# BIOLOGY, BIOTECHNOLOGY

in English

2 hour lecture/week, 3 credits

2 midterm tests, no final examination

12 lectures, 3 lecturers

Handouts, slide shows and readings:

http://oktatas.ch.bme.hu/oktatas/konyvek/abet/Biology-biotechology_in_English/

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# BIOLOGY, BIOTECHNOLOGY

| Date | Lecture | Topic | Lecturer | tests | room |
|---|---|---|---|---|---|
| 1-Mar | 1 | Cells | M. Pécs | | |
| 8-Mar | 2 | Industrial microbiology | Á. Németh | | |
| 15-Mar | | National Holiday | | | |
| 22-Mar | 3 | Enzymes | M. Pécs | | |
| 29-Mar | 4 | Enzymes | M. Pécs | | |
| 05-Apr | 5 | Microbial growth | Á. Németh | | |
| 12-Apr | | Spring Holiday | | | |
| 19-Apr | 6 | Aeration, agitation | Á. Németh | | |
| 26-Apr | 7 | Sterilization | Á. Németh | midterm test 1 | |
| 3-May | 8 | Downstream processing | M. Pécs | | |
| 10-May | 9 | Technologies, case studies | M. Pécs | | |
| 17-May | 10 | Wastewater treatment | V. Bakos | | |
| 24-May | 11 | Wastewater treatment | V. Bakos | | |
| 31-May | 12 | | | midterm test 2 | |
| 07-Jun | | | | makeup tests | |

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# BIOLOGY, BIOTECHNOLOGY

Lecturers:

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# BIOLOGY, BIOTECHNOLOGY

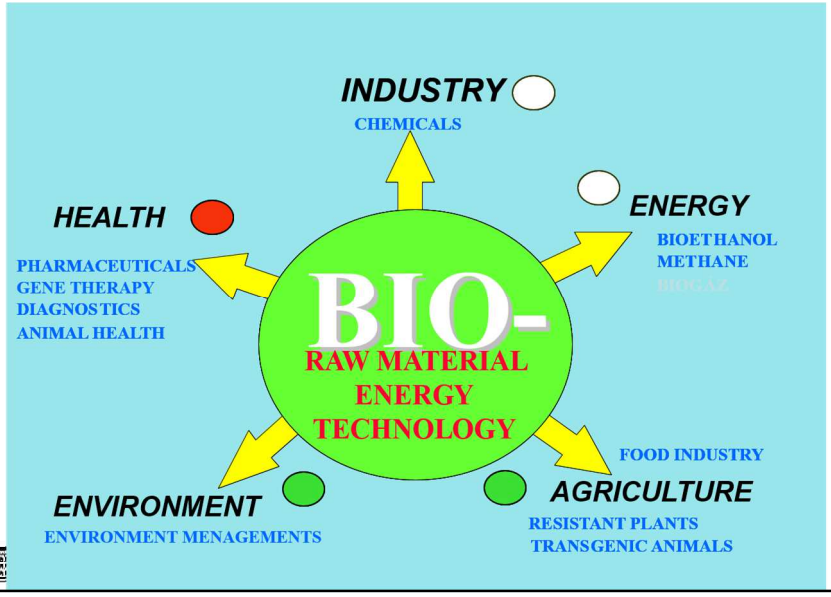
Biology: everybody knows - a natural science dealing with living beings.
But what is Biotechnology?

… is an integrated application of
biochemistry,
microbiology and
engineering sciences

… principles in order to the technological use of
microorganisms
animal and plant cells/tissues
or parts of these (e.g. enzymes)

…to produce something.

## Branches and colors of biotechnology

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## 1st lecture: Composition and structure of cells

### 1. Prokaryotes and eukaryotes

Karyon = nucleus pro- = before/first eu- = true/good

Basic difference: they don't have/have real, isolated nucleus

In the evolution: the prokaryotes are ancient, simple forms, the eukaryotes are more complex and evolved later

Prokaryotes: all bacteria, included the filiform Actinomycetales and blue algae (Cyanobacteriales)

Eukaryotes: yeasts, moulds, protozoa, green algae, and all multicellular living being.

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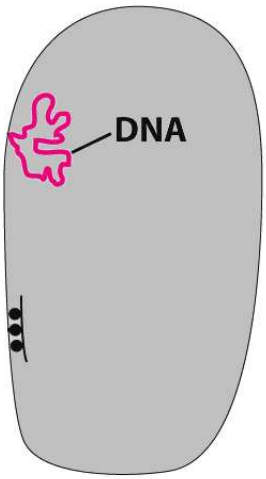
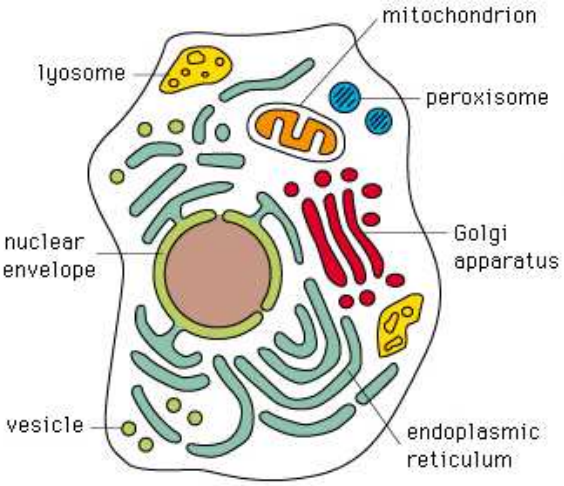
## Prokaryotic and eukaryotic cell

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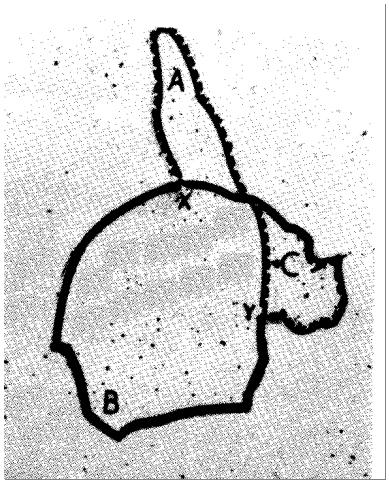
## Prokaryotic DNA (*E. coli*) (during duplication)




## Eukaryotic DNA (chromosomes)

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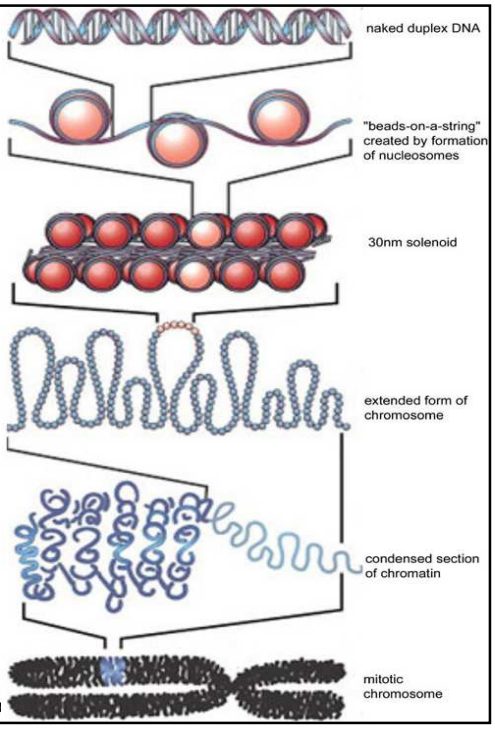
## DNA packaging

DNA is stored in coiled and multiply folded form in chromosomes.

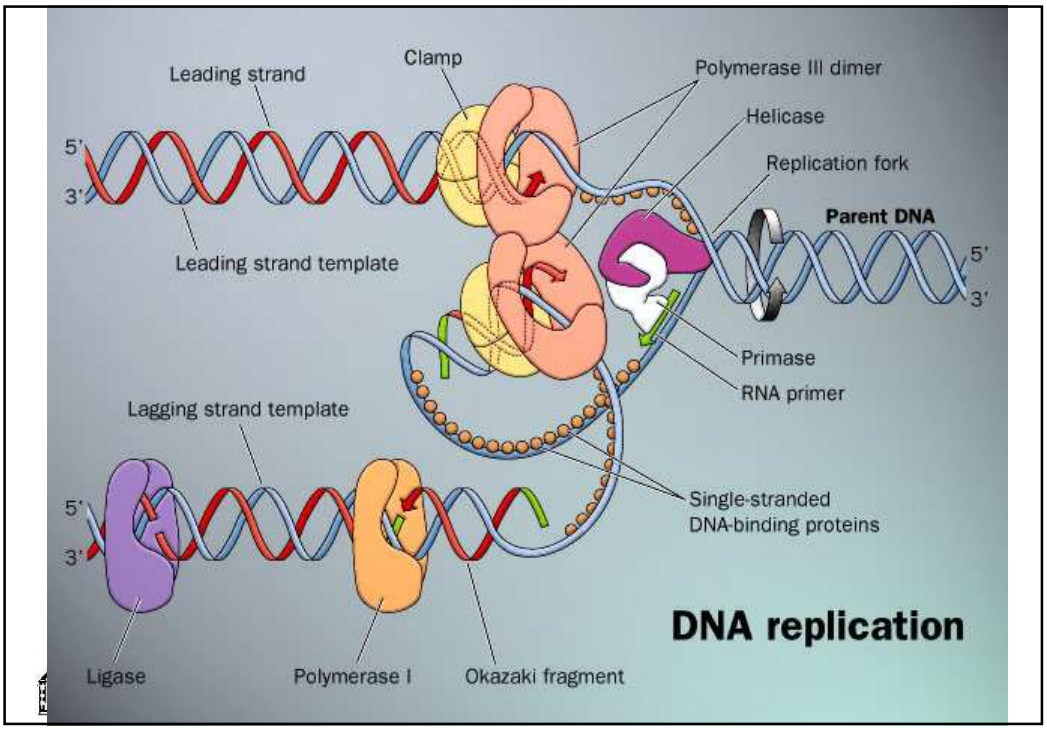
A DNA molecule is approximately 50.000 times longer than the chromosome






## 2. Functions and operation of DNA

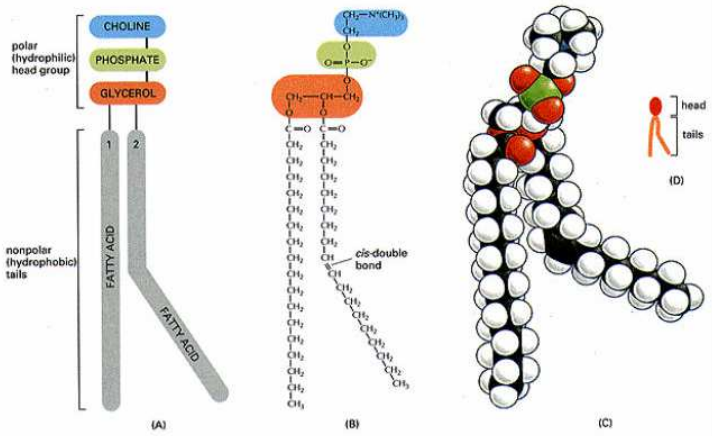
- Transcription from DNA to DNA (replication):
  - unwinding
  - synthesis of complementary strand
  - opposite direction synthesis
  - Okazaki fragments
- Transcription from DNA to mRNA: the first step of protein biosynthesis (transcription)
  - coding strand, - template strand
- Transcription from DNA to other RNA (ribosomal RNA, transfer RNA) base sequence of these is stored here, their synthesis is direct transcription.




# Biological membranes

1. Structure: phospholipid double layer + proteins

phospholipid molecules contain two parts: a nonpolar (hydrophobic) alkyl chain and a polar (hydrophilic) group containing phosphoric acid and amino compound.

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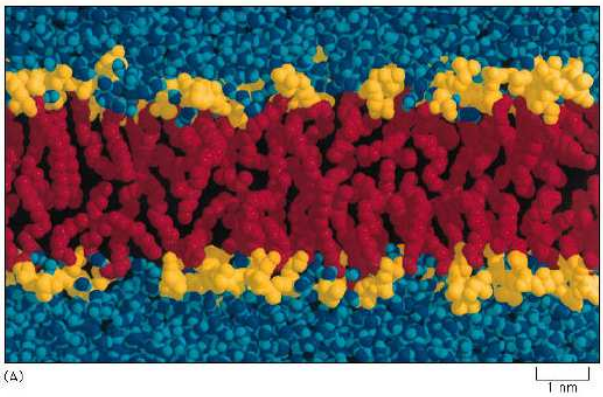
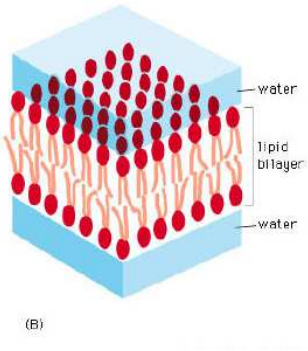
# The structure of double layer

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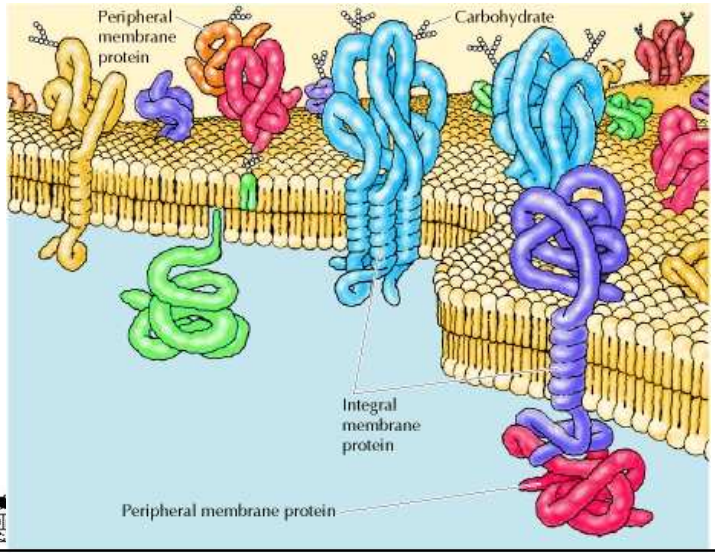
# Membrane proteins

Integral and peripheral membrane proteins. Fluid mosaic model

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# Membrane functions

Separates and connects the two spaces.

- Diffusion barrier – osmotic barrier
- Selective transports
- Types of transports:

– passive transport
– active transport

- uniport
- symport
- antiport

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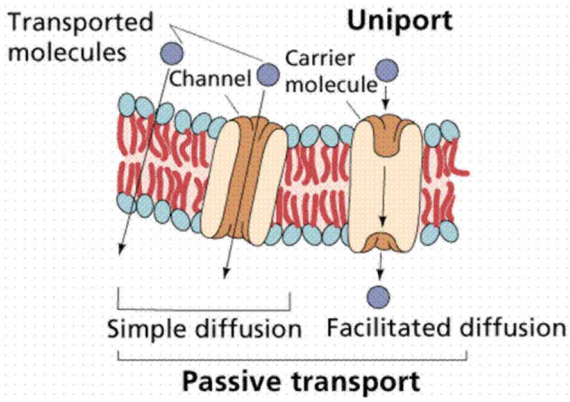
# Passive transport

Driving force: concentration gradient (→ diffusion)
No energy demand.
It may be:

– Membrane diffusion
– Pore diffusion
– Carrier diffusion

Uniport:
the molecular transport is independent from other transports

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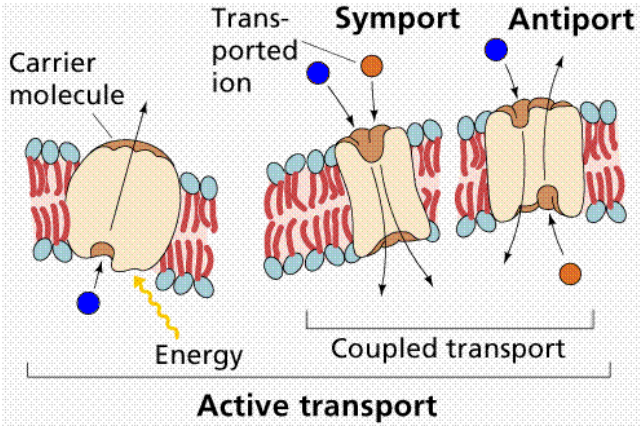
# Active transport

Against concentration gradient → energy is required
An active (energy-transforming) protein is necessary.

Symport:
two molecules transport together, to the same direction.

Antiport:
two molecules transport together, to opposite direction

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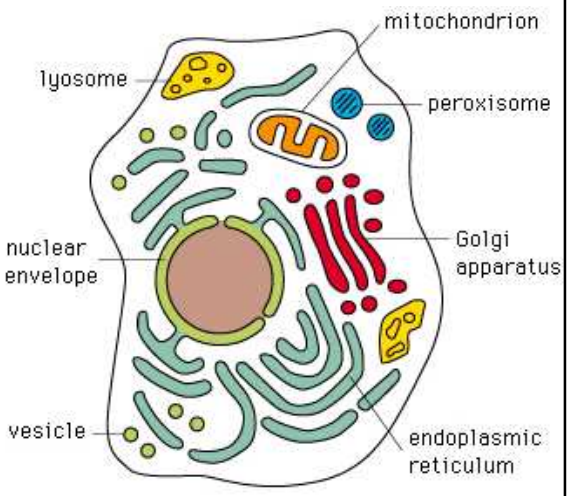
# Biological membranes in cells

Cytoplasmic/cell membrane
Nuclear membrane
Other membranes:
- Mitochondrion
- Endoplasmic reticulum
- Golgi complex
- Chloroplast
- Vesicles
- Special (retina, neuron)

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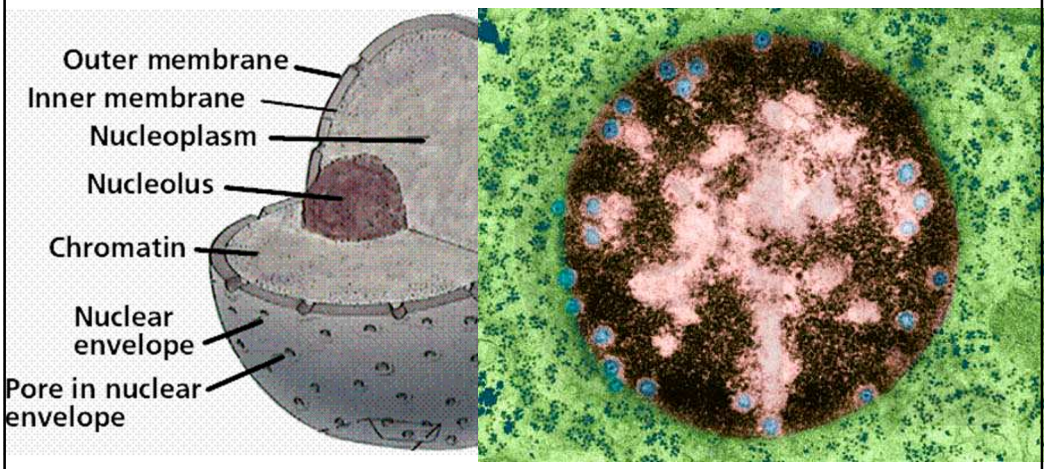
# Nuclear envelop

Nuclear pores for transporting mRNA out into cytoplasm

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# Endoplasmic reticulum and Golgi complex

Endoplasmic reticulum: flat, closed membrane sacks, covering the nucleus in few layers.

RER: rough endoplasmic reticulum, it has small particles on the surface = ribosomes (→ protein synthesis)

Golgi apparatus: flat, closed membrane sacks surrounding ER in more layers.

The synthesized proteins are let into ER lumen and during the maturation process they are moved through the layers of Golgi and transported to proper place. This transport is carried out in small transport vesicles covered with double lipid membrane, too.

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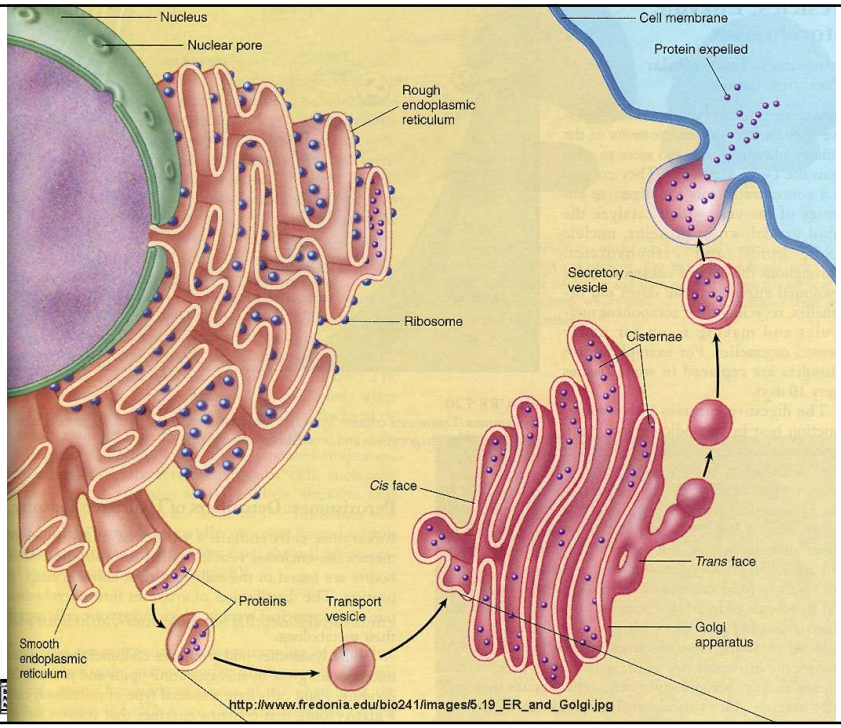


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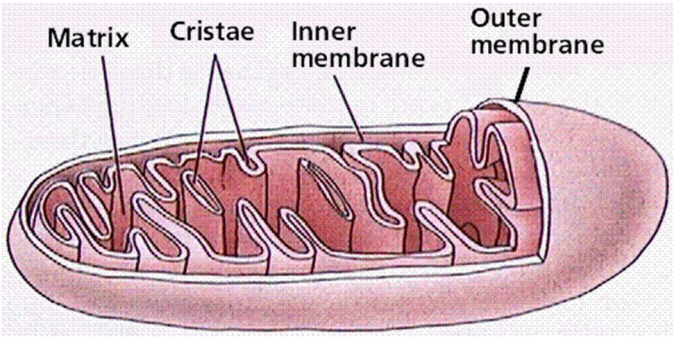
# MITOCHONDRIA – structure

Elongated particles, observable with microscope
Number: ~10 – 1000 /cell
They only occure in eukaryotes

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# MITOCHONDRIA – biochemical functions

Located in the matrix space:

- The citrate cycle = Krebs cycle
- β-oxidation of fatty acids

Located in the inner membrane:

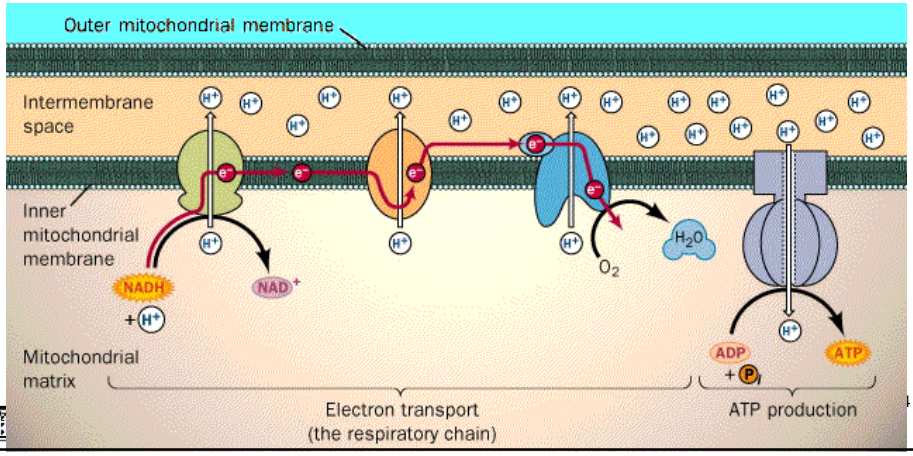
- Terminal oxidation



# Terminal oxidation

The substrate hydrogens arrive in the form of NADH or FADH. These are oxidized in three steps with oxygen. $H^+$ ions accumulate in the intermembrane space. This Δc is converted to ATP.

1 $NADH_2$ ⟶ 3 ATP  1 $FADH_2$ ⟶ 2 ATP



# Protein biosynthesis

All proteins have a fixed sequence of amino acids. This must be exactly (re)produced in the biosynthesis.

The sequence is stored in the DNA encoded (genetic code, 64 different base triplets). This information is transcripted to mRNA in the nucleus.

The mRNA moves out of nucleus and the assembly of amino acids is going on the surface of ribosomes (translation).



# Transcription - translation

# Ribosome

Ribosomes consist of two subunits, containing rRNA and protein. The two parts are coupled with a $Mg^{2+}$ ion.

The size of sub
characterized w
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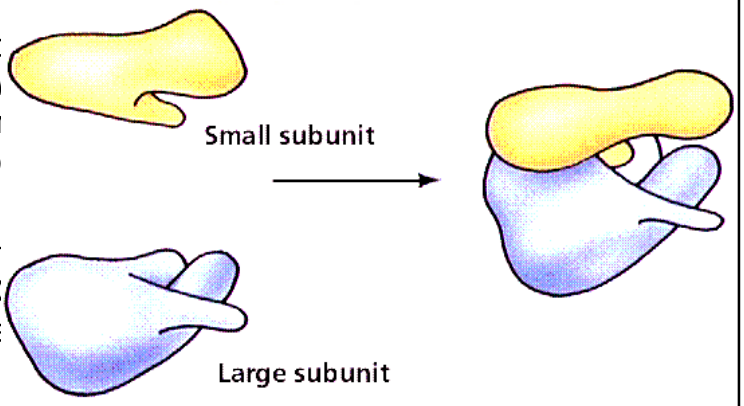
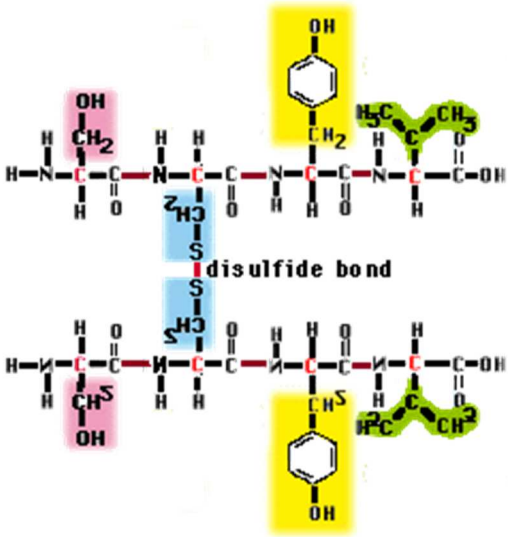
number (30 S an

The ribosome h
binding sites. (
mRNA, and three
ding tRNA.

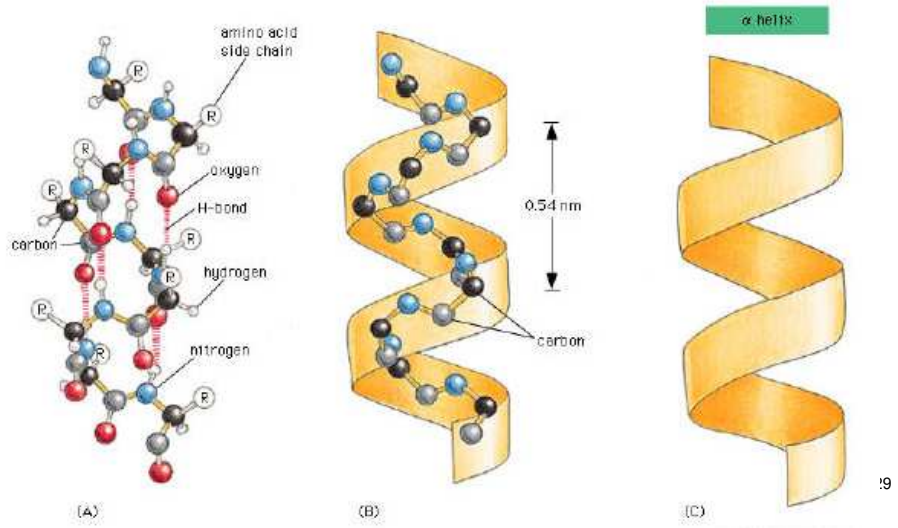





# Primary structure: the amino acid sequence



## SECONDARY STRUCTURE: α-helix

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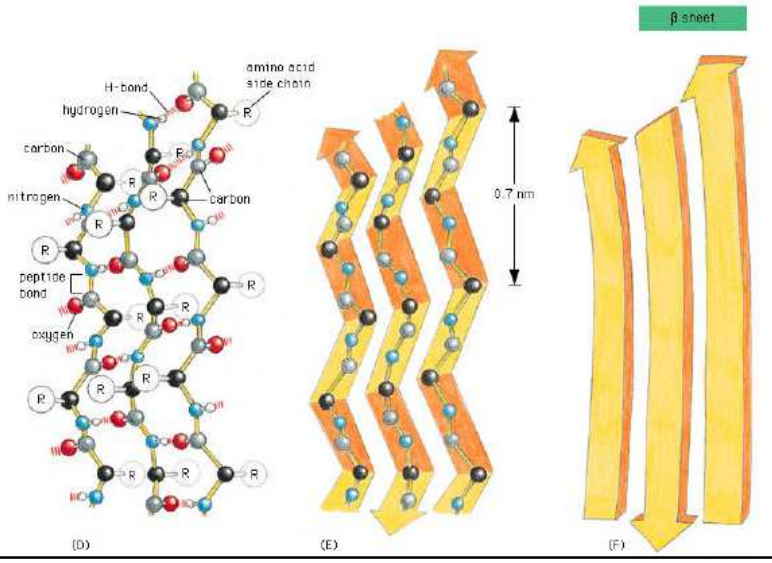
## SECONDARY STRUCTURE: β-pleating

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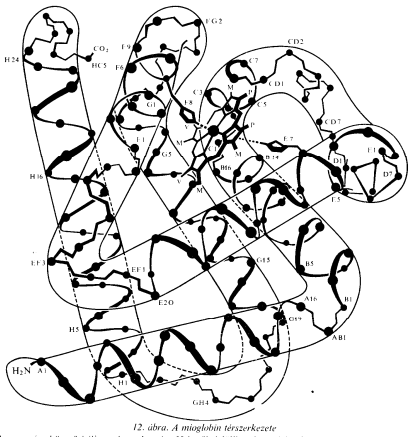
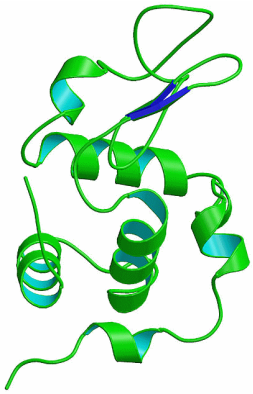
# TERTIARY STRUCTURE



12. ábra. A mioglobin térszerkezete

Az egymást követő hélix-szakaszokat A—H betűk jelölik; pl. B5 jelenti a B szakasz ötödik aminosavját (vö. a könyvhöz mellékelt összehajtogatott táblázattal). Alul balra az N-terminális aminocsoport ($NH_2$), felül balra a C-terminális karboxilcsoport ($CO_2$) látható

3D structure of the whole chain



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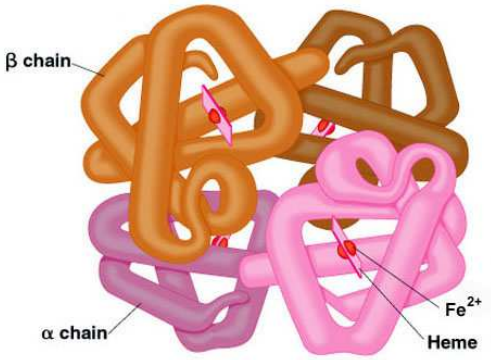
# QUATERNERY STRUCTURE

Quaternary structure: 3D structure of a protein complex consisting of more chain.

Example: hemoglobine, build up of two α and two β chain: $\alpha_2\beta_2$

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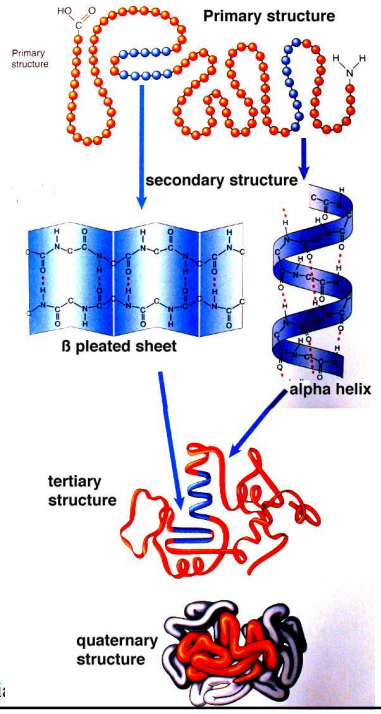
# Levels of protein structure

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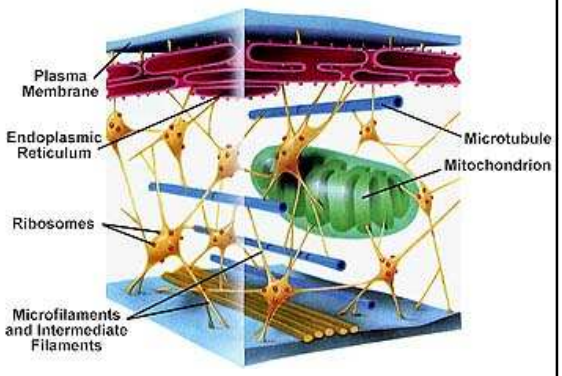
# Cytoplasm

It is not a simple liquid, it has an inner structure, slightly elastic and deformable like *gels*.

(Gels: some macromolecules in solutions – like proteins or carbohydrates – form a crosslinked structure holding the liquid in form. This shows a quasi-solid properties – like jelly or jam.)

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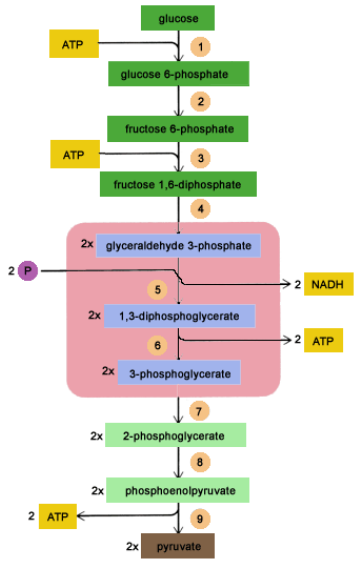
The most important biochemical process in cytoplasm is:

# GLYCOLYSIS




It is an energy producing process, it works both under aerobic and anaerobic conditions.

The energy balance of process:

-2 ATP + 4 ATP =

+2 ATP /molecule of glucose

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# Cell wall

The microbial cell wall is a shield against mechanical stress and osmotic pressure. (Animal cells don't have cell wall, they don't need such protection.)

The two basic types of bacterial cell wall: Gram-positive, and Gram-negative.

The Gram-staining

is a staining method for microscopic preparates. Cells are stained with chrystal violet and iodine, decolorized with alcohol and investigated under microscope. Cell walls colored violet-blue are identified as Gram-positive, Gram-negative cells remain pink.

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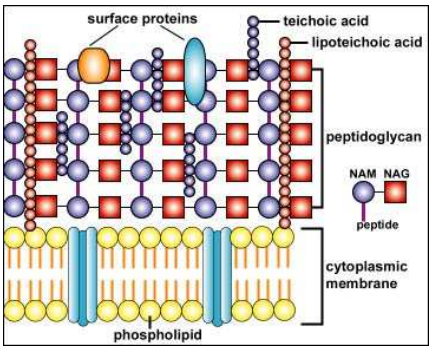
# Differences of cell wall structure

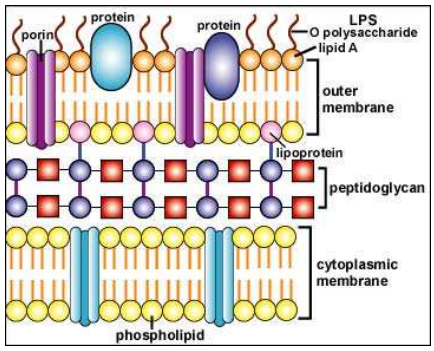
Gram positive

Cell membrane + a thick peptidoglycan layer




Gram negative .

a thin peptidoglycan layer between two lipid membranes

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