13.1 Originating Events

- **Primary abiogenesis**: The theory that the 1st living things arose from nonliving material
- **1953 Urey and Miller experiment**: Modelled water cycle with early atmospheric gases: NH$_3$, CH$_4$ and H$_2$
  - Spontaneously formed organic molecules including two amino acids

Townsend, 2009
13.1 Originating Events

- 1977 Sidney Fox triggers spontaneous formation of +200 amino acid chains
- Early 1980s-1990s there are a number of experiments showing self-replication of RNA molecules
- Liposomes: protocells formed spontaneously by lipids in water (form membranes and can react to environment)
13.1 Originating Events

- Greenland → 3.8 billion year old sediments show traces of microbial activity
- Stromatolites → oldest fossils on Earth (3.5 billion years old)
  → resemble present-day cyanobacteria
- First Lifeforms → prokaryotes, anaerobic, chemoautotrophic
  → still exist today Archaebacteria & Eubacteria
  → “extremophiles”
13.2 Diversification & Extinction

- World-wide deposits of iron ore suggest that an oxygen rich atmosphere existed
- This in turn implies that photosynthetic organisms must have been commonplace
- **ENDOSYMBIOSIS** → the combination of prokaryotic cells to form the first eukaryotic cells
- [http://www.sumanasinc.com/webcontent/animations/content/organelles.html](http://www.sumanasinc.com/webcontent/animations/content/organelles.html)
13.2 Diversification & Extinction

- From about 3.8 billion years ago to 1.2 billion years ago all life was unicellular
- A huge number of fossils have been found in the Burgess Shale
- These are representative of the Cambrian Explosion
13.2 Diversification & Extinction

- There is much debate as to the speed at which evolutionary changes occur
- GRADUALISM $\rightarrow$ theory that states that organisms change slowly over time
- If gradualism was true then there would be numerous “transitional forms” in the fossil record
- PUNCTUATED EQUILIBRIUM $\rightarrow$ spurts of rapid change followed by stability
  i) Species evolve very rapidly in evolutionary time
  ii) Speciation usually occurs in small isolated populations making transitional forms rare
  iii) After spurts of change there are long periods of stability
- Widely accepted that there is/was most likely a combination of both theories
13.2 Diversification & Extinction
13.3 Pathways of Evolution

- DIVERGENT $\rightarrow$ two or more species evolve increasingly different traits
  $\rightarrow$ result of different selective pressures and/or genetic drift
- CONVERGENT $\rightarrow$ two or more species develop phenotypic similarities
  $\rightarrow$ result of similar selective pressures
- ADAPTIVE RADIATION $\rightarrow$ single species gives rise to 3 or more new species
  $\rightarrow$ best examples: Darwin's Finches & 800 species fruit flies
- COEVOLUTION $\rightarrow$ 2 species become completely dependent on each other
  $\rightarrow$ FIGS & FIG WASPS: each of the 900 species of figs is pollinated by its own species of wasp
13.4 Phylogenetics & Cladistics

- **Phylogeny**
  - evolutionary history
  - based on descent from a common ancestor
- **Clade (Monophyletic Group)**
  - all descendants of a common ancestor
- **Synapomorphies**
  - features shared by a group that have been inherited by 2 or more species
- **Ingroup**
  - members of a clade having 1+ synapomorphies
- **Outgroup**
  - 1st group to diverge from a clade
13.4 Phylogenetics & Cladistics

- Charophytes (a group of green algae)
- Bryophytes (e.g., mosses)
- Seedless vascular plants (e.g., ferns, horsetails)
- Gymnosperms (e.g., conifers)
- Angiosperms

Timeline:
- Origin of plants
- Early vascular plants
- First seed plants
- Radiation of flowering plants

Millions of years ago:
- Cenozoic
- Mesozoic
- Paleozoic
13.5 Human Evolution

- Human evolution began about 65-60 million years ago
  i) Prosimians (65mya)
  ii) Monkeys (35mya)
  iii) Apes (23mya)
  iv) Hominids (5mya)

- Common ancestral traits:
  i) more-flattened molar
  ii) grasping hands/feet
  iii) forward directed eyes
13.5 Human Evolution
13.5 Human Evolution

- Common physical primate traits:
  i) Dense hair or fur covering
  ii) Warm-blooded
  iii) Live young
  iv) Suckle
  iv) Infant dependence

- Common social primate traits:
  i) Social life
  ii) Play
  iii) Observation and imitation
  iv) Pecking order
13.5 Human Evolution

- Major Homonid advances:
  i) Brain size
  ii) Better bipedalism
  iii) Hunting
  iv) Fire
  v) Tools
  vi) Built shelters
  vii) Clothing
  viii) Language
13.5 Human Evolution

Genetic and Language Relationships

A. sediba
A. rudolfensis
A. afarensis
Early Human Variability

A. australis
A. africanus
A. afarensis
A. robustus
A. africanus
A. sapiens
A. neanderthalensis
A. sapiens
A. sapiens

1.8 mya - 400,000
400,000 - 150,000
120,000 - Present

Non-African Homo sapiens

African vs. Out of Africa

South Asian Homo sapiens
60,000 - 400,000
350,000 - 50,000
50,000 - Present

North African Homo sapiens

South Asian Homo sapiens
70,000 - 70,000
70,000 - 70,000
70,000 - Present

North African Homo sapiens

2.5 to 1.8 mya
2.6 to 1.6 mya
3.0 to 2.0 mya
3.9 to 3.0 mya
2.6 to 1.6 mya
3.8 to 2.3 mya
2.3 to 1.0 mya