Final Exam

UCM010

Introduction into Cell and Molecular Biology

Time and location: Monday, June 2nd, 2025, 14.00-18.00, Campus Johanneberg

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

Teacher will be available for questions by phone throughout the exam.

Aids: Dictionary

Exam review: Results will be reported to Ladok within two weeks. 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. 10 points)

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

a) the classification and naming of organisms into groups, according to their evolutionary origin
b) the science of studying the evolutionary origin of and relation between species
c) a regulated signaling cascade leading to the intended and controlled death of a cell
d) the use of a transmembrane proton gradient to drive the synthesis of ATP through the ATP synthase complex
e) the concept that mitochondria and chloroplasts originate from prokaryotes that have been incorporated into eukaryotic cells
f) a single mRNA molecule that carries the information of several genes encoded in the same operon
g) the enzyme-aided amplification of genetic material from a small sample template in a test tube
h) an organelle that contains the respiratory electron transport chain
i) an organelle that contains the photosynthetic electron transport chain
j) a class of enzymes that helps relieve tension in supercoiled DNA and decatenates circular DNA molecules

1 point per correct answer.

Question 2: Cells (max. 15 points)

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

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

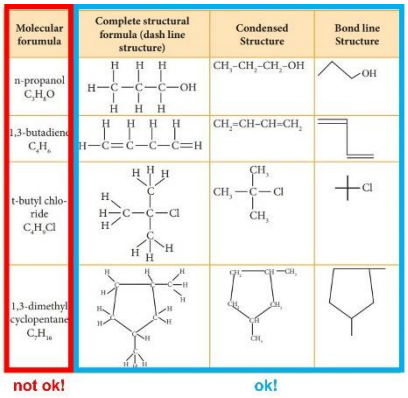
b) Name three things that would be different, if you would have drawn a mammalian cell instead.

One point per correct point, max. 3 points.

c) Name four things that would be different, if you would have 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).

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

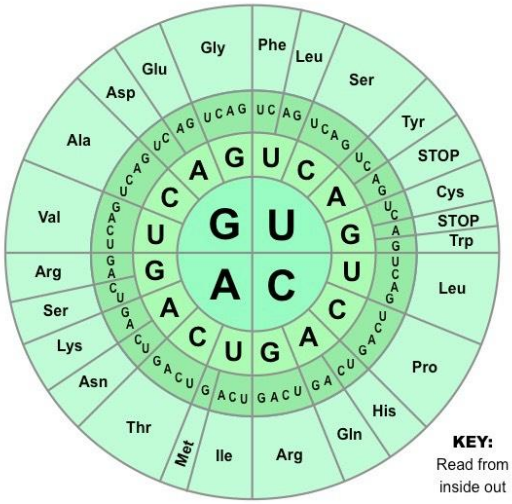
b) Did you draw a sequence that would occur in DNA or RNA? Which structural feature(s) determine this?

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’): ATGAAACACTCACTGCCTGTCAAAGATACC

Complementary strand (5’-3’):

RNA sequence (5’-3’):

Protein sequence (N-C):

b)

DNA sequence (5’-3’):

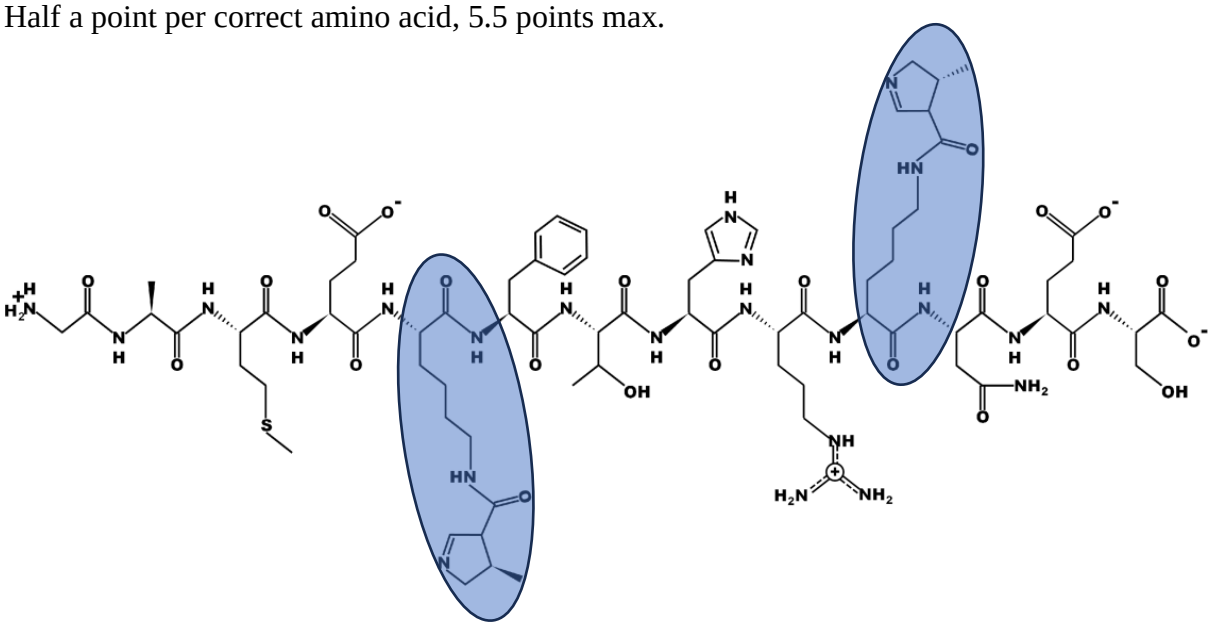
Complementary strand (5’-3’):

RNA sequence (5’-3’): AUGACAGCGACACGCGGUCUUGAAGGGGUU

Protein sequence (N-C):

Question 5: Proteins (max. 23 points)

a) Depicted below is a peptide sequence. Translated into one-letter amino acid codes, it spells a sentence. What does it say?
Half a point per correct amino acid, 5.5 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 pyrrolysin (=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.

His-Ala-Leu-Leu-Pyr-Trp-Glu-Glu-Asn

How would the following amino acid substitutions affect the properties of the peptide?
His -> Ala
Ala -> Lys
Trp -> Gly
Glu -> Asp
Asn -> Asp
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 b1 spell in one-letter code?
5 points.

Question 6: Gene transfer (max. 2 points)

a) What is the difference between vertical and horizontal gene transfer? (1 point)

b) Which one is promoted by plasmids? (1 point)

Question 7: Membranes and transport (max. 11 points)

1. Name the following types of membrane components that contain: (4 points)
    a. A phosphate, glycerol and two fatty acids
    b. A phosphate, a fatty acid and a sphingosine
    c. A fatty acid, a sugar and a sphingosine
    d. A steroid ring structure and a nonpolar hydrocarbon tail

2. Name two modes of passive transport. (2 points)

3. What major membrane feature distinguishes Gram negative and Gram positive cells? (1 points)

4. What major type of molecules are synthesized in a) the rough endoplasmatic reticulum (ER), and b) the smooth ER? (2 points)

5. Define a) exocytosis and b) endocytosis (2 points)

Question 8: Mitochondria (max. 9 points)

1. Which are the three major complexes in the electron transport chain (the names, not the numbers)? (3 points)

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

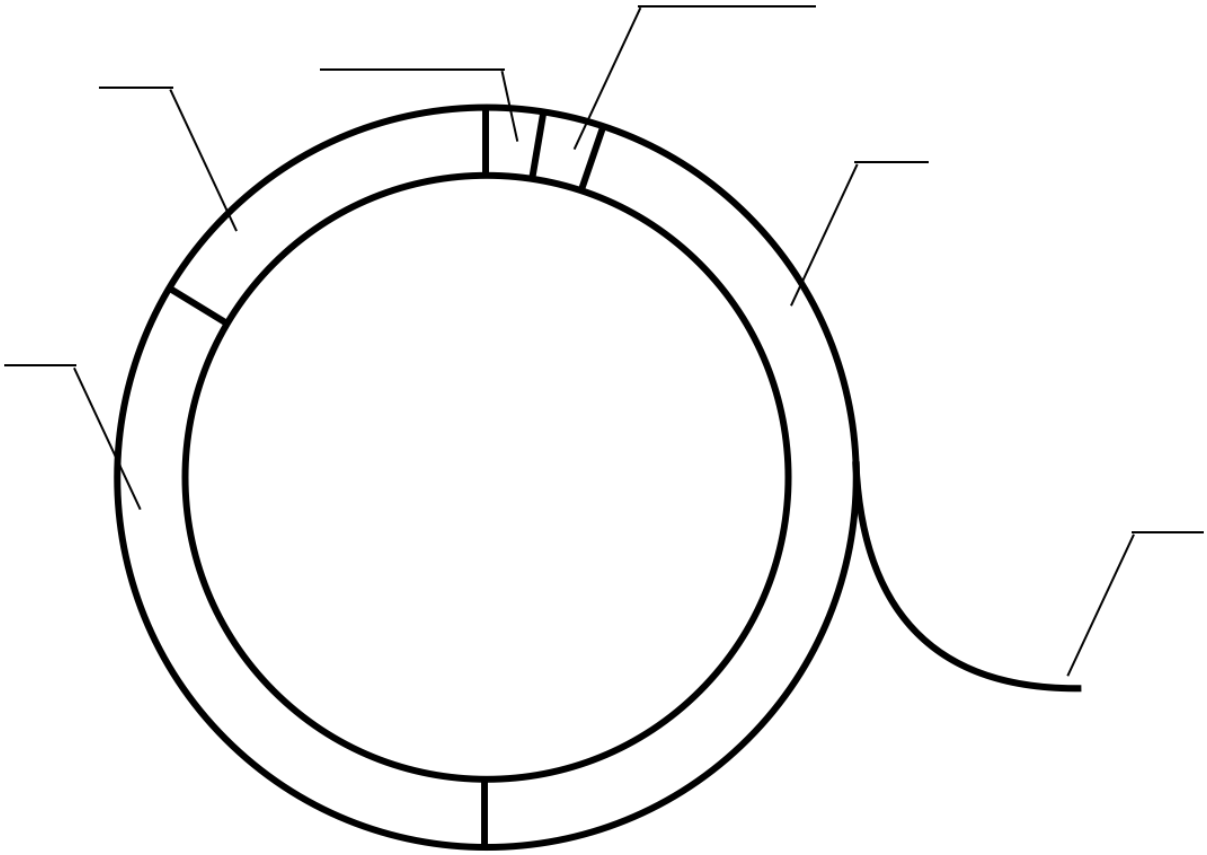
3. What are the two major structural components of ATP synthase? In which one are protons transported? In which one is ATP generated from ADP? (4 points)

Question 9: Cytoskeleton (max. 6 points)

What are the three major components of the cytoskeleton? What is the overall structure of each of these? (6 points)

Question 10: Cell cycle and reproduction (max. 9 points)

a) Fill in the names of the different phases of the cell cycle in the schematic picture! (6 points)



b) Name one thing that happens in each of these phases of the cell cycle! (3 points)