

## Universal principles of living cells

## Unity of life at molecular level

- Genome
  - Common (universal) genetic code
  - Same direction of translation
  - DNA  $\Rightarrow$  RNA  $\Rightarrow$  protein
- All cells are enclosed by plasma membrane
  - Phospholipid bilayer with proteins embedded in it
- Similar mechanisms for signal transduction and cell cycle control

## Differences

- Prokaryotes and eukaryotes
  - Differ by the structure of the cell
- “Lost” genes and new genes
- Differential expression and alternative splicing of genes

## Prokaryotic and eukaryotic cells

- Two types of organisms (cells):
  - prokaryotic - bacteria (eubacteria) and archaea (archaeobacteria)
  - eukaryotic – protists, fungi, plant and animal kingdoms

## Features that distinguish prokaryotic and eukaryotic cells

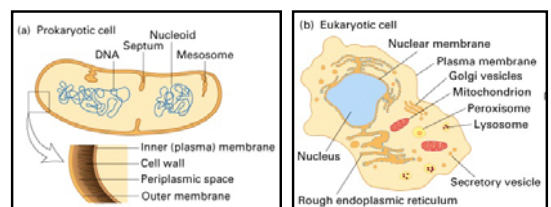
### Eukaryotes

- Have internal compartments
  - Membrane bound organelles
- Cytoplasm contains supporting matrix called cytoskeleton
- Nucleus with multiple chromosomes

### Prokaryotes

- Entire cytoplasm is one unit
  - No membrane bound organelles
- No internal support
- Single circular chromosome in the cytoplasm

## Prokaryotic and eukaryotic cell

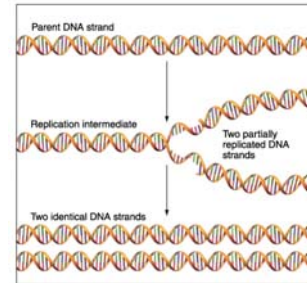


## Universal principles of living cells

- Hereditary information is stored in **one dimensional** chemical sequences
  - All information required for every process in the organism is stored in DNA
  - Easy duplication into daughter cells
  - Universal code



## Duplication of DNA

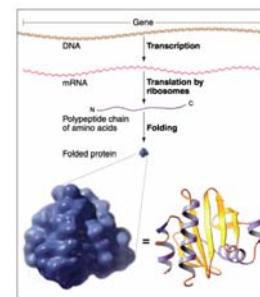


## Universal principles of living cells

- DNA code is the only information required for linear sequences and 3D structures
  - Amino acid sequence of a polypeptide contains sufficient information how to make a protein
  - How to fold it (native state)
  - Where to deliver it within a cell
  - = Function



## Protein folding



## Universal principles of living cells

- Multiunit complexes form by self-assembly
  - Usually diffusion
  - Chaperones can assist by preventing interactions of partially folded proteins but proteins can fold without them

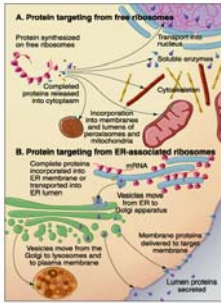


## Universal principles of living cells

- Targeting signals determine cellular localization of proteins
  - All proteins are synthesized on the ribosomes (free in cytoplasm or "sitting" on the endoplasmic reticulum)
  - Targeting signals within protein sequence target molecules to the proper compartments
  - Targeting signals are a part of protein sequence
  - Targeting signal can be later removed from the protein during posttranslational modifications



## Pathways for intracellular protein localization



## Universal principles of living cells

- Membranes grow by expansion of preexisting membranes
  - Organelles can not be formed *de novo*
  - Growth and division of existing organelles
  - Epigenetic information is necessary
  - Maternal inheritance !!!

## Universal principles of living cells

- Cells respond to changes in their environment by activation of specific receptors and signaling pathways
  - Gene expression, changes in metabolism, cell death
  - Receptors can be localized on the external face of plasma membrane or inside a cell

## Universal principles of living cells

- The homeostasis is controlled by molecular feedback
  - Control cell composition and/or activity
  - Multiple levels of feedback – gene induction, suppression, rate of translation, protein degradation, regulation of activity (enzymes)