Final Exam

UCM010

Introduction into Cell and Molecular Biology

Time and location: Saturday, October 10th 2023, 08.30, 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 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 (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) proton motive force
c) beta-sheet
d) phylogeny
e) semi-conservative model of replication
f) operon
g) apoptosis
h) selection pressure
i) splicing
j) meiosis

Question 2: Cells (max. 16 points)

a) Draw a **bacterial** cell and label cellular components/structures. One point per correctly drawn/labelled item, max. 6 points.

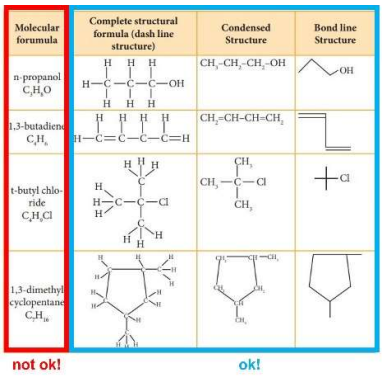
b) Pick 4 of the structures you drew/labelled and describe their function in one sentence. One point each, max. 4 points.

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

d) Which features would be different/missing/added, if you would have drawn a plant 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.

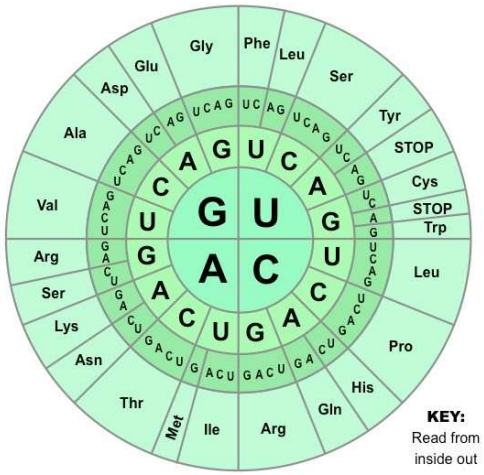
c) Did you draw a monophosphate, diphosphate, or triphosphate version of your nucleotide? Which one of the three would be incorporated into a growing DNA/RNA strand? One point.

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’): ATGCTAGATGTGAACAATTTTGAGTATATG

Complementary strand (5’-3’):

RNA sequence (5’-3’):

Protein sequence (N-C):

b)

DNA sequence (5’-3’):

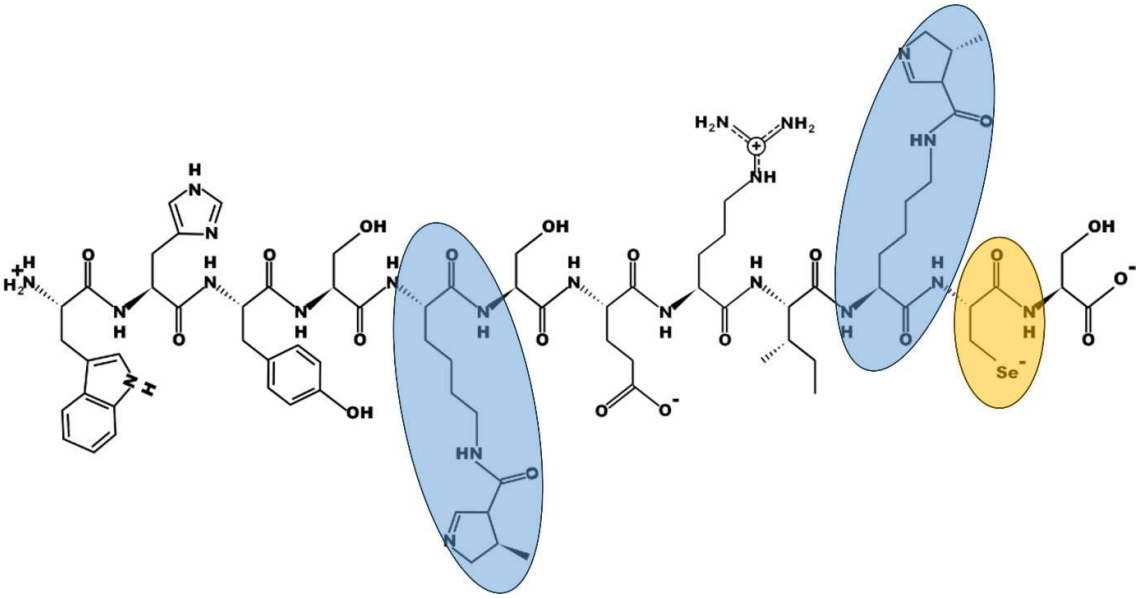
Complementary strand (5’-3’):

RNA sequence (5’-3’): AUGUCAGUCAUUUCUAUGAAGCAAUUGCUU

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? One point per correct amino acid, 9 points max.



Tipp 1: Follow the peptide bonds to mark the peptide backbone and identify the individual side chains!
Blue is pyrrolysin (O) and yellow is selenocysteine (U).

a2) Name each individual amino acid (full names). Half a point per unique amino acid, max. 3.5 points.

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

Cys-His-Ala-Leu-Met-Glu-Arg-Ser

How would the following amino acid substitutions affect the properties of the peptide? One point each, max. 5 points.
His -> Phe
Arg -> Glu
Glu -> Gln
Cys -> 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? One point.

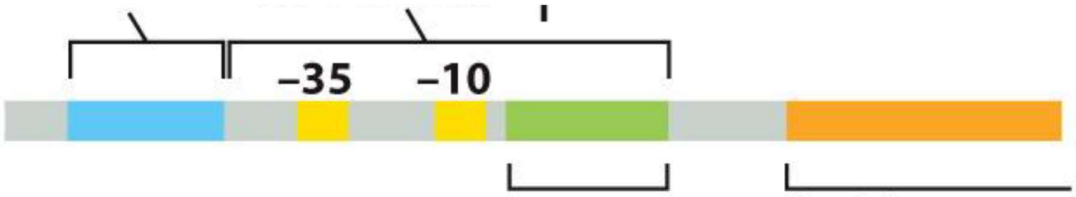
Question 6: Central dogma (max. 10 points)

Describe or draw Translation. Explain each phase and name each involved component, including translation factors, and describe the function of each. Max. 10 points.

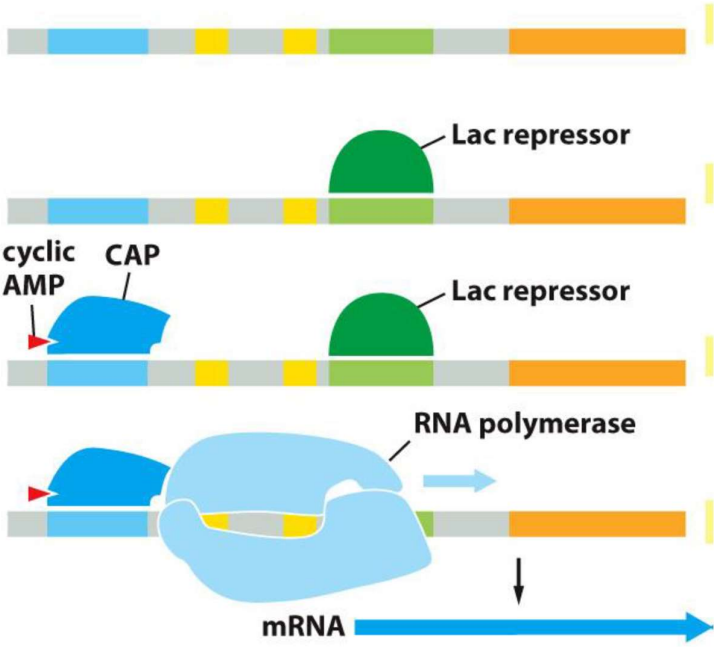
Question 7: Gene expression (max. 15 points)

a) Explain the function of the lac operon. How does it work and what is it good for? Max. 2 points.

b) Label the schematic representation of the lac operon below. Max. 5 points.

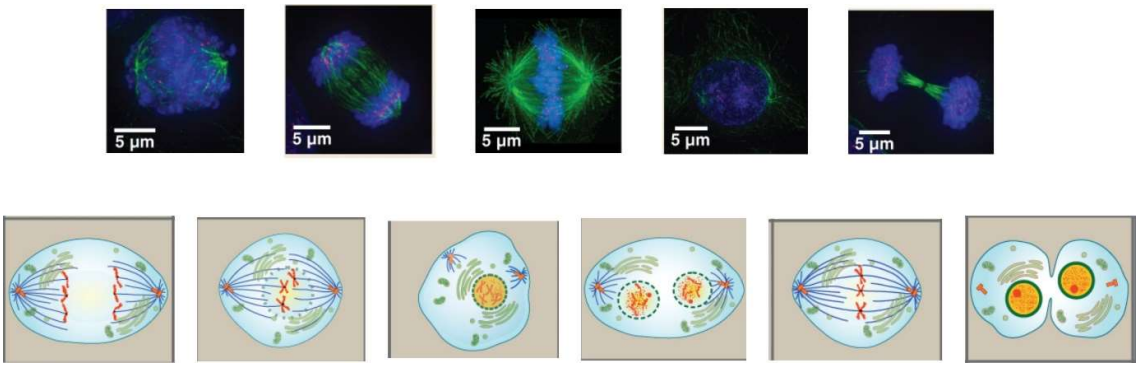


c) The graphic below shows the lac operon under 4 different conditions. Which conditions are depicted? Under which condition does transcription occur and why? Max. 8 points.



Question 8: Cell cycle (max. 15 points)

a) The pictures below show different phases of mitosis in a random order. Order them from prophase to cytokinesis and pair the schematic drawings with their corresponding fluorescence microscopy images (one drawing does not have a microscopy counterpart). Max. 5 points.



b) The colors in the fluorescence microscopy images do not match their counterparts in the drawings. What are the blue and green structures in the microscopy images? Max. 2 points.

c) Describe what happens in each phase (6 phases as indicated in the drawings). max. 6 points.

d) Name one positive regulator of the cell cycle (that allows the process to continue) and one negative regulator (that is involved in aborting the process if something seems to be wrong). Max. 2 points.