Final Exam

UCM010

Introduction into Cell and Molecular Biology

Time and location: Wednesday, August 23th 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 are different expressions and phenomena used in biology. Explain their meaning in one sentence. Be precise!

a) central dogma of molecular biology
b) horizontal gene transfer
c) taxonomy
d) phylogeny
e) active transport
f) operon
g) apoptosis
h) necrosis
i) mitosis
j) meiosis

Question 2: Cells (max. 16 points)

a) Draw a **plant** cell and label cellular structures/organelles. One point per correctly drawn/labelled structure/organelle, max. 6 points.

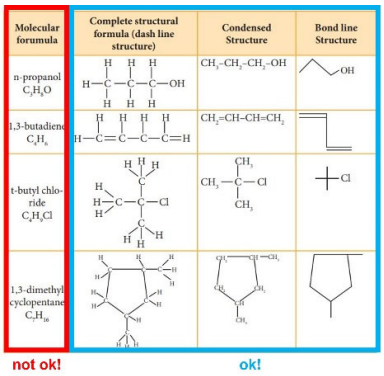
b) Pick 4 of the organelles/structures you drew/labelled and describe their function in one sentence. One point each, max. 4 points.

c) Which features distinguish a plant cell from an animal cell? Name at least two. One point each, max. two points.

d) Which features would be different, if you would have drawn a bacterial cell? Name at least four. One point per feature, 4 points max.

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.

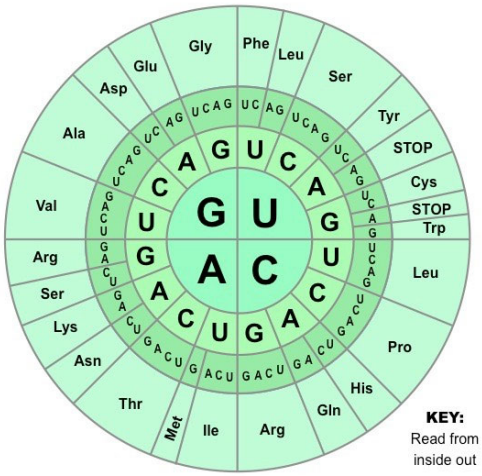
c) Did you draw a monophosphate, diphosphate, or triphosphate version of your nucleotide? Which one of the three would be incorporated into a growing DNA/RNA strand? One point.

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’): ATGGCTAAAGGCCTTGGAAAAGGGATTAAT

Complementary strand (5’-3’):

RNA sequence (5’-3’):

Protein sequence (N-C):

b)

DNA sequence (5’-3’):

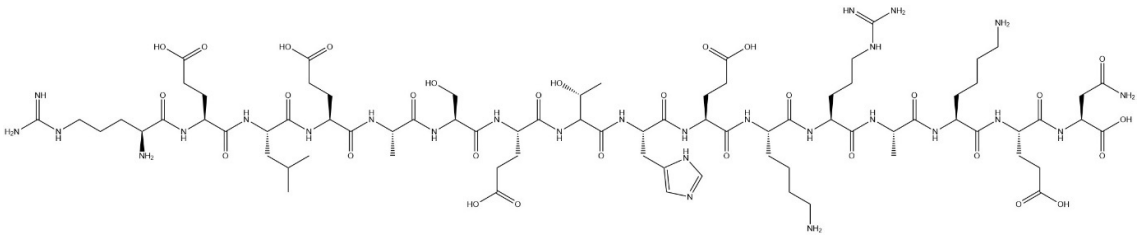
Complementary strand (5’-3’):

RNA sequence (5’-3’): AUGAAAUUUUACACCAUUAAAUUGCCGAAG

Protein sequence (N-C):

Question 5: Proteins (max. 20 points)

a1) 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, 8 points max.



Tipp 1: Follow the peptide bonds to mark the peptide backbone and identify the individual side chains!

a2) Name each individual amino acid (full names). Half a point per unique amino acid, max. 4.5 points.

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

His-Ala-Lys-Sec-Asn-Ala-Met-Ala-Thr-Ala-Thr-Ala

How would the following amino acid substitutions affect the properties of the peptide? One point each, max. 5 points.
His -> Phe
Lys -> Glu
Asn -> Asp
Ala -> Ser
Met -> Gly

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

b3) Bonus question: What does the sequence in b1 spell in 1-letter code (Sec = selenocystein = U)? One point.

Question 6: Central dogma (max. 10 points)

Describe or draw DNA replication. Name each involved enzyme and describe its function and localization in the replication fork. Describe what is happening with both the leading and lagging strand and include strand orientation in your description. Max. 10 points.

Question 7: Mitochondria (max. 15 points)

a) What is the function of mitochondria within cells? One point.

b) What feature makes the mitochondrial inner membrane the best suited for it? One point.

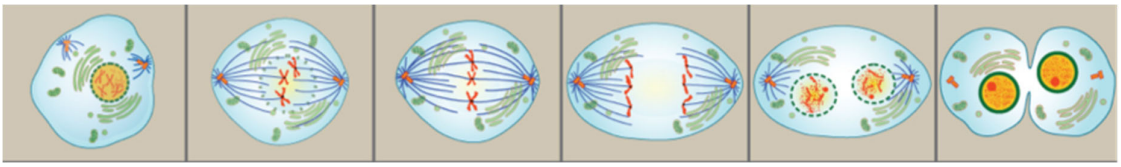
c) Where are the proteins involved in this role encoded and where are they synthesized? Two points.

d) Describe or draw the process of aerobic respiration including the overall process and the different protein components involved. 10 points.

e) Why is it called ‘aerobic’ respiration?1 point.

Question 8: Cell cycle (max. 15 points)

a) Fill in the names of the five different phases of mitosis and the "cleavage phase" that immediately follows it (see picture). One point per phase, max. 6 points.



b) Name one thing that happens in each of these phases of cell division. One point per phase, max. 6 points.

c) Name two positive regulators of the cell cycle (that allow the process to continue) and one negative regulator (that is involved in aborting the process if something seems to be wrong). One point per regulator, max. 3 points.