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/

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	

BIOLOGY, BIOTECHNOLOGY

Lecturers:

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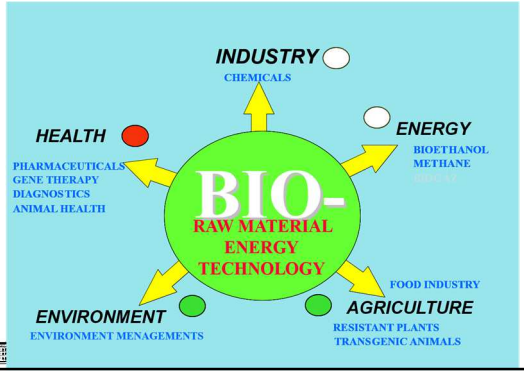
BIOLOGY, BIOTECHNOLOGY

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



1st lecture: Composition and structure of cells

1. Prokaryotes and eukaryotes

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

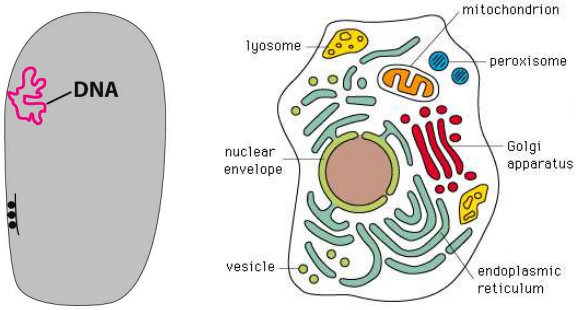
Basic difference: they don't have/have real, isolated nucleus

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.

Prokaryotic and eukaryotic cell



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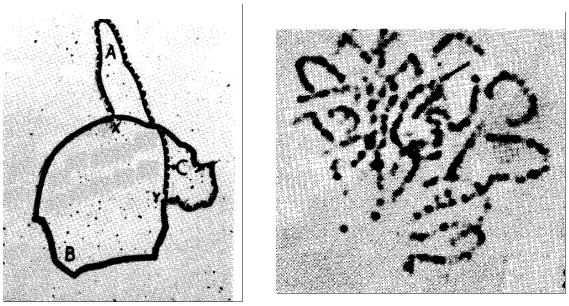
Prokaryotic DNA (*E. coli*) (during duplication)

Eukaryotic DNA (chromosomes)



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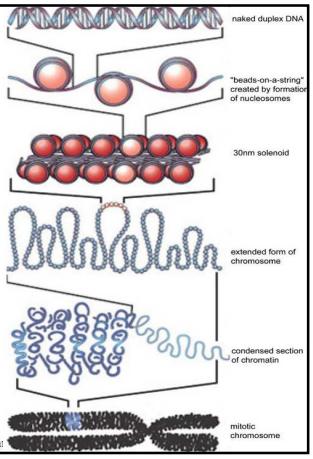
DNA packaging

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

A DNA molecule is approximately 50.000 times longer than the chromosome



BME Alkalmazott Biotech

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.

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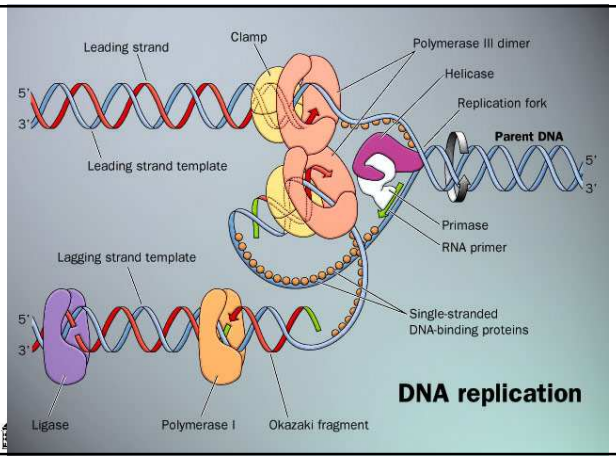
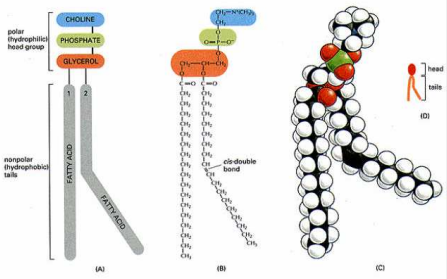


Biological membranes

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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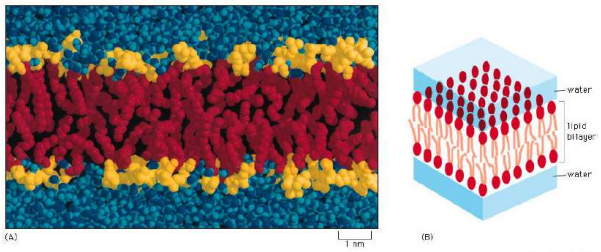
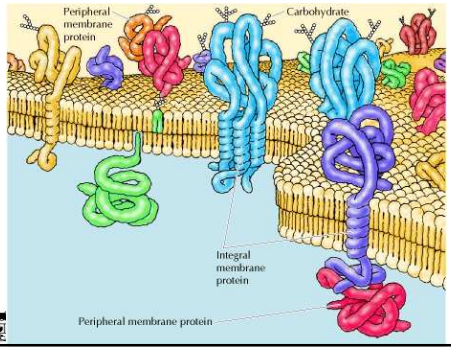
The structure of double layer



Membrane proteins

Integral and peripheral membrane proteins. Fluid mosaic model



Membrane functions

Separates and connects the two spaces.

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

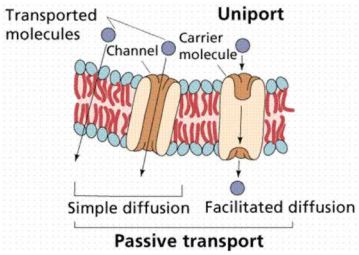
– passive transport
– active transport

- uniport
- symport
- antiport

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

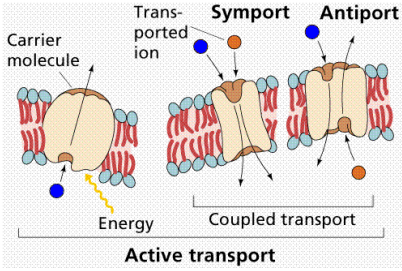


Active transport

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

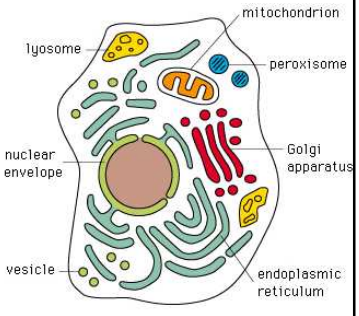
Symport:
two molecules transport together, to the same direction.

Antiport:
two molecules transport together, to opposite direction



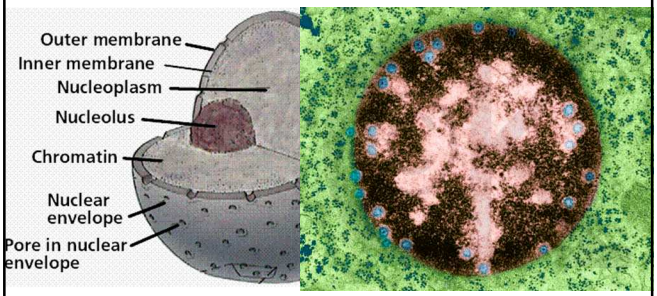
Biological membranes in cells

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



Nuclear envelop

Nuclear pores for transporting mRNA out into cytoplasm



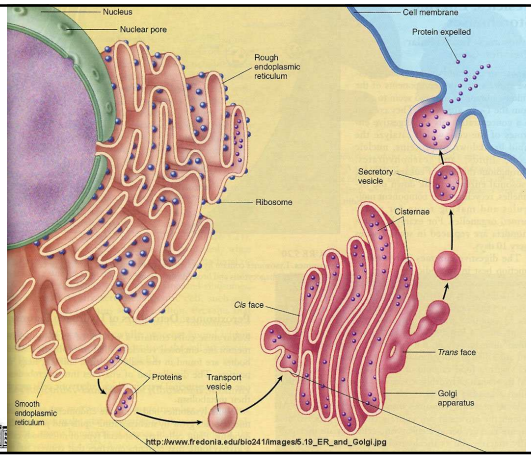
Endoplasmic reticulum and Golgi complex

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.

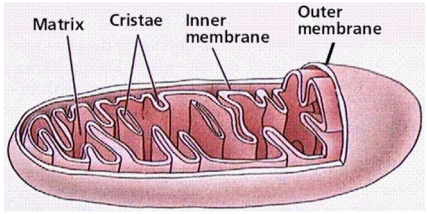


MITOCHONDRIA – structure

Elongated particles, observable with microscope

Number: ~10 – 1000 /cell

They only occure in eukaryotes



MITOCHONDRIA – biochemical functions

Located in the matrix space:

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

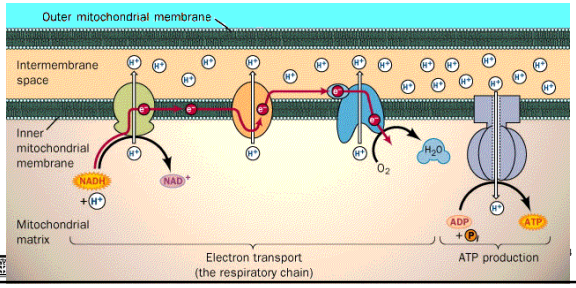
Located in the inner membrane:

- 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.

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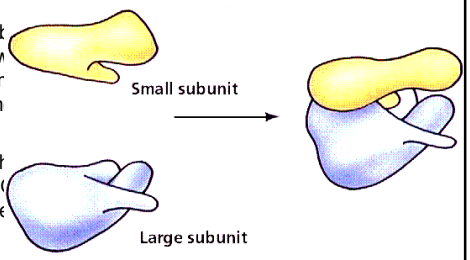
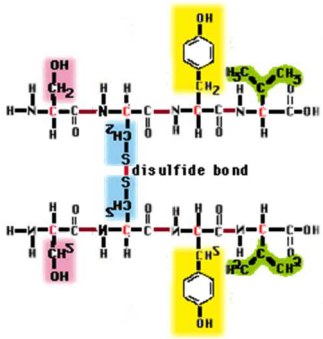
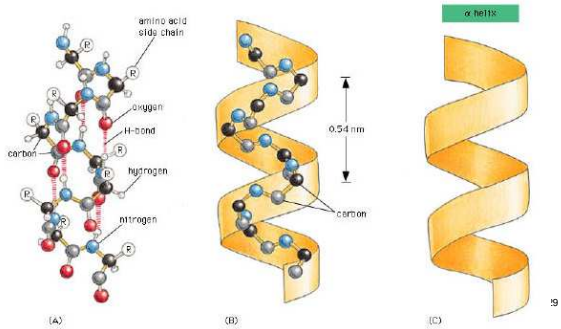


The ribosome h
binding sites. (
mRNA, and three
ding tRNA.

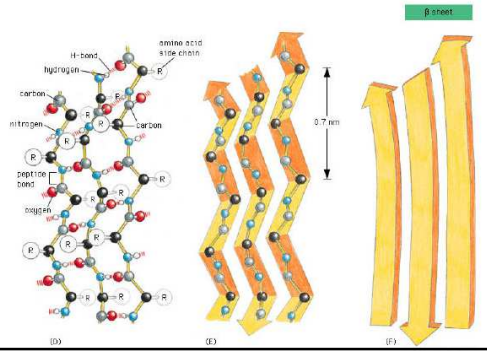
Primary structure: the amino acid sequence



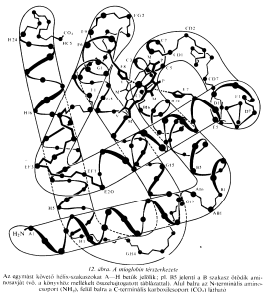
SECONDARY STRUCTURE: α-helix



SECONDARY STRUCTURE: β-pleating



TERTIARY STRUCTURE

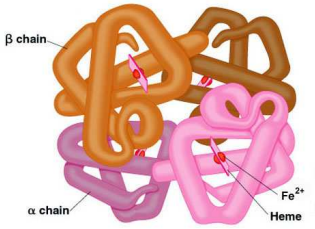


3D structure of the whole chain

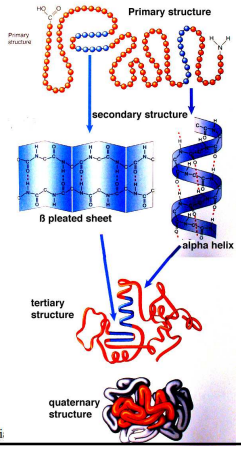
QUATERNERY STRUCTURE

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

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



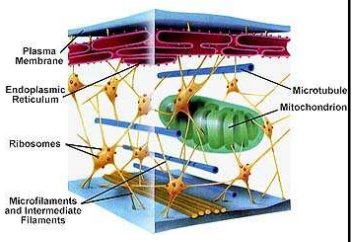
Levels of protein structure



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.)



The most important biochemical process in cytoplasm is:

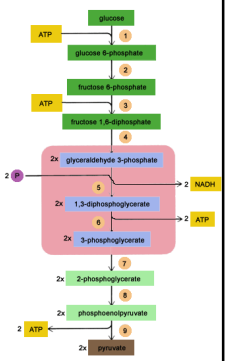
GLYCOLYSIS

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



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.

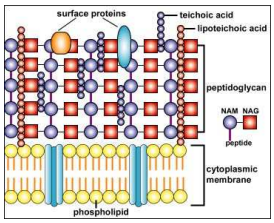
The Gram-staining

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.

Differences of cell wall structure

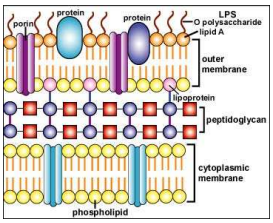
Gram positive

Cell membrane + a thick peptidoglycan layer



Gram negative .

a thin peptidoglycan layer between two lipid membranes



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