Molecular Cell Biology A

"From molecules and cells to tissues and organisms"

BIOX24ZL

Tuesdays 9-10:30

Ray LC

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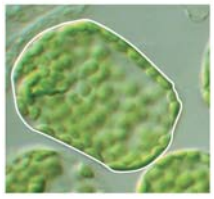
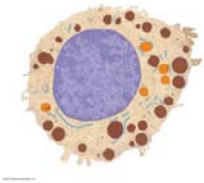
Know Thyself

Molecular biology is the study of what makes who we are.

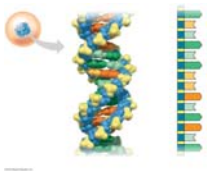
Cell Chemistry



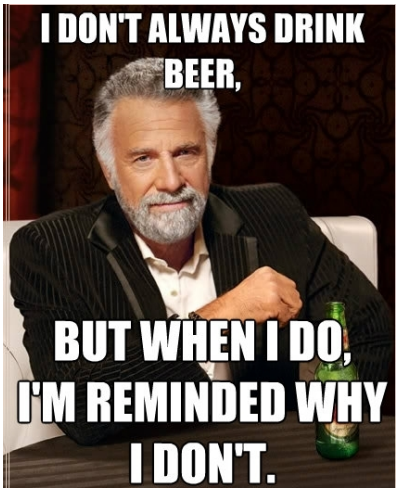


Proteins

DNA



I don't usually set class "rules", but when I do, I prefer "study guides."



Study guides to help you succeed in life… at least Life Science 204 class.

☑ Don't take too much notes, just listen (slides will be entirely on course NAVI).

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and .....

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and .....

✓ Laugh at my jokes (if they are funny).

Info held by cells is contained in DNA and transcribed to RNA.

- Cell fundamental hereditary unit: DNA info
- Nucleotide monomer: sugar phosphate + base
- One strand complementary to other: AT, GC
- Replicate by templated polymerization
- Info expression: transcribed to RNA (U not T)
- Single strand RNA can bind and catalyze rxn

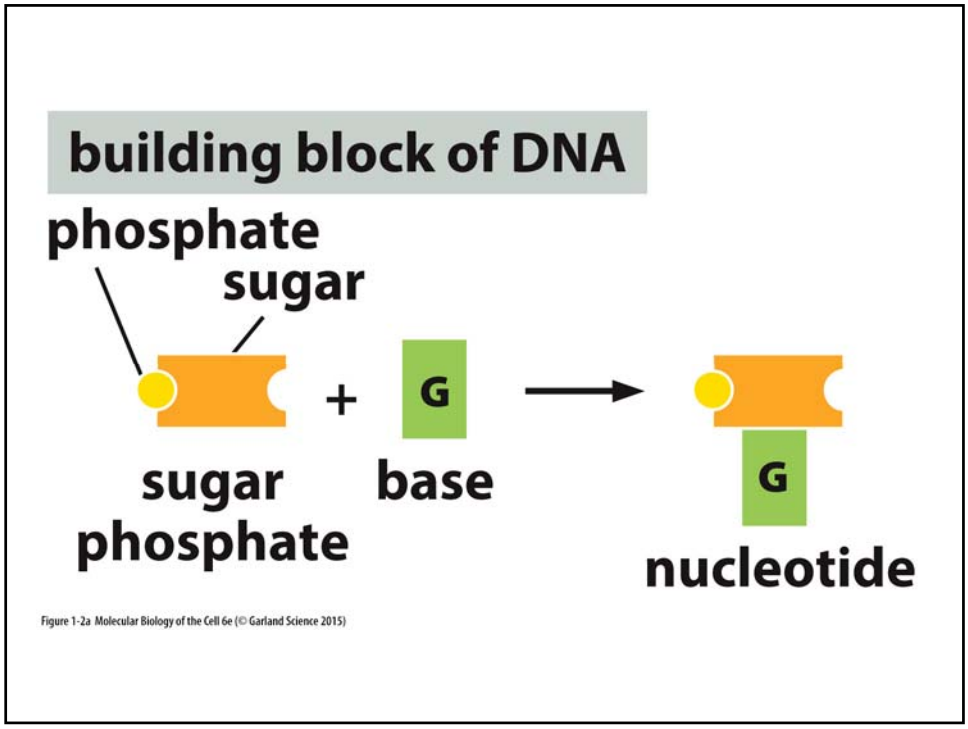


Figure 1-2a Molecular Biology of the Cell 6e (© Garland Science 2015)

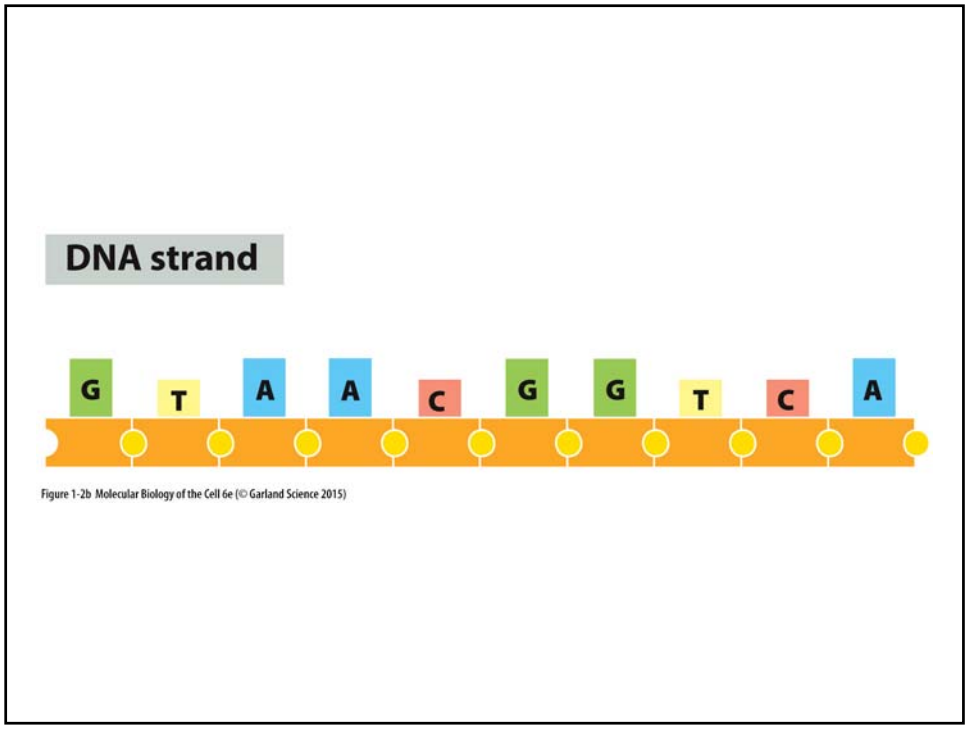


Figure 1-2b Molecular Biology of the Cell 6e (© Garland Science 2015)

templated polymerization of new strand

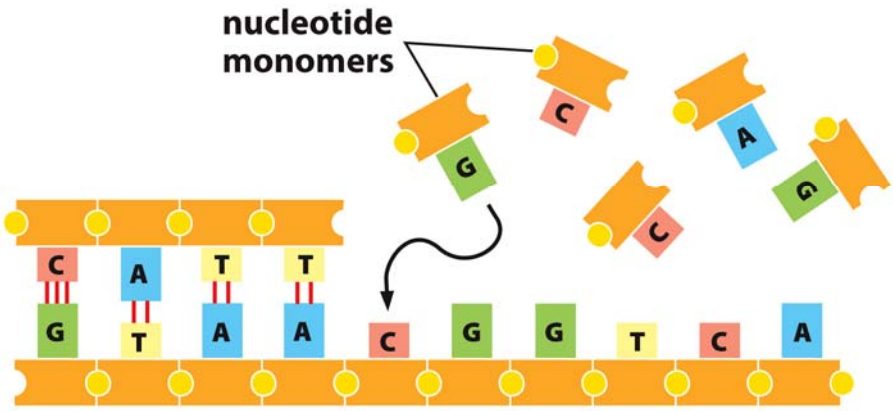
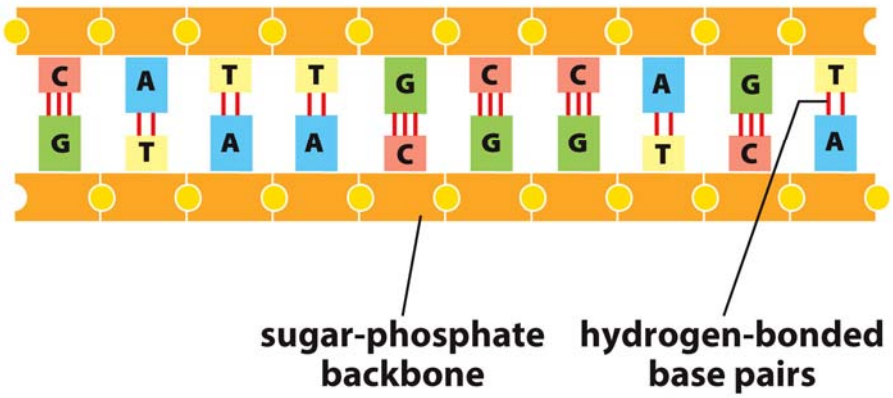


Figure 1-2c Molecular Biology of the Cell 6e (© Garland Science 2015)

double-stranded DNA



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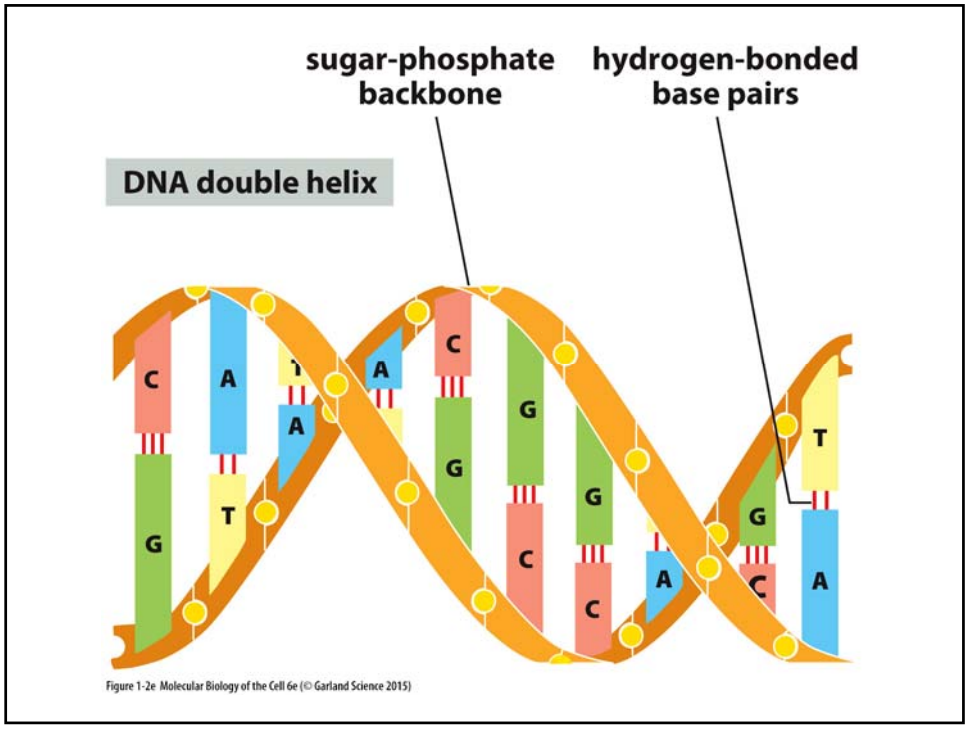

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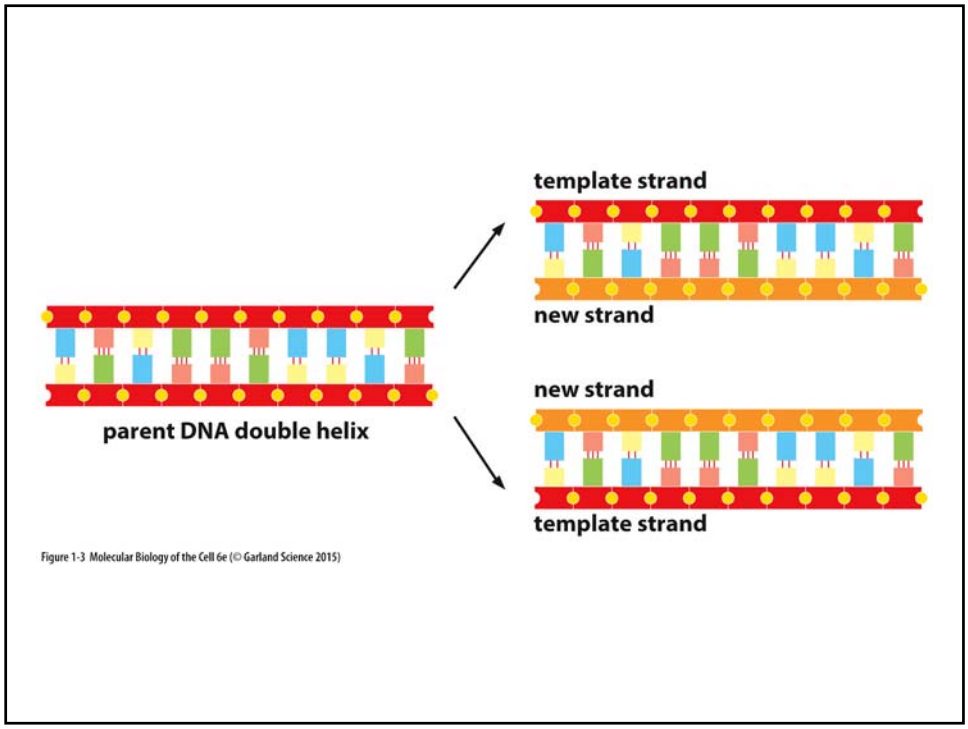

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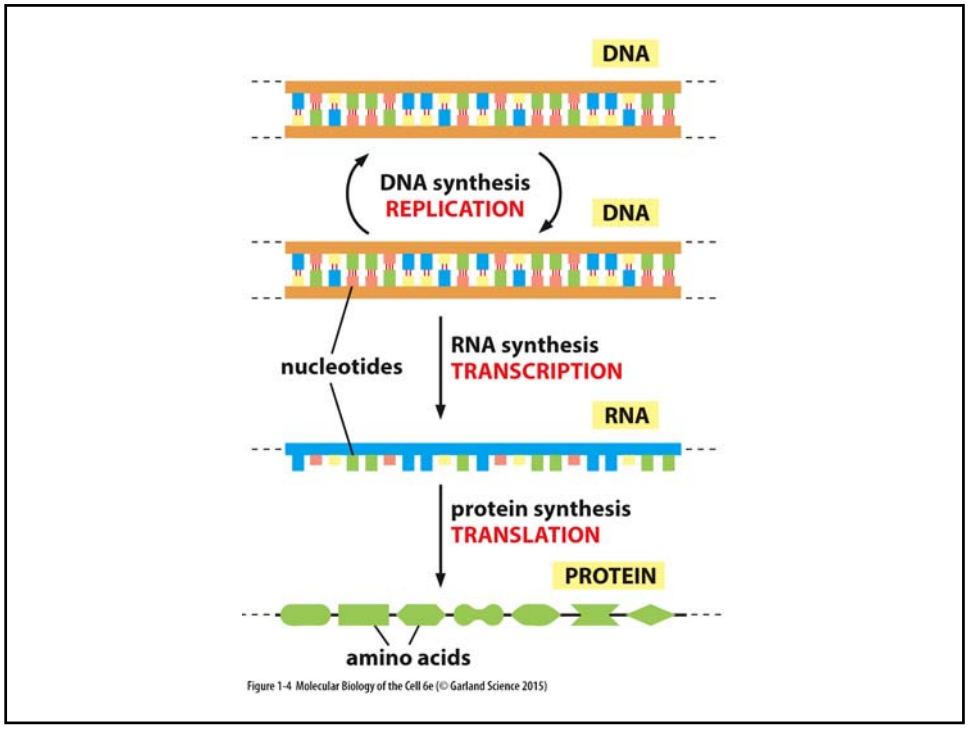


Figure 1-4 Molecular Biology of the Cell 6e (© Garland Science 2015)

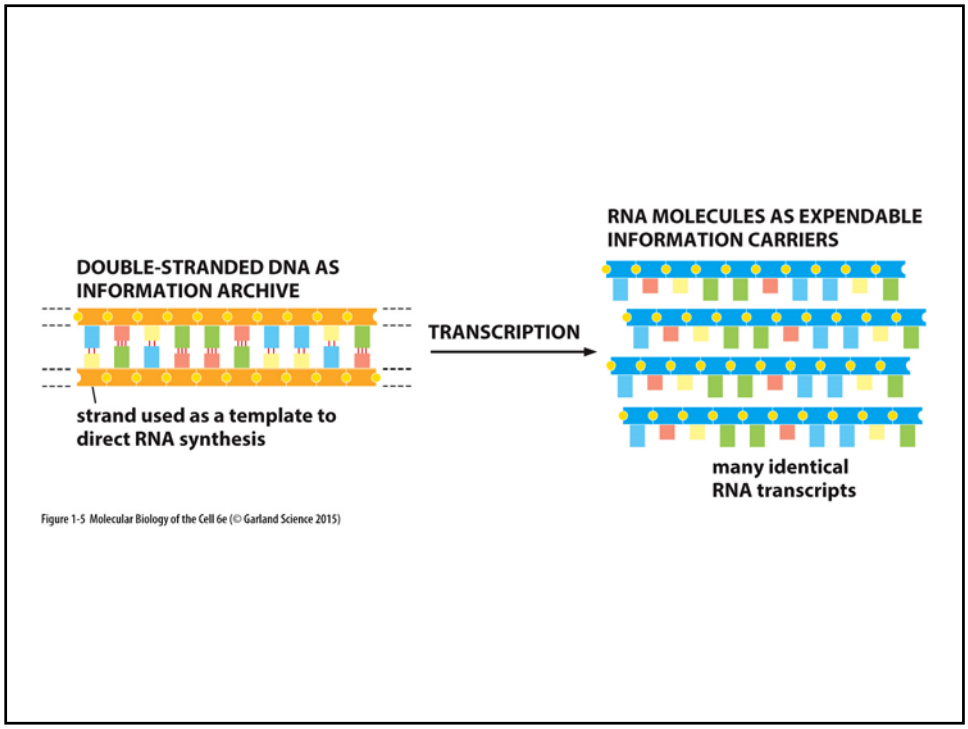
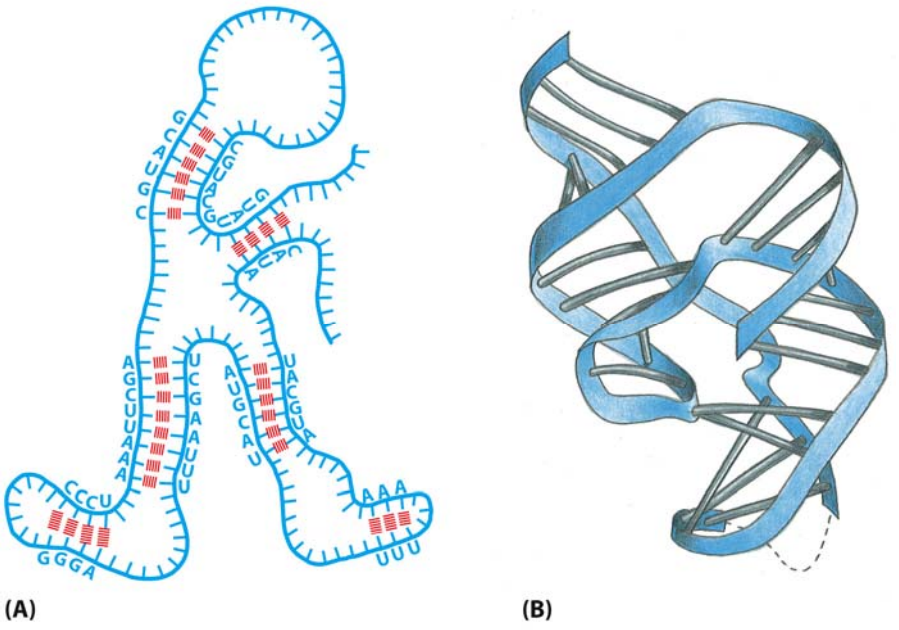


Figure 1-5 Molecular Biology of the Cell 6e (© Garland Science 2015)

Messenger RNA is translated into proteins, which catalyze reactions.

- Proteins built from 20 (distinctive) amino acids
- Translation: triplet of nucleotides into single amino acid (64 possible) via transfer RNA
- Ribosomal RNA stitch amino acids together
- Gene: DNA segments coding for a protein (var)
- Regulatory seq control when gene expressed



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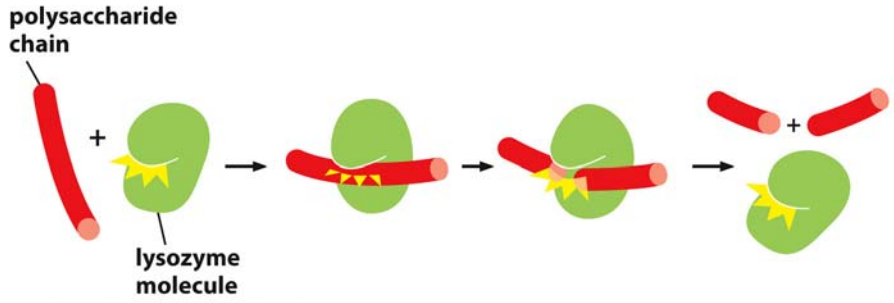


Figure 1-7b Molecular Biology of the Cell 6e (© Garland Science 2015)

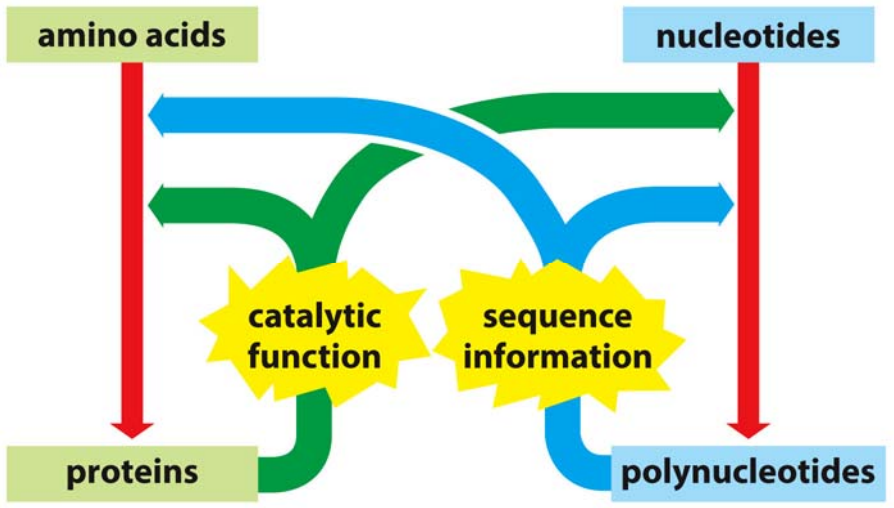
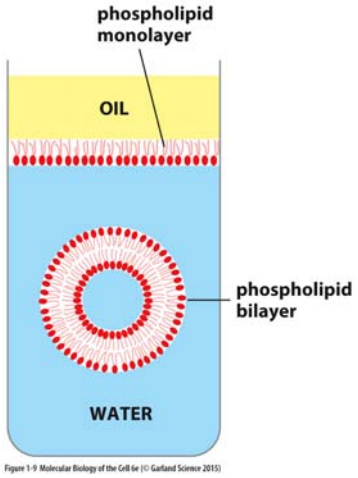


Figure 1-8b Molecular Biology of the Cell 6e (© Garland Science 2015)

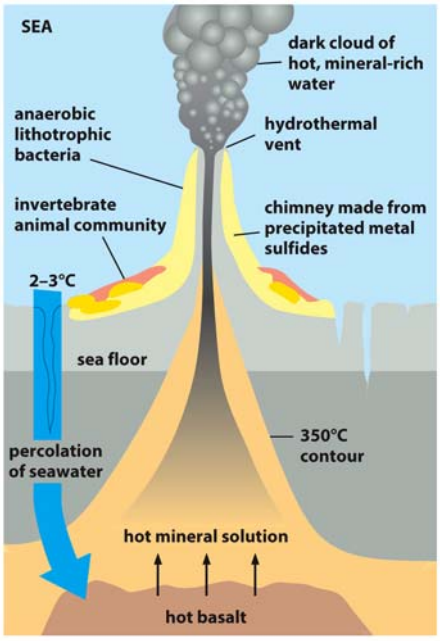
Cells are enclosed by bilayers of plasma membrane.

- Hydrophobic and hydrophilic ends -> amphiphilic
- Spontaneously aggregate
- Transport proteins determine cell traffic



Most forms of life are from the little explored world of microorganisms.

- Organotrophic: feed on others (humans)
- Phototrophic and lithotrophic: harvest energy
- Hydrothermal vents: crust chemicals microbes
- DNA RNA and proteins: need to fix carbon dioxide and nitrogen
- Prokaryotes have no nuclei around DNA
- Prokaryotes classified into bacteria and archaea based on genome and cell machinery



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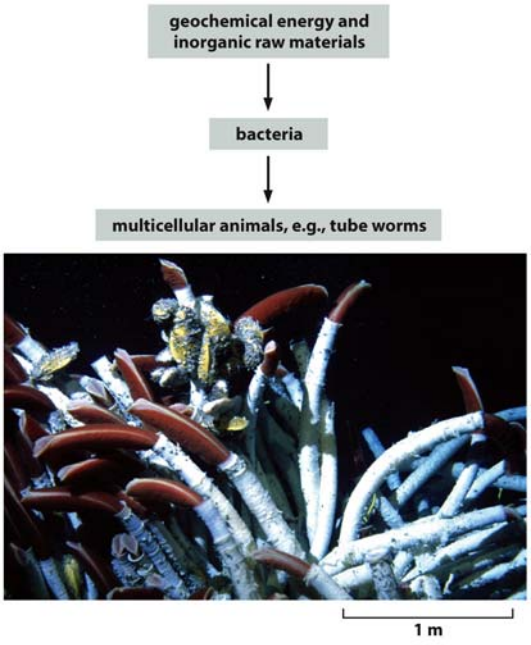

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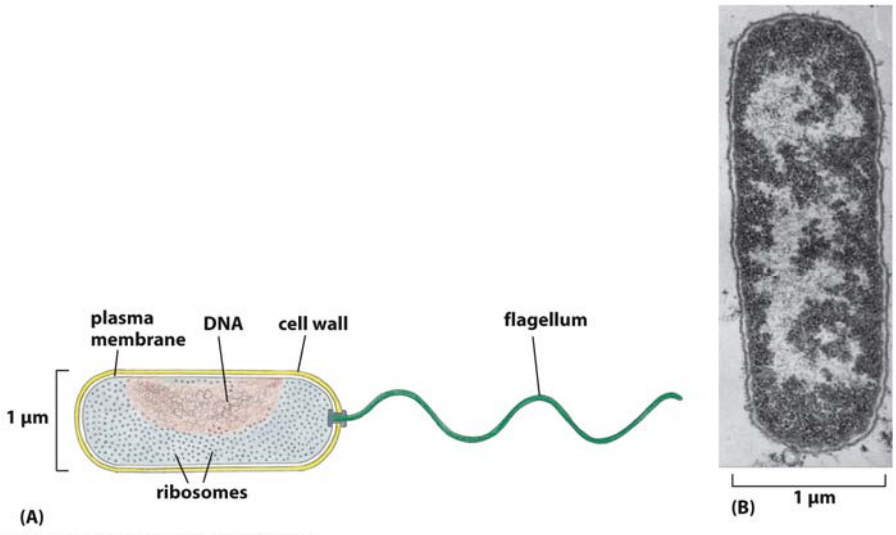

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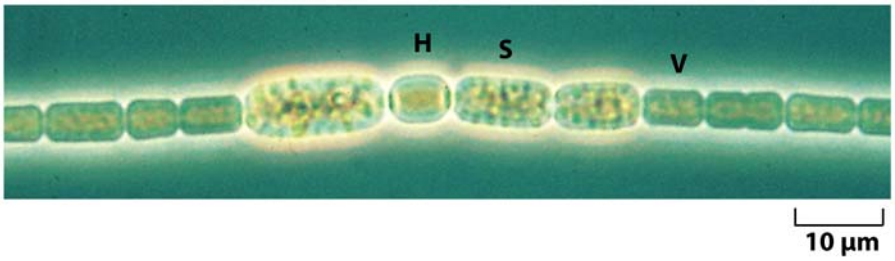


Figure 1-15 Molecular Biology of the Cell 6e (© Garland Science 2015)

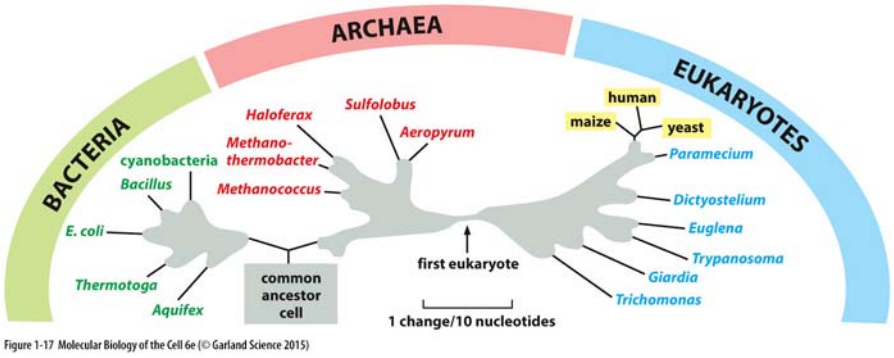
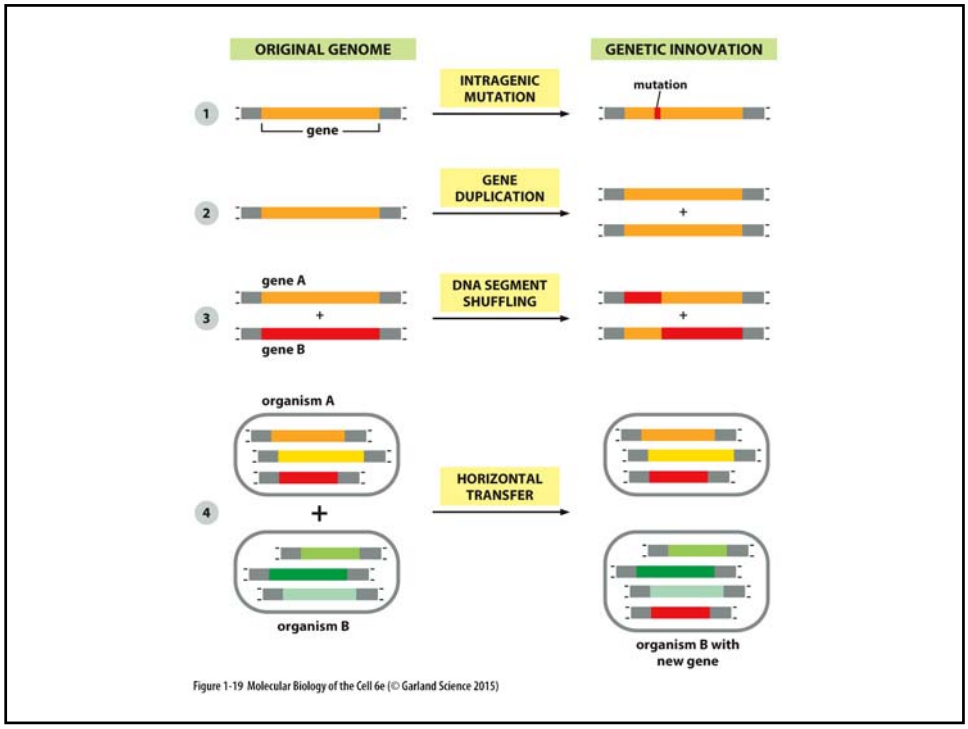


Figure 1-17 Molecular Biology of the Cell 6e (© Garland Science 2015)

New genes that diverge from existing gene can form homolog families.

- Mutations (copy errors) can be neutral or cause damage -> elimated by natural selection
- Efficient core genes (rRNA) highly conserved
- New gene by: mutation, duplication, shuffling (break & join), horizontal transfer (cell to cell)
- Duplication allow extra copy to mutate
- Orthologs: similar func genes from diff species
- Paralogs: duplication -> divergence in function



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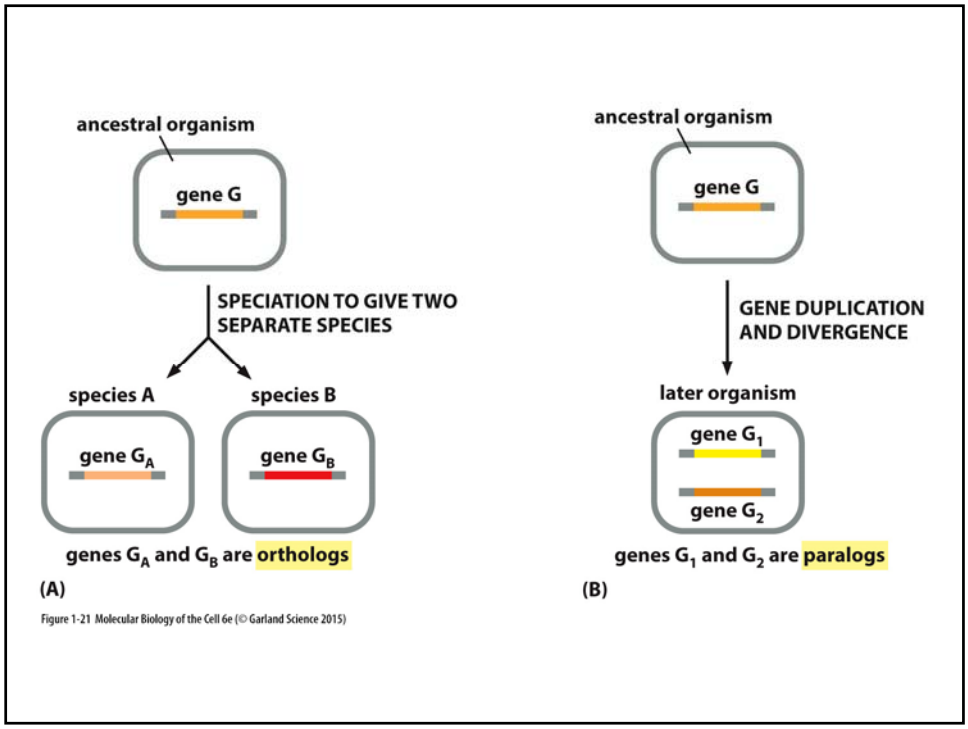


Figure 1-21 Molecular Biology of the Cell 6e (© Garland Science 2015)

Prokaryote: gene transfer, mutations allows inference of gene function.

- Horizontal gene transfer: viruses can infect cells with carried DNA (plasmid or internal)
- Gene transfer common in diff species prokaryotes, same species eukaryotes (sex)
- Highly diverse *E. coli* containing homologous genes used to study genetic mechanisms
- Cell wall, intermingled DNA and transcription

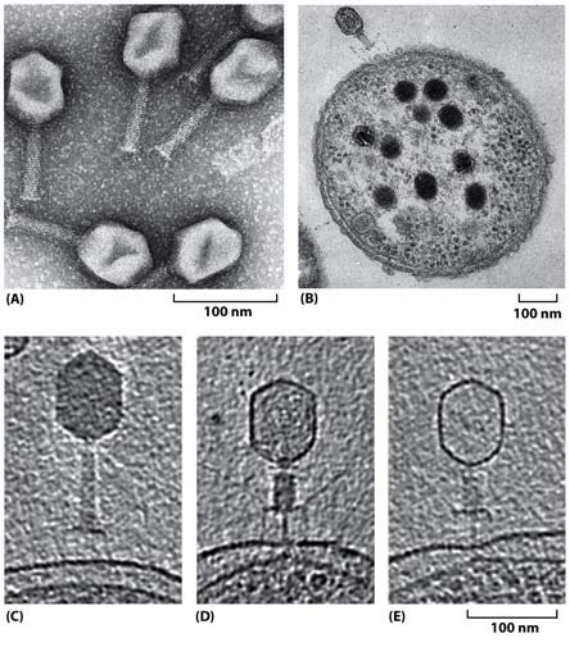


Figure 1-22 Molecular Biology of the Cell 6e (© Garland Science 2015)

Team work:

Which of the following does NOT typically involve horizontal gene transfer?

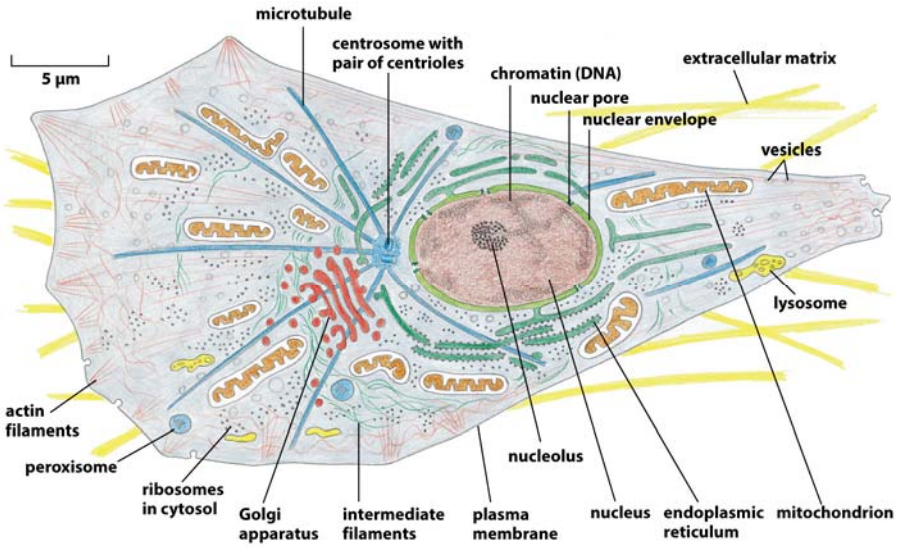
- A. Sexual reproduction in humans
- B. Bacteriophage infection of bacteria
- C. The evolutionary history of the eukaryotic cell
- D. The accidental duplication of a small region of a bacterial chromosome followed by cell division
- E. Introduction of plasmids into bacteria in a laboratory

Which of the following would you NOT expect to find in a bacterial cell?

- A. Swimming using flagella
- B. Having a cell wall around the plasma membrane
- C. ATP production in mitochondria
- D. Protein production on the ribosome
- E. Sexual exchange of DNA with other bacteria

Eukaryotes organize genetic material in internal compartments.

- Nuclear envelop, cytoskeleton, internal membrane, phagocytosis, predatory
- Mitochondria are engulfed aerobic bacteria with their own circular DNA tRNA ribosome
- Chloroplasts use sunlight to synthesize carbohydrates from carbon dioxide and water
- Mit DNA and chl DNA lack essential genes
- Fungi scavenge leftovers (digestion)



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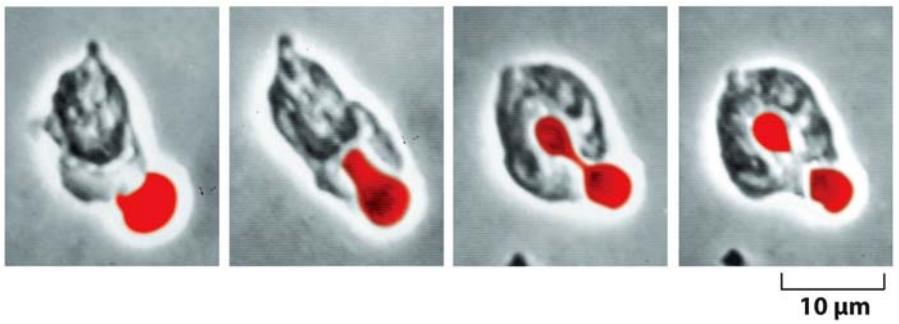

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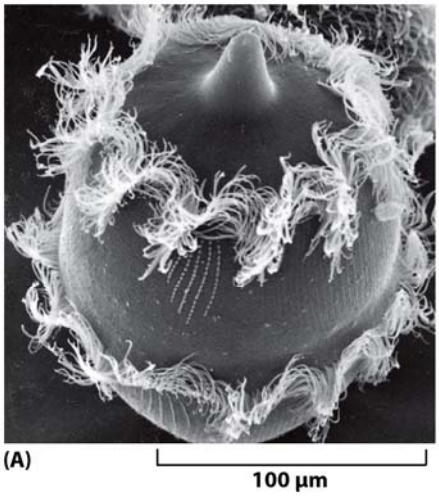

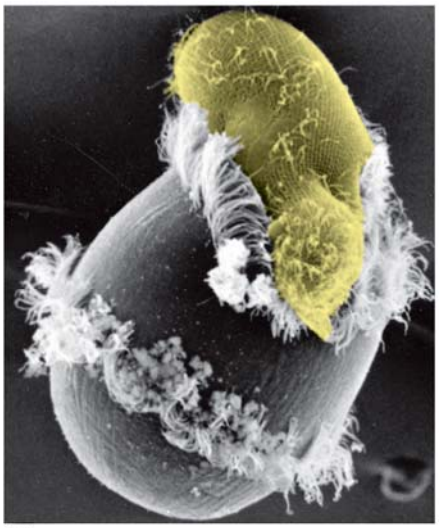

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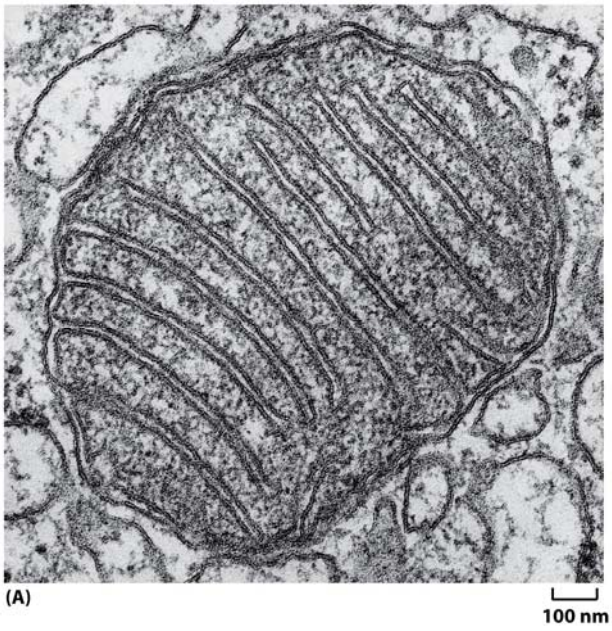

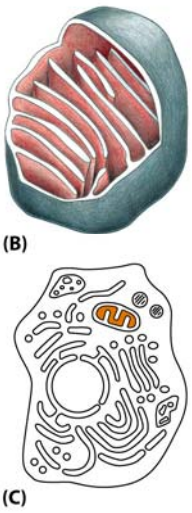

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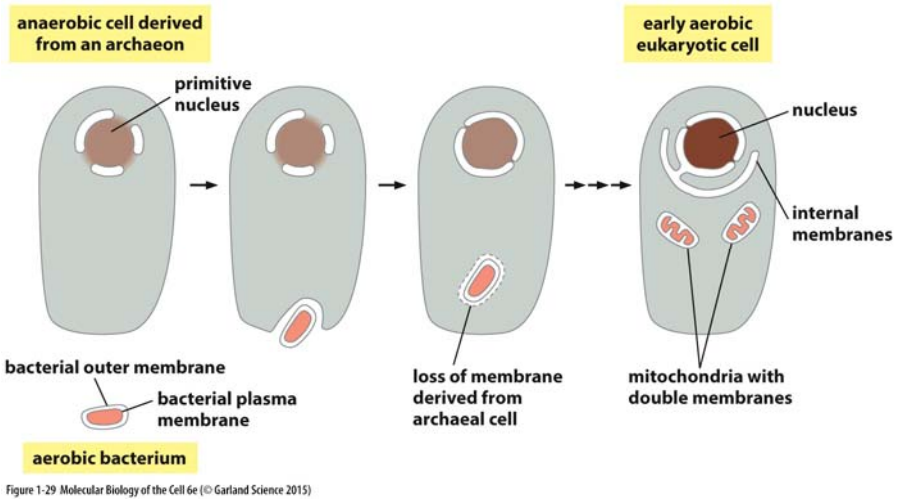

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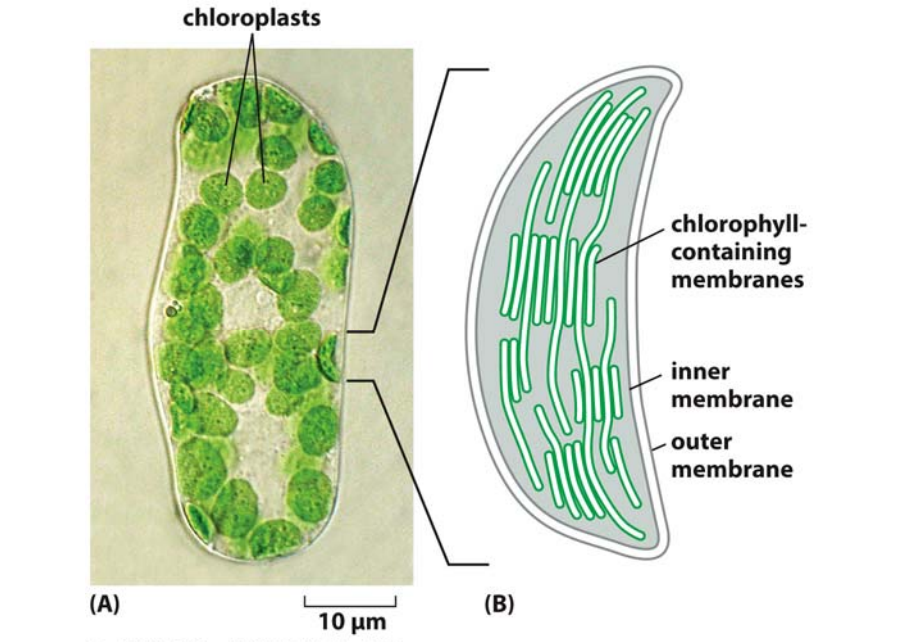

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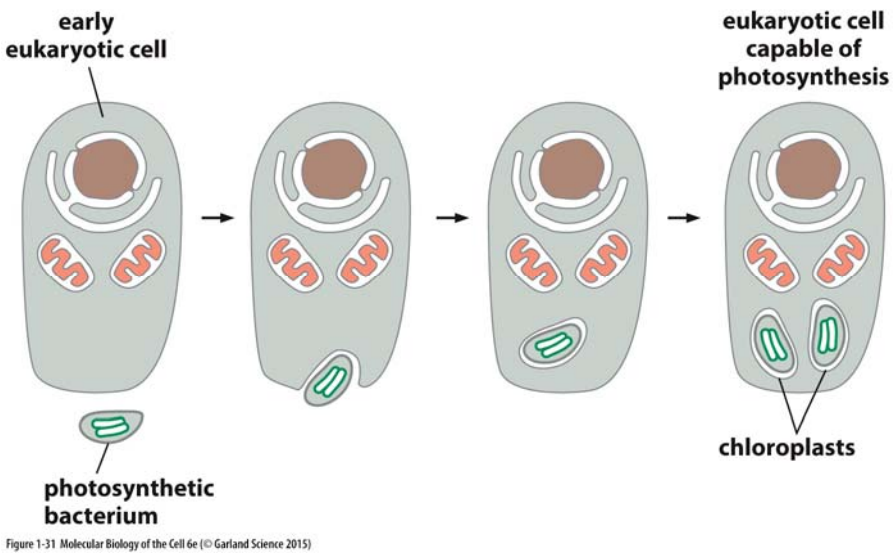
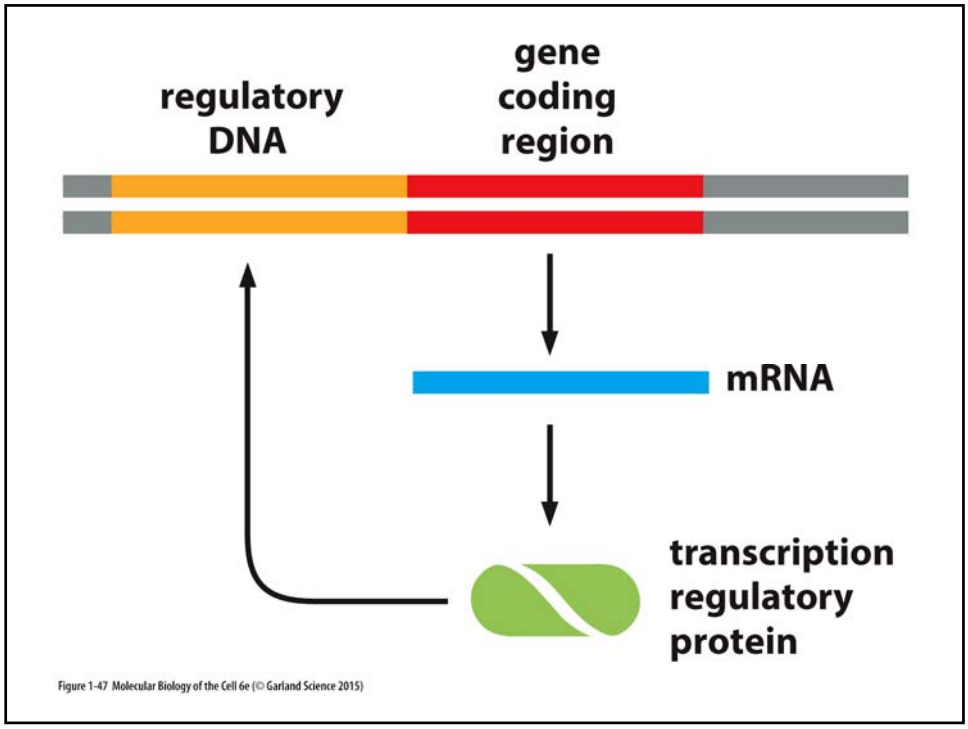


Figure 1-31 Molecular Biology of the Cell 6e (© Garland Science 2015)

Eukaryotic genomes contain redundancy like archive of genes.

- Eukaryotic genome bigger and contain much more noncoding DNA (98.5% in humans)
- Fugu: like zebrafish but much smaller genome
- Regulatory sequences and proteins
- Protists are complex single cell eukaryotes
- *S. cerevisiae* yeast animal-like fungi with mitochondria, can exist haploid (one copy) or diploid state, compact genome 2.5x of *e. coli*



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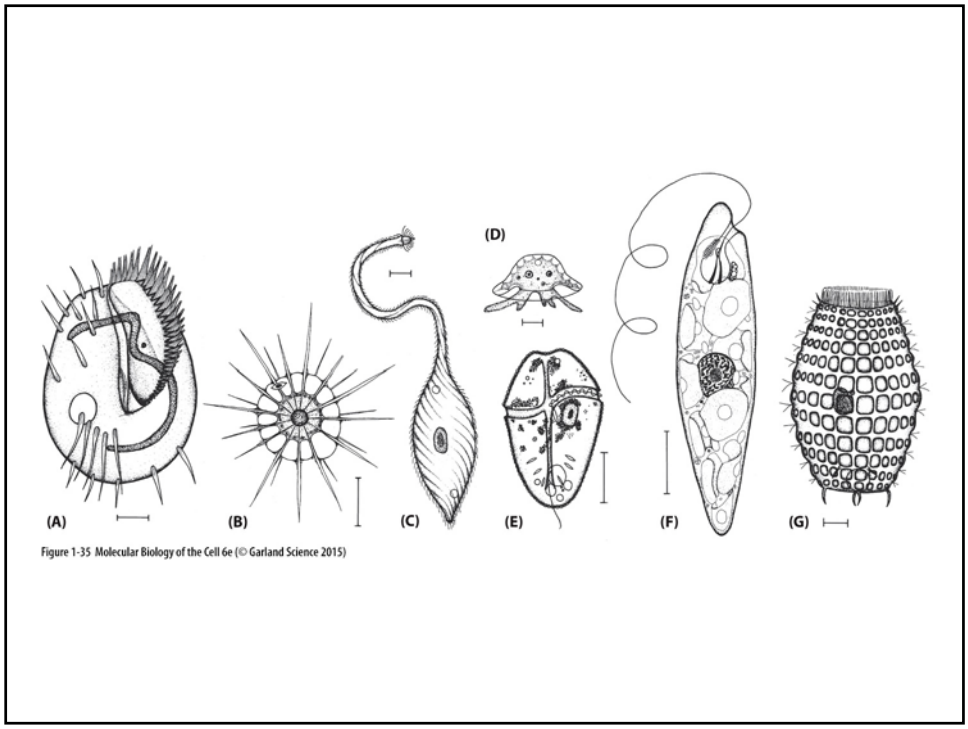

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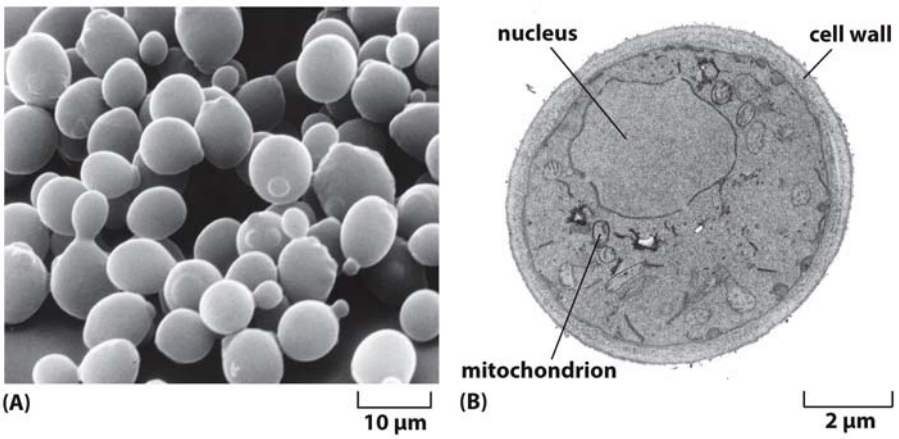

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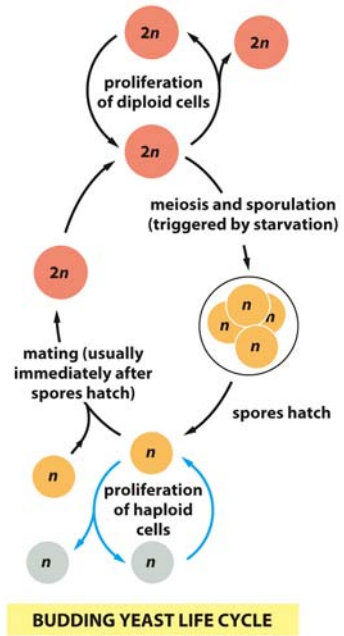

Figure 1-37 Molecular Biology of the Cell 6e (© Garland Science 2015)

Model organisms: *Arabidopsis* plant can be grown easily, quickly.

Figure 1-38 Molecular Biology of the Cell 6e (© Garland Science 2015)

Model organisms: *C. elegans* worm 959 cell, study apoptosis, cell division

Figure 1-39 Molecular Biology of the Cell 6e (© Garland Science 2015)

Model organisms: *Drosophila* fruitfly bands body part mutant, development

Figure 1-41 Molecular Biology of the Cell 6e (© Garland Science 2015)

Model organisms: *Xenopus* frog variants, 2x to 6x genome duplication

Figure 1-42 Molecular Biology of the Cell 6e (© Garland Science 2015)

Vertebrates:
Overlapping functions of paralogous genes, e.g. for diff organs.

Model organisms: rodents mammalian knock-outs vs human genetic disease.

Figure 1-46 Molecular Biology of the Cell 6e (© Garland Science 2015)

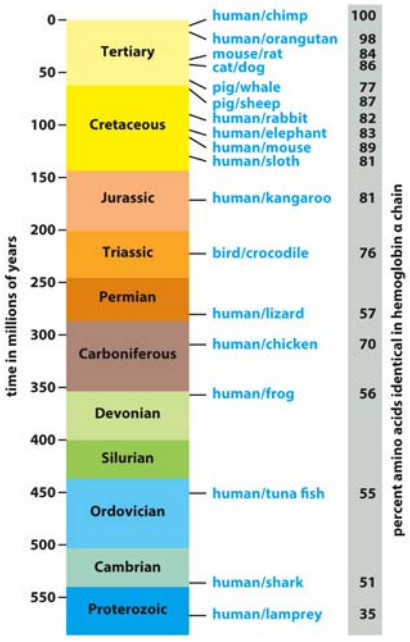

Figure 1-45 Molecular Biology of the Cell 6e (© Garland Science 2015)

Team work:

To trace family relationships between distantly related organisms such as humans, algae, bacteria, and archaea, one should compare their genomes in regions …

- A. that evolve rapidly.
- B. that have a higher mutation rate.
- C. that code for proteins.
- D. where mutations are hardly tolerated.
- E. where most mutations are selectively neutral.

It is a model organism used to study various cell processes such as regulation of the eukaryotic cell cycle. Mutants are available for every gene in its exceptionally small genome. It can live indefinitely in either a haploid or a diploid state. Which of the following describes this organism?

- A. It can reproduce only asexually.
- B. It is a fungus.
- C. It lacks a cell wall.
- D. Its cell cycle is typically much slower than that of human cells.
- E. All of the above