

Final Exam

UCM010

Introduction into Cell and Molecular Biology

Time and location: Monday, August 28th 2024, 14.00, 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 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 (max. 10 points)

Below are different expressions and phenomena used in biology. Define the meaning of each one in one sentence max.

- a) homologous recombination
- b) reverse transcription
- c) apoptosis
- d) meiosis
- e) endosymbiotic theory
- f) polycistronic mRNA
- g) polymerase chain reaction
- h) oxidative phosphorylation
- i) endoplasmatic reticulum
- j) Meselson-Stahl experiment

One point per correct answer, max. 10 points.

Question 2: Cells (max. 15 points)

a) Draw a mammalian 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 plant 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. 6 points)

a) Draw a single nucleotide (in any common structural formula, see image).

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

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!

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

One point.

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.

d) Which base would pair with your chose nucleotide? Indicate where the hydrogen bridges would happen that enable this pairing.

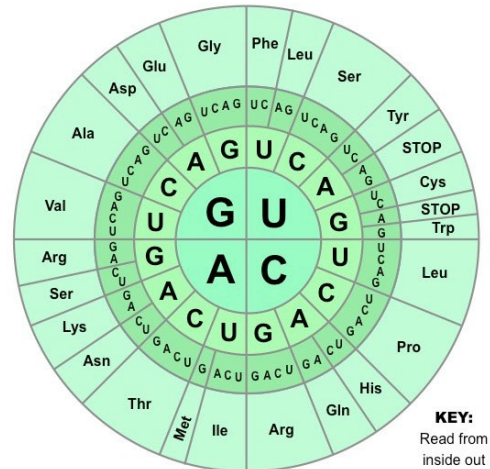
One point.

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'): ATGGATTTCGAAAAGATGAAGCAGTGGATG

Complementary strand (5'-3'):

RNA sequence (5'-3'):

Protein sequence (N-C):

b)

DNA sequence (5'-3'):

Complementary strand (5'-3'):

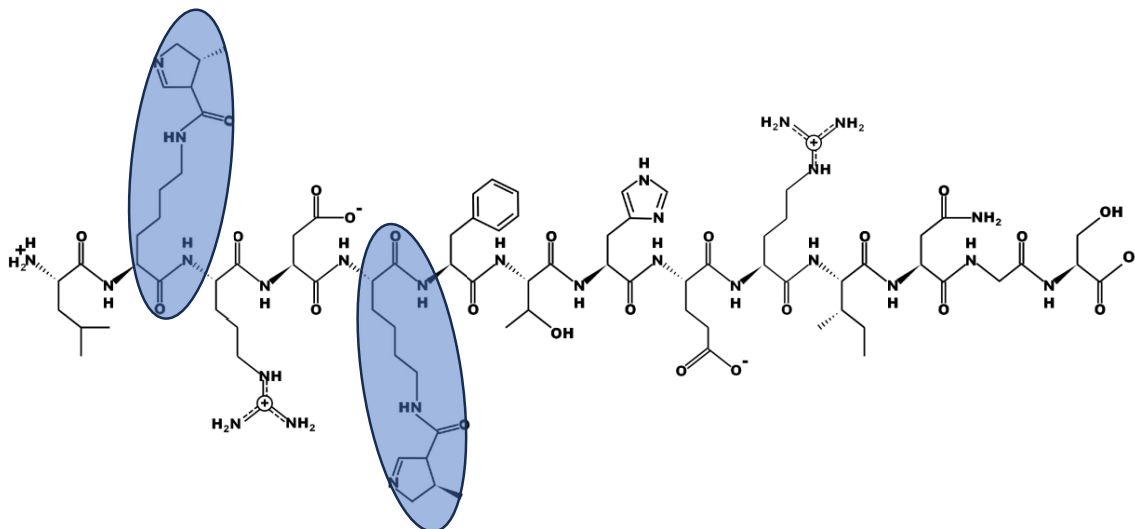
RNA sequence (5'-3'): AUGAGUCAUUCUCAAGAAAAAUUGCACUA

Protein sequence (N-C):

Question 5: Proteins (max. 25 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, 7 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. 5.5 points.

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

Thr-Glu-Arg-Met-Ile-Asn-Ala-Thr-Pyr-Arg

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

Thr -> Gly

Glu -> Lys

Arg -> Asp

Ile -> Leu

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.

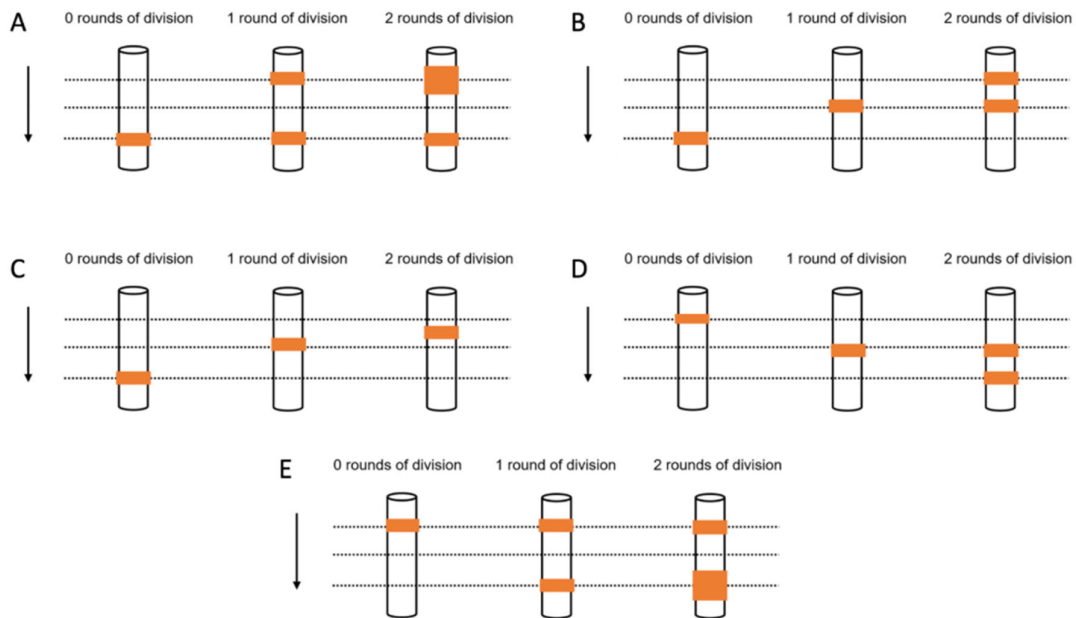
e) What does the amino acid sequence in b1 spell in one-letter code?

5 points.

Question 6: DNA replication (max. 3 points)

In 1958, Matthew Meselson and Franklin Stahl conducted a famous experiment that proved the concept of semi-conservative DNA replication.

The picture below shows theoretical outcomes of the Meselson-Stahl experiment (the arrow indicates increasing density). Which one correctly depicts semi-conservative DNA replication? Motivate your answer. 3 points



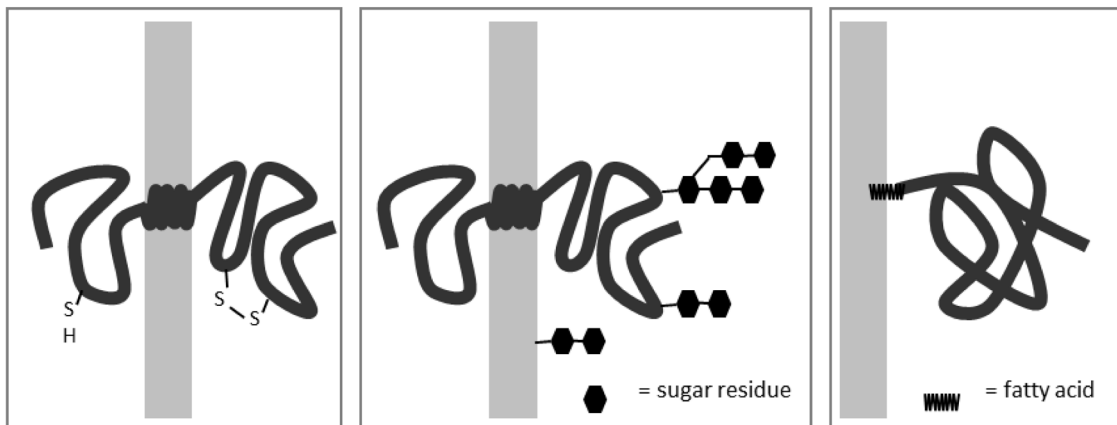
Question 7: Membranes and transport (max. 11 points)

a) Name three of the major components of the cell membrane!

3 points

b) In the three figures below, which side of the membrane is likely to be the cytoplasmic side?

3 points



c) What is the role of the lysosome? In what process (that can also take care of potentially infectious bacteria) is that particularly important?

One point each, max. 2 points.

d) In what three ways can proteins be moved between compartments of the cell?

3 points

Question 8: Mitochondria (max. 9 points)

a) Which of the following 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 correct answer, 6 points total.

b) Give three evidences for the endosymbiont theory!

3 points

Question 9: Cytoskeleton (max. 5 points)

a) What is the major function of the cytoskeleton?

2 points

b) What are the three major components of the cytoskeleton?

3 points

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

a) What is the difference between mitosis and meiosis in humans with regards to:

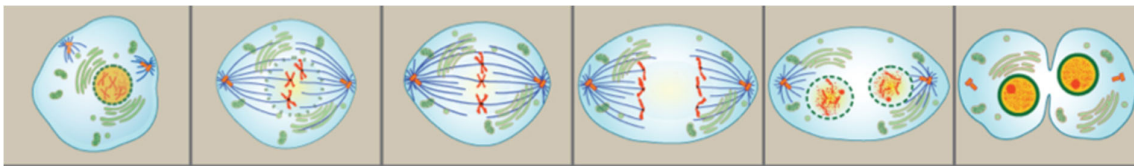
Final number of daughter cells?

Number of rounds of divisions?

The alignment of the chromosomes in the metaphase?

One point per correct answer, 3 points total.

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



6 points

c) Name one negative regulator of the cell cycle (that is involved in aborting the process if something seems to be wrong).

1 point