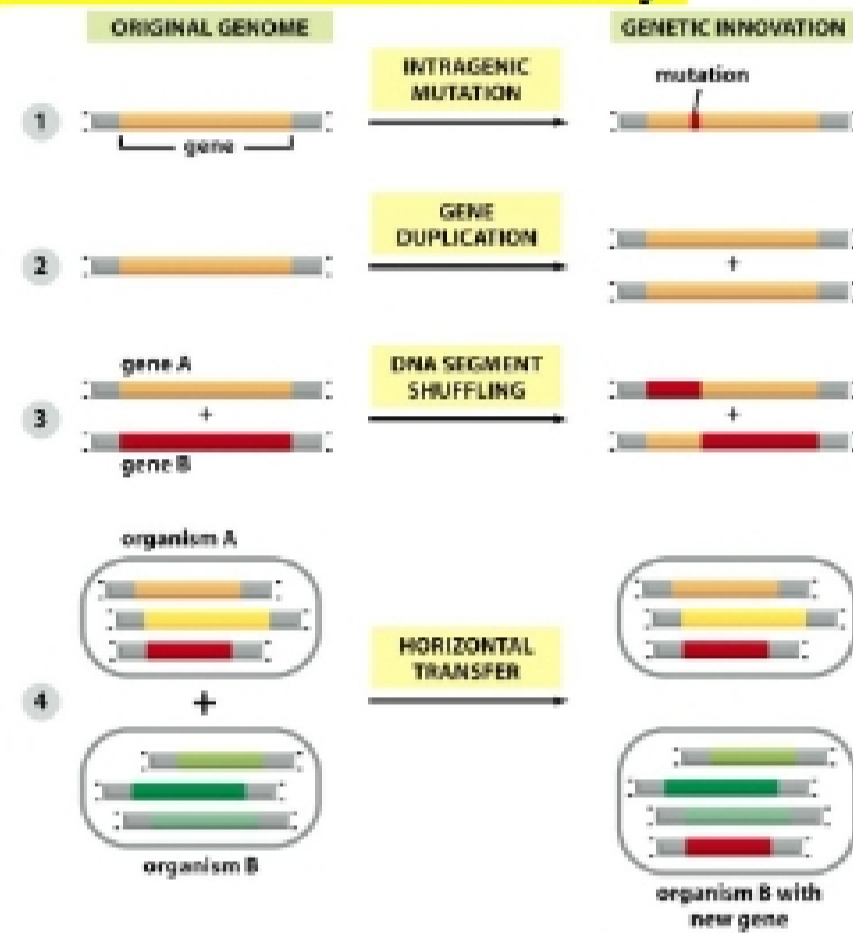


Introduction to the Cell (Ch. 1)

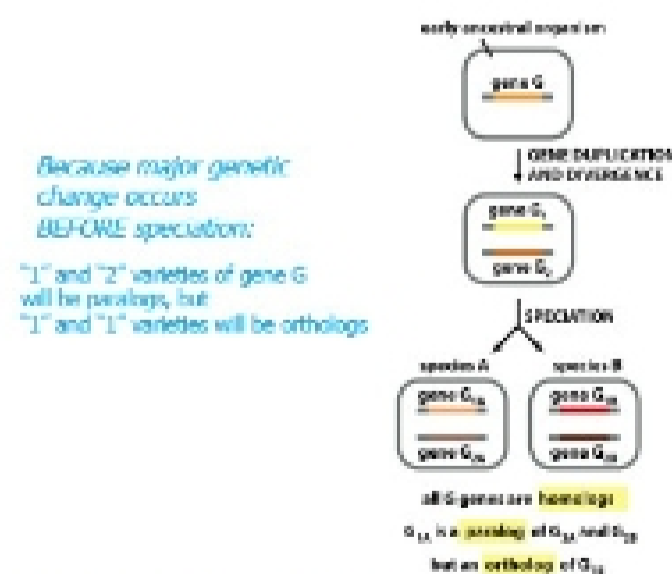
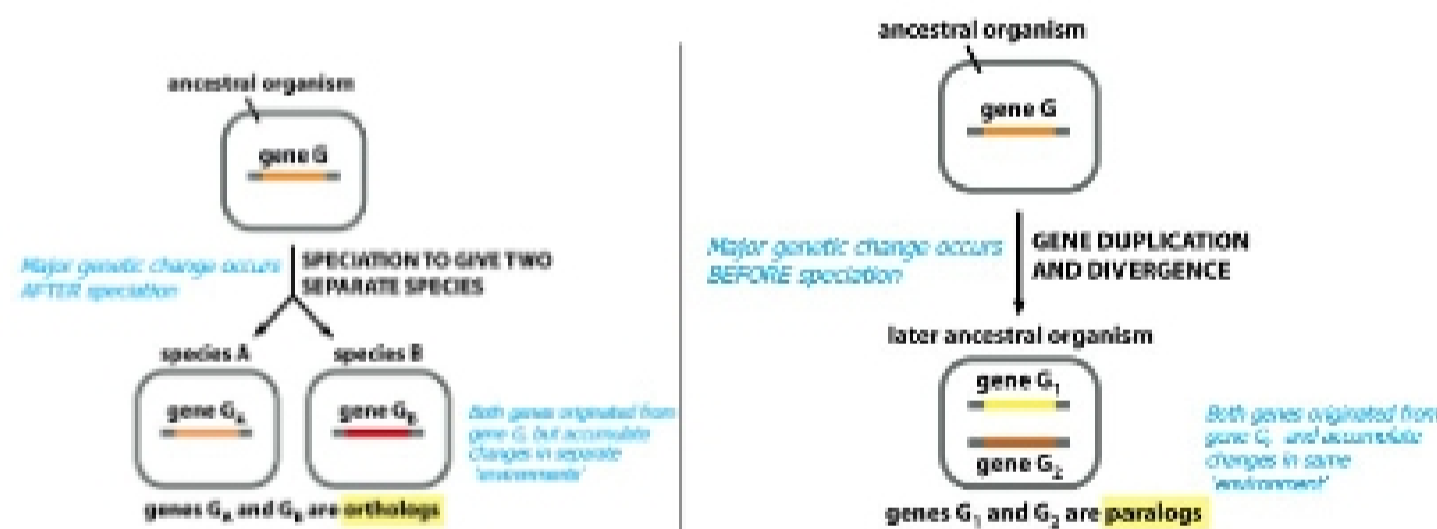
- More than 10 million species
 - o Common threads:
 - Growth and reproduction
 - Communication with the environment
 - Acquisition and assimilation of energy
 - Homeostasis
- **Cell Theory**
 - o Cells are the functional units of life
 - o All living organisms are composed of cells
- **8 common features of all cells**
 1. Highly complex and organized
 2. Possess a genetic program
 3. Capable of producing more of themselves
 4. Biochemical factories that constantly acquire and utilize energy
 5. Engage in mechanical activities
 6. Able to respond to stimuli
 7. Capable of self regulation
 8. Evolution first happens at the level of molecules and cells
 1. Cells are constructed from a hierarchy of molecular organization
 2. Cells possess a genetic program
 - a. **Organisms are built according to information stored in a collection of genes**
 - b. **Hereditary information defines a species**
 - c. **Genes**
 - i. Store information
 - ii. Blue prints for constructing cellular material
 - iii. Directions for running cellular activities
 - iv. Program for making more cells
 - v. **the fundamental molecular mechanisms by which genetic programs are carried out are identical among all cell types**
 - vi. All cells speak the same hereditary language
 1. Can place a gene from one organism into cell of another organism and it will be able to read it
 - d. **Cells duplicate their hereditary information by way of 'Templated Polymerization'**
 - i. **Cells transcribe their hereditary information in chemically similar, short-lived copies**
 1. Fixed set of DNA molecules → Working RNA copies
 - ii. **Proteins carry out the tasks specified by DNA and are the work horses of the cell**
 1. **"Central Dogma" → Flow of information**
 - a. DNA → RNA → protein
 2. Proteins carry out a cell's activities
 - a. Widely varied in structure and function
 - b. **Many proteins are catalysts**

- i. Cells use special classes of proteins as chemical catalysts (enzymes)
- 3. Cells are capable of producing more of themselves
 - a. Growth and reproduction ultimately occur at the cellular level
 - b. Genetic programs enable 2 classes of reproduction that either preserve identical copies of pre-existing cells or generate genetic change that lead to variations among individual cells
 - i. Identical copies → mitosis
 - ii. Genetic change → meiosis
- 4. Cells are biochemical factories constantly acquiring and assimilating energy
 - a. Cells must accomplish biological order in a universe that favors disorder
- 5. Cells engage in mechanical activities
 - a. Of the astonishing variety of protein classes that carry out the cells activities, motor proteins are among the most fascinating
- All cells fall into one of two major categories of existence:
 - o 1. Eukaryotic Cells
 - Animal Cells, Plant Cells
 - 10-100um in diameter
 - Nucleus
 - Highly structured internal organization
 - o 2. Prokaryotic Cells
 - 1-5um
 - Lack distinct nucleus
 - Lack detailed internal organization
- Cell size constraints: surface area to volume ratio
 - o Surface-area-to-volume ratio requires that cells be relatively small
 - As cells get larger in volume, relative surface area actually decreases
 - Limits how large actively metabolizing cells can become
 - Larger cells needing greater surface area use modifications such as membrane folding
- Prokaryotes
 - o Evolutionarily optimized for rapid and efficient reproduction
 - o Most biochemically diverse among all organisms:
 - Organotrophs – obtain energy by feeding on living things or organic material
 - Phototrophs—obtain energy by using sunlight to convert inorganic substances into organic material
 - Lithotrophs—obtain energy by converting inorganic chemicals into organic material
- Genome Analysis provides a direct means of deducing evolutionary relationships among species
 - o DNA accumulates random changes through mutation over long periods of time
 - o The number of differences between the DNA sequences of two organisms is proportional to the evolutionary distance between them
- The Tree of Life
 - o Three different domains in the “tree of life”
 - o Eukaryotes (protists, fungi, plants, animals)

- o Prokaryotes (Archea, Bacteria)
 - Archea and Eukaryotes may have had a common ancestor
 - Archea and Bacteria generally have 1000-6000 genes (1-10Mbp)
- o More than 200 gene families are common to all 3 primary branches of life
- Genetic Change
 - o New genes arise from existing genes by intragenic mutation or gene duplication
 - o Some genes evolve rapidly, others are highly conserved
 - o Not gene is ever entirely new
 - Innovation can occur in several ways



- Repeated rounds of the process of duplication and divergence over many millions of years have enabled one gene to give rise to a family of genes that may all be found within a single genome



- How did Eukaryotic cells arise?
 - o Endosymbiosis – ancestral eukaryotic cell engulfed bacterial cell = mitochondria