Objectives:
- Understand geological time & origin of life
- Understand the classification of life on earth
- Understand the origins and biology of vertebrates
- Describe adaptive radiation and give an example
- What characteristics distinguish mammals from vertebrates
- Understand differences among mammals

Geological Time

- Eon, Era, Period, Epoch, Age
- Phanerozoic Era
- Precambrian

Phanerozoic Era (544 mya-present)

← Precambrian
Timeline of history of life on Earth

Precambrian (~ 4.5 billion - ~544 million years ago)

- Hadean
  4.5-3.8 billion years ago
- Archaean
  3.8-2.5 billion years ago
- Proterozoic
  2.5 billion-542 million years ago

Proterozoic

Paleozoic

Mesozoic
Phanerozoic Era
540 mya - present

- Cenozoic ["Cen" = Recent] Age of Mammals
- Mesozoic ["Meso" = middle] Age of Dinosaurs
- Paleozoic ["Paleo" = ancient] Age of Fishes
  - "zoic" = zoo = animal

Paleozoic
(544-245 mya)

- Cambrian Explosion
- Permian Extinctions
- Life on land

Mesozoic
(245-65 mya)

- "Middle" animals
- Dinosaurs
- Cycads, ferns, etc.
- Angiosperms
Cenozoic Age of Mammals

- Tertiary (5 epochs) -65 mya
- Quaternary: Pleistocene (1.8 mya) and Recent (Holocene ~ 11,000 BP)

Invertebrates

- Animals without backbones (e.g., insects)
- Abundant 600 Ma
- 80% fossil animal species

Kingdom
Phylum
Class
Order
Family
Genus
Species
Five Kingdoms

- Bacteria
- Protozoans and algae
- Fungi and molds
- Plants
- Animals

Phylum

- Arthropoda (ext. skeletons e.g., insects, spiders, lobsters, and crabs)
- Mollusca (soft, unsegmented bodies usually enclosed in hard shells: Octopi, squids, snails, slugs, clams)

Chordata

- bilaterally symmetrical
- gill slits
- notochord

mammals, birds, reptiles, amphibians, fish, primitive lancelets and tunicates
Vertebrata:

- Bilaterally symmetrical
- Internal spinal cord surrounded by vertebrae
- Notochord replaced by spinal chord

Fish, amphibians, reptiles, & mammals

7 Classes of Vertebrates

- Agnatha: jawless fish (lampreys and hagfish)

Chondrichthyes: Sharks & Rays
Osteichthyes
► Bony Fishes

Amphibia

Reptilia
► turtles, snakes, lizards etc.
► Amniote egg
Amphioxus—sea lancelets

Jawless fishes 435-335 mya
e.g., lamprey,

Bony Fishes
Lungfish

Terrestrial Life

► Respiration
► Reproduction

Solutions
Breathing air
Retention of body fluids
Reproduction
Locomotion
Lobe-finned fish

Devonian: 417-354 mya

Coelacanth

Amphibian Evolution

Reptiles

Amniotic Egg
Reptilian Extinctions

Mammals

Mammalian Traits
Homiothermy
Intelligence
Placenta
Postnatal
Immune system
Mammals

- Mammary Glands
- Heterodont Teeth
- Endothermy
- 4-chambered hearts
- Complex nervous systems
- Reproduction

Class Mammalia

Subclass Prototheria: monotremes: platypus and echidnas
Subclass Theria: live-bearing mammals
  - Infraclass Metatheria: marsupials
  - Infraclass Eutheria: placentals

Sub-Class Prototheria (Monotremes)

platypus
Sub-class Theria

- live-bearing mammals
  - Infraclass Metatheria: marsupials
  - Infraclass Eutheria: placentals

Marsupials:
- Kangaroo
- Tasmanian Devil

Infraclass: Eutheria (Placental)
Mammalian Orders

Figure 15. Diagrammatic family tree of the major orders and some suborders of mammals. Different animals,做一些说明图旨意。Fig. 15. Diagrammatic family tree of the major orders and some suborders of mammals.