

Final Exam

**UCM010**

**Introduction into Cell and Molecular Biology**

**Time and location:** Wednesday, August 27<sup>th</sup>, 2025, 14.00-18.00, Campus Johanneberg

**Teacher and examiner:** Michaela Wenzel, 772 2074, wenzelm@chalmers.se

Teacher will be available throughout the exam.

**Aids:** Dictionary

**Exam review:** Results will be reported to Ladok within one week. Graded exams can be viewed by making an appointment with Gunilla Bankel-Andersson (gunilla.bankel.andersson@chalmers.se). Grading of the exam may be reviewed in agreement with Michaela Wenzel (after consultation with the other teachers, if necessary).

**Points breakdown:** Total points and point breakdowns are given for each question. The exam gives 100 points in total.

Grading: 50% = 3; 65% = 4; 80% = 5

10 bonus points can be acquired through the lab report, if it is submitted in time and approved upon first submission (that means that you could pass the course with 40 points on the exam plus 10 points from the lab report).

**Read all questions carefully!**

Remember that some questions may have more than one correct answer.

Questions can be answered in English or Swedish (or even a mix of both).

**Please write legibly!! We will not guess correct answers from unreadable handwriting!**

**Question 1: Definitions and concepts** (max. 9 points)

Below is a short explanation of different expressions and phenomena used in biology. Name the concept that is described.

- a) the process of converting light energy into chemical energy through a membrane-bound electron transport chain
- b) the process of converting inorganic atmospheric carbon into organic carbon units usable for cellular metabolism
- c) a regulated signaling cascade leading to the intended and controlled death of a cell
- d) a form of cell injury which results in the premature death of cells by autolysis
- e) a group of consecutive genes that is read from the same promoter and transcribed as one single mRNA
- f) a class of enzymes that enables sequence-specific cleavage of DNA and can be used in cloning
- g) a multiprotein-RNA complex that enables the production of proteins from an RNA template
- h) an organelle involved in protein and lipid processing and transport
- i) a short gene sequence that allows binding of a repressor molecule and thus regulation of gene expression

1 point per correct answer.

**Question 2: Cells** (max. 15 points)

a) Draw an animal cell. Draw and label at least eight different cell components/structures.

One point per correctly drawn and labeled structure, max. 8 points.

b) Name three things that would be different, if you had drawn a plant cell instead.

One point per correct point, max. 3 points.

c) Name four things that would be different, if you had drawn a bacterial cell instead.

One point per correct point, max. 4 points.

### Question 3: Nucleic acids (max. 10 points)

a) Draw a nucleic acid sequence consisting of three nucleotides (in any common structural formula, see image). Your sequence does not have to have three different bases, but the individual nucleotides must be connected into a correct DNA or RNA strand. In case of DNA, drawing a single strand is sufficient (i.e., you do not need to draw the complementary strand).

Molecular formula	Complete structural formula (dash line structure)	Condensed Structure	Bond line Structure
n-propanol $C_3H_8O$		$CH_3-CH_2-CH_2-OH$	
1,3-butadiene $C_4H_6$		$CH_2=CH-CH=CH_2$	
t-butyl chloride $C_4H_9Cl$		$CH_3-C(CH_3)_2-Cl$	
1,3-dimethylcyclopentane $C_7H_{14}$			

not ok!

ok!

7 points, no partial points (your sequence must exist in nature and occur in fully functional DNA or RNA).

b) Did you draw a sequence that would occur in DNA or RNA? Which structural feature(s) determine this?

1 point.

c) Which bases would pair with your chosen sequence? Indicate where the hydrogen bridges would happen that enable this pairing.

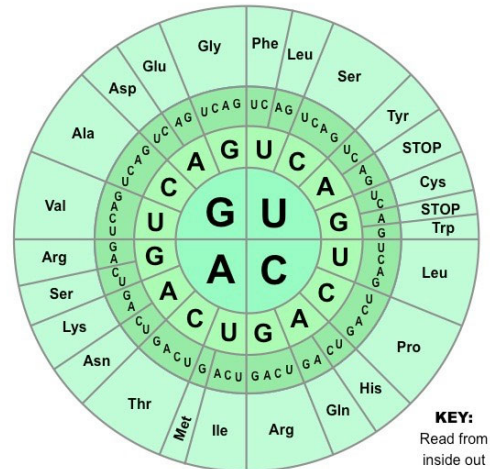
2 points.

**Question 4: Sequences** (max. 6 points)

Translate the given sequence into the missing corresponding sequences (see genetic code to the right).

Mind the orientation!

One point per translated sequence, max. 6 points.



a)

DNA sequence (5'-3'): ATGAATAAGCTTTATCGCTCAGAAAAAAT

Complementary strand (5'-3'):

RNA sequence (5'-3'):

Protein sequence (N-C):

b)

DNA sequence (5'-3'):

Complementary strand (5'-3'):

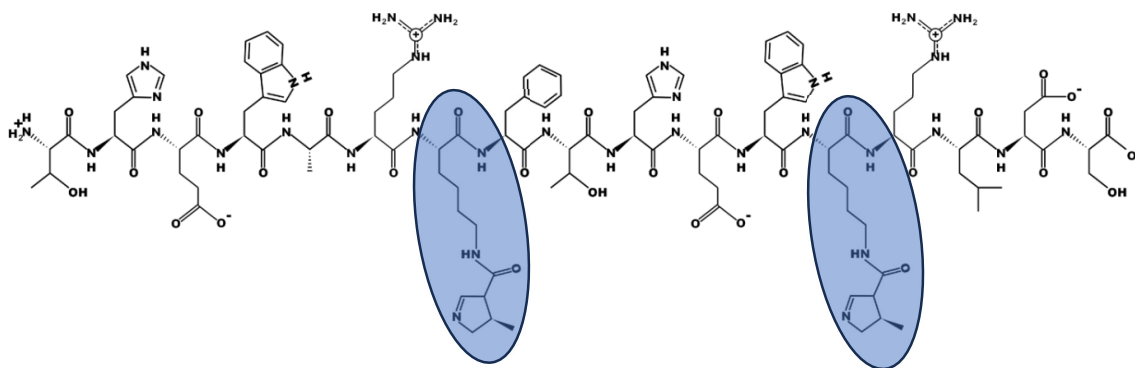
RNA sequence (5'-3'): AUGGCAGAGAGUCUUCUUAUCAAGACAUU

Protein sequence (N-C):

**Question 5: Proteins** (max. 23 points)

a) Depicted below is a peptide sequence. Translated into one-letter amino acid code, it spells a famous book title. What does it say?

Half a point per correct amino acid, 8.5 points max.



Tipp: Follow the peptide bonds to mark the peptide backbone and then identify the individual side chains!

Tipp: The amino acids marked in blue are pyrrolysine (=Pyr=O).

b) Name each individual amino acids in the sequence above (full names).

Half a point per unique amino acid, max. 5 points.

c) Below is a peptide sequence in three-letter codes.

**Thr-Ile-Met-Glu-Thr-Arg-Ala-Val-Glu-Leu**

How would the following amino acid substitutions affect the properties of the peptide?

Arg -> Asp

Ala -> Trp

Met -> Gly

Glu -> Asp

Glu -> Gln

One point each, max. 5 points.

d) Which of these substitutions would have small, moderate, or strong effects? Justify your reasoning!

Half a point per answer, max. 2.5 points.

e) What does the amino acid sequence in c) spell in one-letter code?

2 points.

**Question 6: Membranes and transport** (max. 12 points)

1. Name three of the major components of the cell membrane.

One point per answer, max 3 points.

2. What are the three major types of active transporters? Where do these transporters get their energy from?

One point per answer, max. 6 points

3. What major membrane feature distinguishes Gram-negative and Gram-positive cells?

1 point

4. What major type of molecules are synthesized in

1. the rough endoplasmatic reticulum (ER), and b) the smooth ER?

1 point per answer, max 2 points.

**Question 7: Mitochondria** (max. 8 points)

1. Which of these processes take place in the mitochondrial inner membrane (mark with A), the matrix (mark with B), and outer membrane (mark with C).

Electron transport chain

ATP synthesis

Krebs cycle

Synthesis of mitochondrial DNA

Synthesis of mitochondrial proteins

Uptake of energy used in the TCA cycle

One point per answer, max. 6 points.

2. Which are the two important electron mediators that transport electrons between the complexes in the electron transport chain?

One point per answer, max. 2 points.



**Question 8: Cytoskeleton** (max. 5 points)

1. What is the major function of the cytoskeleton?  
2 points
  
2. What are the three major components of the cytoskeleton?  
3 points

**Question 9: Cell cycle and reproduction** (max. 12 points)

1. What is the difference between mitosis and meiosis in humans with regards to:

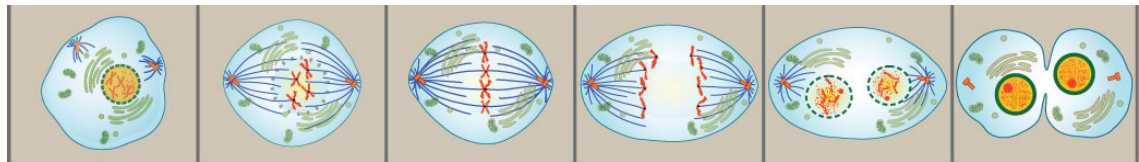
Final number of daughter cells?

Number of rounds of divisions?

The alignment of the chromosomes in the metaphase?

One point per answer, max. 3 points.

2. Fill in the names of the five different phases of mitosis and the "cleavage phase" that immediately follows it (see picture).



One point per answer, max. 6 points.

3. Name one thing that happens in each of these phases of the cell cycle.

3 points.