27008 – Life Science

LIFE 9e, Figure 1.1

CBS, Department of Systems Biology
The teachers

Christine Finnie

Federico De Masi

Mette Voldby Larsen

Maria Oettinger

Trine Krab Larsen
27008 Life Science F13

You have administrator rights to this group
Indtast/rediger: velkomsttekst

Course 27008 Life Science

Teachers:
CF: Christine Finnie
FDM: Federico De Masi
MVL: Mette Voldby Larsen

Student Helpers:
Maria Gøttinger, Trine Krab Larsen


Lectures: 13:00-14:30 (208/051)
Exercises: 14:45 - 16:15 (210/142 + 148)

<table>
<thead>
<tr>
<th>Date</th>
<th>Teacher</th>
<th>Subject</th>
<th>Chapter in textbook</th>
<th>No. of pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 6</td>
<td>MVL</td>
<td>L1. Course Introduction, Cells - Structure and Function</td>
<td>3(±42-54)+5</td>
<td>40</td>
</tr>
<tr>
<td>Feb 13</td>
<td>CF</td>
<td>L2. Lipids and Cell Membranes</td>
<td>3(±54-57)+6</td>
<td>25</td>
</tr>
<tr>
<td>Feb 20</td>
<td>CF</td>
<td>L3. Energy, Enzymes and Metabolism</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Feb 27</td>
<td>CF</td>
<td>L4. Cellular Pathways and Chemical Energy</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Mar 6</td>
<td>MVL</td>
<td>L5. Cell Cycle and Division</td>
<td>11</td>
<td>19</td>
</tr>
</tbody>
</table>
Life Science - 27008

This is the main page for the Life Science course, which runs in spring 2013.

LIFE Sc, Figure 1.1

About the course

For content, learning objectives etc, see DTU coursebase:

- Link: 27008 in DTU coursebase
Ch. 3 and 5
Cells – Structure and Function

Mette Voldby Larsen
PhD, associate professor
Lesson overview

- Introduction to macromolecules
- Proteins
- What is a cell
- Prokaryotes
- Eukaryotes: Animal vs. Plant cells

Learning objectives:
After today you should be able to...

Describe the spatial, logistic, and structural organization of the living cell as well as the overall mechanisms and chemical structures behind its function.
What are our “building blocks”? 

<table>
<thead>
<tr>
<th>Group name</th>
<th>monomers</th>
<th>polymers</th>
<th>% dry mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proteins</td>
<td>amino acids</td>
<td>polypeptides</td>
<td>50</td>
</tr>
<tr>
<td>nucleic acids</td>
<td>nucleotides</td>
<td>polynucleotides</td>
<td>18</td>
</tr>
<tr>
<td>carbohydrates</td>
<td>monosaccharides</td>
<td>polysaccharides</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group name</th>
<th>components</th>
<th>largest unit</th>
<th>% dry mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>lipids</td>
<td>fatty acids + glycerol</td>
<td>Triglycerides</td>
<td>10</td>
</tr>
</tbody>
</table>
What are our “building blocks”? 

These macromolecules are formed by the assembly of smaller units/components:

- Amino acids $\rightarrow$ Proteins
- Sugars $\rightarrow$ Polysaccharides (carbohydrates)
- Nucleotides $\rightarrow$ Nucleic acids
- Fatty acids (+ glycerol) $\rightarrow$ Lipids
What are our “building blocks”?

- These macromolecules can be assembled to generate bigger functional structures, e.g.:

  - Proteins → Proteasome
  - Polysaccharides → Starch grains
  - Nucleic Acids → Chromosomes
  - Lipids → Adipose deposits
Macromolecules are generated by condensation and broken by hydrolysis

(a) Condensation

(b) Hydrolysis

Uses Energy

Releases Energy
What are proteins?

• Macromolecules formed by the condensation of amino acids.

• Proteins play a critical role in life, as they are the main biological “working machines”.

• Enzymes (kinases, phosphatases), transcription factors, membrane receptors, antibodies, etc. are all proteins.
Amino acids

- **Amino group**
- **Carboxyl group**
- **Side chain**
Proteins consist of 20 different amino acids.
Amino acids are linked by peptide bonds.

Amino group + Carboxyl group → Peptide linkage

N terminus (⁺H₃N)  C terminus (COO⁻)
Proteins: Primary structure

The amino acid sequence

>gi|6007801|gb|AAF01047.1|AF188200_1 beta-lactamase variant TEM-1D [Escherichia coli]

N’MSIQHRVALIPFFAAFCPLPVFAHPETLVKVKAEDQLGARVGYIELDLNSGKILESFRPEERFPMSTFKVLLCGAVLSRDAGQEQLGRRIHYSEQNDLVEYSPVTEKHLTDGMTRVELCSAAITMDNTAAANLLTTTIGGPKELTAFLHNMGDHVTFLDWEPELNEAIPNDERDTTMPAAMATTLLRKLTTGELLETLASRQQLIDWMEADKVAGPLLRSALPAGWFIADKSGAGERSGRGIAALGPDKPSRIVVIIYTGSQATMDERNRQIAEIGASLIKHW C’
Proteins: Secondary structure

The two most important to remember

**α-helix:**
Right-turning helix. Stabilized by hydrogen bonds between a hydrogen from the N-H of one amino acid to the oxygen from the C=O in the next amino acid.

**β-plated sheets:**
Formed by two or more polypeptide chains in close proximity. Stabilized by hydrogen bonds from the N-H of one chain and the C=O of another chain.
Proteins: Secondary structure

>gi|6007801|gb|AAF01047.1|AF188200_1 beta-lactamase variant TEM-1D [Escherichia coli]

MSIQHFRVALIPFFAAFCLPVFAHPETLKVVKDAEDQLGARVGYIELDLNSGKILESFRP
EERFPMMSTFKVLLCGAVLSRVDAGQEQLGRRIHYSDNLDVEYSPVTKEHLTDGMTVREL
CSAAITMSDNTAANLLLTITGGPKELTAFLHNMGDHVTRLDRWHELNEAIIPNDERDTTM
PAAMATTLRKLLTGLLLTLASRQQLIDWMEADKVAGPLLRSALPGFWIADKSGAGERGS
RGIIAALGPDGKPSRIVVIIYTTGSQATMDERNRQIAEIGASLIKHW
Proteins: Tertiary Structure

The 3-dimensional structure of beta-lactamase, TEM-1D

PDB: 2V1Z

http://www.rcsb.org/pdb/explore/explore.do?structureId=2V1Z
Proteins: Quaternary structure

Individuel polypeptide chains held together by non-covalent bonds. Ex in hemaglobin.
BREAK
Evolution has resulted in 2 cell types

Prokaryotes (before nucleus)  Eukaryotes (real/true nucleus)
Prokaryotic cell

- Capsule
- Cell wall
- Plasma membrane
- Cytoplasm
- Ribosomes
- Plasmid
- Pili
- Bacterial Flagellum
- Nucleoid (circular DNA)
Bacterial cell wall structure

Color and shape of the cells help classify which type of bacteria are present.
Prokaryotic flagella

*LIFE 8e, Figure 4.5 (Part 1)*
Prokaryotic flagella

- Outer membrane
- Peptidoglycan
- Plasma membrane
- Inside of cell
- Outside of cell
- Filament of flagellum
- Drive shaft
- Rotor
- Transport apparatus
- 45 nm
Eukaryotes
Eukaryotic Cell Structure

- Nucleoplasm
- Outer membrane
- Inner membrane
- Nucleolus
- Chromatin
- Nuclear envelope
- Nuclear pore

1 μm
Golgi apparatus

The Golgi Apparatus

ribosomes

Click to play animation
CYTOTOXIC T-LYMPHOCYTE: A specialized white blood cell responsible for eliminating unwanted body cells (e.g. cancer) is killing a cell infected with the influenza virus.
Plant cells: different from animals