Final Exam

UCM010

Introduction into Cell and Molecular Biology

Time and location: Monday, May 26th 2023, 14.00, Campus Johanneberg

Teacher and examiner: Michaela Wenzel 772 2074

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

Aids: Dictionary

Exam review: Results will be reported to Ladok within maximum four weeks. Graded exams can be viewed by making an appointment with Jenny Hörlyk (jenny.horlyk@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 (1 point per correct answer, max. 10 points)

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

a) the theory that mitochondria and chloroplasts originate from prokaryotes that have been incorporated into eukaryotic cells
b) the concept that DNA is replicated, RNA is made from DNA by transcription, and proteins are made from RNA by translation
c) the classification and naming of organisms into groups, according to their evolutionary origin
d) the science of studying the evolutionary origin of and relation between species
e) a typical species of a certain group of organisms that is well-characterized and used as representative to study the whole group
f) the passing of genetic material between individual cells/organisms that are not in a direct parent-offspring relationship
g) the enzyme-aided amplification of genetic material from a small sample template in a test tube
h) a regulated signaling cascade leading to the intended and controlled death of a cell
i) the use of a transmembrane proton gradient to drive the synthesis of ATP through the ATP synthase complex
j) the theory that DNA replicates by using each of the two DNA single strands as templates

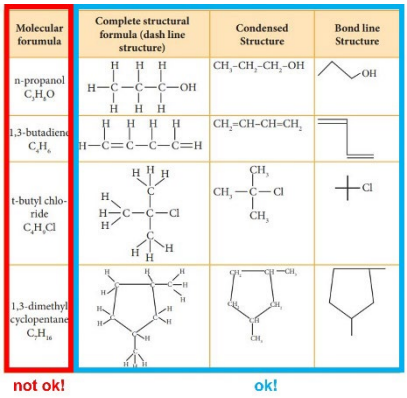
Question 2: Cells (max. 10 points)

a) Draw a cell (your choice of what type of cell) and label cellular structures/organelles. One point per correctly drawn/labelled structure/organelle, max. 6 points.

b) Pick 4 of the organelles/structures you drew/labelled and describe their function in one sentence. One point each, max. 4 points.

Question 3: Nucleic acids (max. 8 points)

a) Draw a single nucleotide (in any common structural formula, see image). Five points, no partial points (your nucleotide must exist in nature and occur in fully functional DNA or RNA).



b) Did you draw a nucleotide that would occur in DNA or RNA? Which structural feature(s) determine this? One point each, max. 2 points.

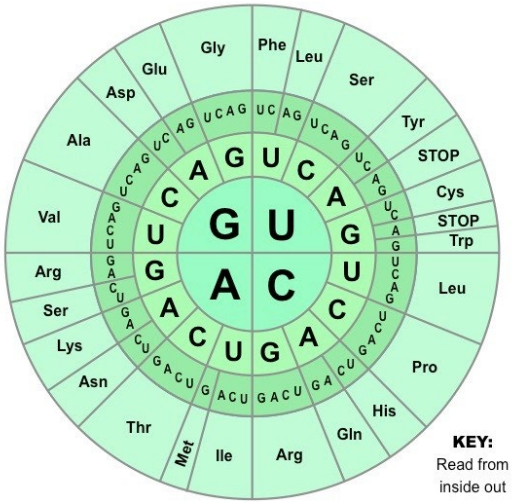
c) Did you draw a monophosphate, diphosphate, or triphosphate version of your nucleotide? Which one of the three would be incorporated into a growing DNA/RNA strand? One point.

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’): ATGAGAATAGCTGTAGATGCAATGGGAGGA

Complementary strand (5’-3’):

RNA sequence (5’-3’):

Protein sequence (N-C):

b)

DNA sequence (5’-3’):

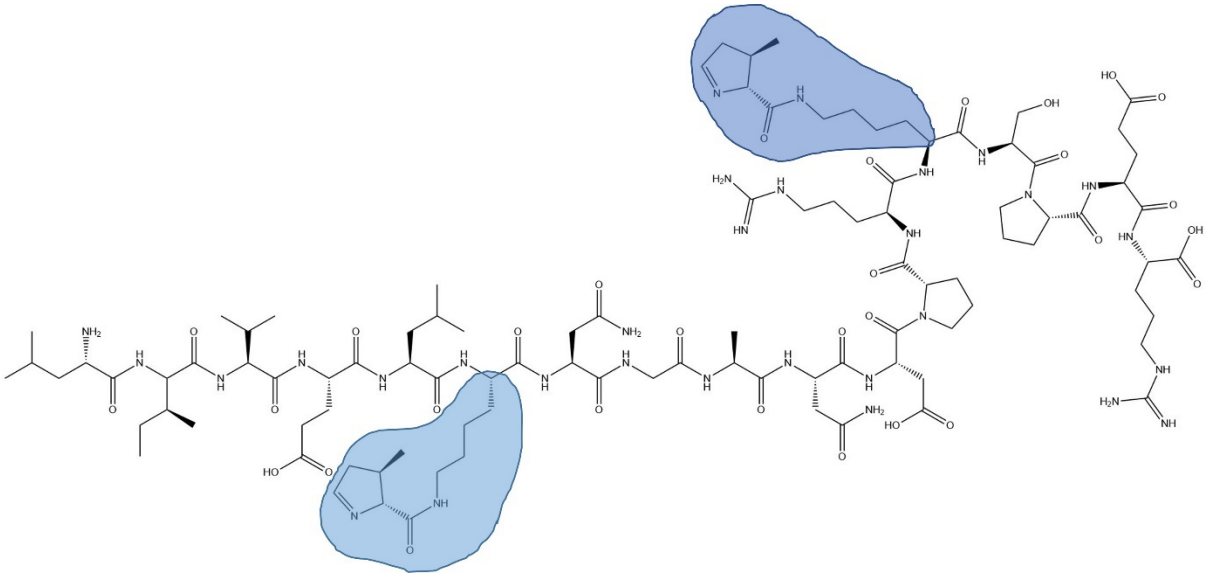
Complementary strand (5’-3’):

RNA sequence (5’-3’): AUGUUUAACUUACCAAAUAAAAUCACACUA

Protein sequence (N-C):

Question 5: Proteins (max. 20 points)

a1) Depicted below is an peptide sequence. Translated into one-letter amino acid codes, it spells a sentence. What does it say? Half a point per correct amino acid (except the blue ones, they are given below), 8 points max.



Tipp 1: Follow the peptide bonds to mark the peptide backbone and identify the individual side chains!
Tipp 2: Marked in blue is an unusual amino acid not discussed in the course. This is pyrrolysin = Pyl = O.

a2) Name each individual amino acid (full names). Half a point per unique amino acid (except pyrrolysin), max. 5.5 points.

b1) Below is a peptide sequence in three-letter codes.

Met-Ser-Trp-Leu-Arg-Glu-His-Asn-Phe-Asp-Gly-Gly-Lys

How would the following amino acid substitutions affect the properties of the peptide? One point each, max. 5 points.
Trp -> Phe
Glu -> Gln
Asp -> Lys
Ser -> Gly
Leu -> Ile

b2) Which of these substitutions would have small, moderate, or strong effects? Justify your reasoning! Half a point per answer, max. 1.5 points.

Question 6: Central dogma (max. 17 points)

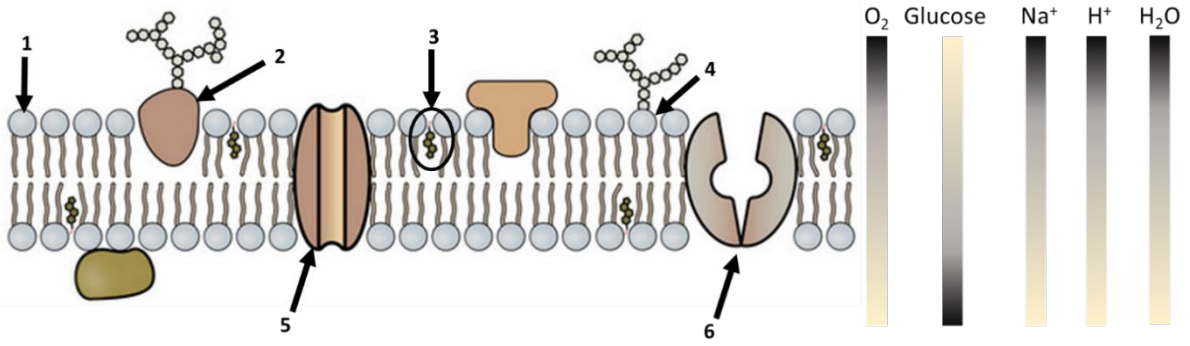
a) Draw the schematic structure of a bacterial gene including all structural and regulatory sequences discussed in the course. Label your drawing. One point per correctly drawn and labelled feature, max. 5 points.

b) Schematically draw the resulting mRNA including all structural and regulatory sequences discussed in the course. Label your drawing including the part that will be translated into the final protein. One point per correctly drawn and labelled feature, max. 6 points.

c) In contrast to prokaryotic mRNA, eukaryotic mRNA must undergo maturation before it can be used for translation. Name the three major maturation processes and describe their function in one sentence each. One point per answer, max. 6 points.

Question 7: Membranes and transport (max. 12 points)

a1) Below is a schematic representation of a cell membrane (on the right, black means high, yellow low concentration). Identify the marked components 1-6. One point per correct answer, max. 6 points.



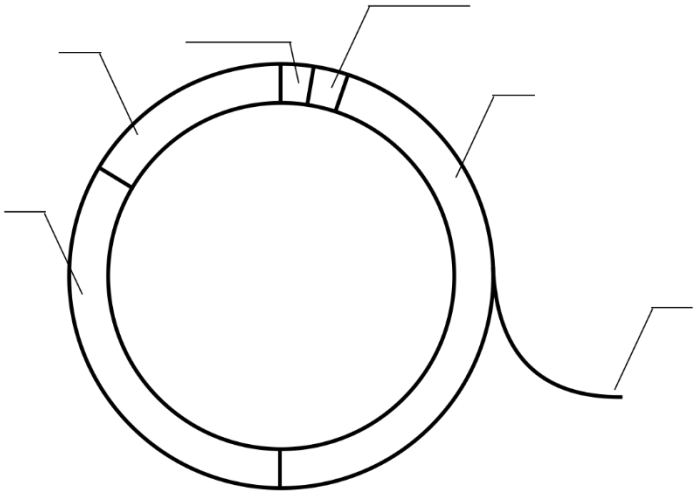
a2) Which side corresponds to the cytoplasm and which one to the extracellular space? Justify your answer! Two points.

b) Which type of transport and which type of protein (transporter, channel, pump, or none) would allow the movement of the following molecules? Justify your answer. One point per answer, max. 4 points.

1) O_2 towards the cytoplasm.
2) Water molecules towards the cytoplasm.
3) Glucose and Na^+ towards the cytoplasm (transported together).
4) H^+ from the cytoplasm to the extracellular space (ATP hydrolysis).

Question 8: Cell cycle (max. 17 points)

a) Fill in the names of the different phases of the cell cycle in the schematic picture below. One point per correct answer, max. 6 points.



b) Name one thing that happens in each of these phases of the cell cycle. One point per correct answer, max. 6 points.

c) In one sentence each, describe what mitosis and meiosis are. One point each, max. 2 points.

d) What is the difference between mitosis and meiosis in humans with regards to… One point per correct answer, max. 3 points.

1) Final number of daughter cells?
2) Number of rounds of divisions?
3) The alignment of the chromosomes in the metaphase?