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- Phylum Platyhelminthes – the simplest of the triploblastic animals but they exemplify an organ level of complexity compared with the tissue level shown by cnidarians and ctenophores.
- Class Turbellaria – only class of free-living flatworms.
- Parasitic flatworms – Monogenea, Trematoda, Cestoda
- Phylum Rhynchocoela – proboscis worms resemble platyhelminthes, possess anus and moderately well developed circulatory system
Pseudocoelomates

- Phylum **Rotifera** — are tiny and may be smaller than some large amoebas.
- Phylum **Nematoda** — most numerous of all phyla in terms of actual numbers of individuals.
- Phylum **Gastrotricha** — hermaphroditic
- Phylum **Kinorhyncha** — spiny, virtually trapped within an external layer of cuticle.

Protostome Coelomates

- Phylum **Annelida** — segmented worms
  - closed circulatory system in which enclosed vessels (arteries, capillaries, veins) ramify throughout the transport system.
  - Metamerism - segments
  - Class **Polychaeta** (numerous bristles)
    - Dioecious
    - Possess Parapodia
  - Class **Oligochaeta** (few bristles)
    - Hermaphroditic
  - Class **Hirudinea** (leeches)

Phylum Mollusca

- Open circulatory system, all save bivalvia have extensible radula and flat, highly muscular feet
- Class **Polyplacophora** — chitons
- Class **Gastropoda** — snails, periwinkles, conchs, slugs
- Class **Bivalvia** — mussels, scallops, clams, oysters
- Class **Cephalopoda** — squids, octopi
Phylum Arthropoda (jointed feet)

- Open circulatory system
- Chitin
- Metamerism
  - Give rise to various types of appendages e.g. crustaceans, insects
    - Mandibulates – grasshoppers, ants, etc
    - Chelicerates – arachnids, horseshoe crabs...
- Compound eyes - Ommatidia

Phylum Arthropoda

- Class Arachnida – eight legged, book lunged
  - spiders, mites, ticks, scorpions
- Class Crustacea – antennae (sensory probes)
  - lobsters, shrimps, crabs, barnacles
- Superclass Myriopoda
  - Class Diplopoda - millipedes
  - Class Chilopoda - centipedes
- Class Insecta – compound eyes, most species than all other organisms combined. Most successful terrestrial animals
  - 25+ orders

Deuterostome Coelomates: An Overview

- Phylum Echinodermata
- Phylum Chordata
- Subphylum Vertebrata
- Phylum Tetrapoda
Deuterostome Coelomates

- **Phylum Echinodermata** — Starfish, sea dollars
  - All marine, share a common basic structure —
  - Central disk — circled by 5 radiating arms
- **Phylum Chordata** — fish, vertebrates
  - 2 subphyla —
    - Urochordata, Cephalochordata
  - 3 basic characteristics all share:
    - Notochord
    - Hollow dorsal nerve cord derived from ectoderm
    - Pharyngeal gill slits

Subphylum Vertebrata — special features: skeletal backbone, cranium enclosing the spinal cord and brain, high degree of cephalization and segmentation of the muscles of the trunk into somites at some time in the course of development.

- Cephalization — the specialization of the anterior end of the nervous system into a complex brain w/ associated specialized sense organs.
- **The Fishes** — 3 classes:
  - **Agnatha** — jawless, cartilaginous fish
  - **Chondrichthyes** — cartilaginous fish, sharks, rays, skates
  - **Osteichthyes** — bony fish in fresh and salt water

The Tetrapods, an overview

- **The Tetrapods** — four legged animals
  - **Amphibia**
  - **Reptilia**
  - **Aves**
  - **Mammalia**
  - **Protheria**
  - **Metatheria**
  - **Eutheria**
    - **Cetacea**
    - **Carnivora**
    - **Rodentia**
    - **Chiroptera**
    - **Artiodactyla**
    - **Perissodactyla**
The Tetrapods

- **Class Amphibia** – frogs, toads, and salamanders.
  - Partially successful as terrestrial inhabitants. Many respire through moist surface membrane, frogs undergo metamorphosis to become lung-bearing adult terrestrials.

- **Class Reptilia** – alligators, crocodiles, lizards, snakes, turtles, tortoises
  - Scales on a rough waterproof integument, functional lungs, enclosed egg w/ leathery shell.

- **Class Aves** – birds
  - "flying lizards" have eggs like reptiles do (only brittle)
    - Have very light skeleton – hollow bones
    - Tough light beak
    - Feathers ideal for flight
    - Most advanced lungs (not mentioned in text), four-chambered heart

The Tetrapods (Cont’d)

- **Class Mammalia** – fur, four-chambered heart, endothermic, functional lungs, mammary glands, most members possess very complex brains.
  - 3 subclasses –
    - **Protheria** – duck-billed platypus, echidnas
    - **Metatheria** - marsupials
    - **Eutheria** – placentals
      - **Cetacea** – whales, dolphins, porpoises

The Tetrapods (Cont’d)

- **Order Carnivora** – ranges through dogs, wolves, to large cats to otters, seals
- **Order Rodentia** – squirrels, beavers, rats, mice
- **Order Chiroptera** – bats
- **Order Artiodactyla** – (even toed) sheep, cattle
- **Order Perissodactyla** – (odd toed) horses, zebras, rhinoceroses
Ch. 33 – The Primates

- Primates appear to have evolved, at least at first, for an arboreal existence
  - the digits are relatively unspecialized and best serve for grasping vines or branches of trees.
- Digits are unmodified much as the primitive reptilian structure.
  - Mammals have modified forms of the original 5-digit arrangement at end of forelimbs into specialized structures, such as the flipper, thesingle-digit hoof, etc.
- Changes in vision, modification of the pelvis for an upright stance, behavioral variations, and, eventually, great expansion of the higher brain centers also occurred during primate evolution.

Primate Lineages

- The present-day order Primates
  - the prosimians (lemurs, tarsiers, etc.)
  - the anthropoids (monkeys, apes, humans).

Primate Characteristics

- Flexible shoulder joints – branch swinging
  - First recognized by Sir Arthur Keith
- Eyes closer to the face’s center
  - Enables depth perception
- Lavish care for the young
- Can grasp objects w/ big toe (lost in bipedal primates)
- The opposable thumb
  - tools
  - Culture
  - Association, speech, fine motor movement achieved (in hominids)
Humankind and its Destiny

• Dryopithecines – diverged into…
  • Ramapithecus – assumed to be ancestral to apes and humans
    – Lucy – found by Donald Johanson in 1974 in Ethiopia
      - Classified under Australopithecus afarensis
    • Later on, A. Robustus, A. boisei, H. habilis, and H. erectus fossils were found

Misconceptions of the Evolutionary Relationship between Humans and Apes

• 1. Humans developed from a creature similar to or identical with present-day apes.
  - Truth: Actually both humans and apes developed from a common ancestor probably completely unlike present-day apes.
• 2. Evolution always proceeds in straight-line fashion (orthogenic evolution) from one ancestral form directly through a series of descendant forms to some highly adaptive and relatively permanent organism.
  - Truth: The process of evolution goes on continually and the lineage develops, in most cases, like a bush rather than a tree.
• 3. All the traits associated with hominids either arose at one time or at least began their development together.
  - Such traits as an erect posture appear to have settled in long before other distinctive hominid characteristics appeared.
• 4. The creationist view that evolutionary descent of humans is incompatible with either a belief Judeo-Christian deity or a commitment to religion in general.
  - Falsity is demonstrated by the active participation of religious figures such as Father Teilhard de Chardin in evolutionary theory and fieldwork.
  - “The bulk of religious adherents can resolve their intellectual and spiritual commitments.”

Literature Cited