UNIVERSITY
OF SKÖVDE

School of Bioscience

WRITTEN EXAMINATION

Course: Molecular Biotechnology

Course code: BV703A

Credits for written examination: 4 hp

Date: 2025-03-14

Examination time: 08.15-12.30

Examination responsible: Sanja Jurcevic

Aid at the exam/appendices

Instructions

- ☒ Take a new sheet of paper for each teacher.
- ☐ Write your answer in the exam sheet.
- ☒ Write only on one side of the paper.
- ☒ Write your name and personal ID No. on all pages you hand in.
- ☒ Use page numbering.
- ☒ Don´t use a red pen.
- ☒ Mark answered questions with a cross on the cover sheet.

Grade points

Maximum score: 70p

Grades: A ≥ 90%, B ≥ 80%, C ≥ 70%, D ≥ 60%, E ≥ 50% of the total points.

Examination results should be made public within 18 working days

Good luck!

Total number of pages 4 (excluding this page)

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Question 1

What are the 4 types of biotechnology briefly describe each type? **(4p)**

Question 2

When plant cells are transformed by any of the transformation methods, it is necessary to isolate the transformed cells. There are certain selectable marker genes present in vectors or reporter gene.

What is the difference between selectable marker gene and reporter gene? Give at least one example of each. **(3p)**

Question 3

Two types of Ti-plasmid-derived vectors used for genetic transformation of plants are binary vectors and co-integrate vectors. Answer the following questions about these two systems:

a) What is the difference between a binary vector and a co-integrate vector system? **(3p)**

b) What is the role of vir genes in T-DNA transfer, and how does their presence or absence in the vectors affect T-DNA transfer in the binary and co-integrate vector systems? **(3p)**

c) Why is recombination necessary in the co-integrate vector system but not in the binary vector system? **(5p)**

Question 4

Multiple choice questions about transgenic animals (1p for correct answer, 0p for no answer, and -1p for incorrect answer) **(6p)**

What is the term used for the first mouse carrying the foreign gene?

A) Transgenic founder
B) Mutant strain
C) Hybrid offspring
D) Recombinant vector

Which technique is used to confirm the presence of the transgene in the pups?

A) Gel electrophoresis
B) Southern blotting
C) Polymerase Chain Reaction (PCR)
D) Immunohistochemistry

How is the foster mother made pseudo-pregnant?

A) By hormone injections
B) By mating with a vasectomized (infertile) male
C) By genetic modification
D) By exposure to transgenic pups

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What is the main difference between a transgenic mouse and a knockout mouse?

A) A transgenic mouse has a foreign gene added, while a knockout mouse has a specific gene inactivated.
B) A transgenic mouse has no genetic modifications, while a knockout mouse has multiple foreign genes.
C) A transgenic mouse has one gene removed, while a knockout mouse has a foreign gene added.
D) A transgenic mouse is a wild-type mouse, while a knockout mouse is genetically modified.

How do retroviruses contribute to transgene insertion?

A) They integrate a DNA copy of themselves into the host chromosome
B) They directly modify the host genome without integration
C) They act as immune system enhancers
D) They remove unwanted genes from the host DNA

Under what condition is the transgene passed on to offspring in the retroviral method?

A) If the retrovirus only infects non-dividing cells
B) If the embryo is exposed to the transgene for more than 24 hours
C) If the foster mother carries the transgene in her somatic cells
D) If the germ cells of the founder animal contain the retroviral transgene

Question 5

There are three commonly used vectors in gene therapy: retroviral virus, adenoviral virus and Adeno-associated virus.

a) Lentivirus belongs to a class of retrovirus. The lentivirus contains 3' LTR and 5' LTR regions. Describe the function of these LTR regions and how modification of LTR regions would reduce biosafety risk? **(3p)**
b) What is the difference between 1st generation and 3rd generation of adenoviral vector? **(4p)**

Question 6

What are the advantages of using miRNAs as biomarkers? **(4p)**

Question 7

Fill in the blanks using terms from the list below. Each blank space corresponds to one point (1p for correct answer, 0p for no answer, and -1p for incorrect answer). **(10p)**

When a (1) _____ infects a bacterial cell, it injects its (2) _____ into the cell. This viral genome forces the cell to produce viral (3) _____ and (4) _____, which help create more viruses and eventually kill the cell. However, if the bacterium has a (5) _____ system encoded in its DNA, it can detect the foreign DNA and insert a small piece of it into a region called the (6) _____. This process provides a (7) _____ of past infections.

The bacterial cell then produces (8) _____ copies of the CRISPR sequence, which are chopped into smaller units. These RNA molecules include sequences that match the DNA of the (9) _____. These RNA molecules combine with (10) _____ encoded by genes next to the CRISPR locus.

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List of terms:

bacteriophage	tRNA
plasmid	microRNA
bacterial cell	CRISPR RNA (crRNA)
viral genome	proteins
ribosome	enzymes
CRISPR	restriction enzyme
RNA polymerase	Cas protein
memory	DNA polymerase
CRISPR locus	cut
virus	replicate

Question 8

Answer the following five multiple choice questions (1p for correct answer, 0 p for no answer, and -1p for incorrect answer). **(5p)**

a) In DNA fingerprinting, what makes Short Tandem Repeats (STRs) particularly useful?
A) STRs are always identical in all humans.
B) STR regions are not subject to mutations.
C) STR loci vary greatly among individuals.
D) STR loci represent the entire genome.
E) STRs are only found in coding regions of DNA.

b) Why is whole-exome sequencing particularly useful for studying genetic diseases?
A) It focuses on non-coding regions that regulate gene expression.
B) It sequences protein-coding regions where most disease-causing mutations occur.
C) It is the most expensive and comprehensive sequencing method.
D) It provides insights into chromosomal deletions exclusively.
E) It only identifies mutations that have no impact on health.

c) What is the role of epigenetic changes in disease?
A) They involve mutations in the nucleotide sequence.
B They exclusively cause monogenic disorders.
C) They are unrelated to molecular diagnostics.
D) They have no impact on gene regulation
E) They alter gene expression without changing the DNA sequence.

d) How was DNA technology used to identify the Golden State Killer?
A) By comparing DNA from the crime scene with public genetic profiles.
B) Through direct matching of the suspect's DNA.
C) By using whole-exome sequencing to identify inherited mutations.
D) By testing for specific diseases linked to the suspect.
F) By using CRISPR to modify DNA and recreate the suspect's profile.

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e) What is a key feature of the SHERLOCK (Specific High-sensitivity Enzymatic Reporter UnLOCKing) technique?

A) It uses CRISPR-Cas13 to detect nucleic acids with high sensitivity.
B) It edits DNA sequences to correct genetic mutations.
C) It only works for detecting protein biomarkers.
D) It requires whole-genome sequencing for accurate results.
E) It is ineffective for detecting viral RNA.

Question 9

a) Identify three key criteria that a reliable diagnostic test should meet. **(3p)**

b) How do monogenic diseases differ from polygenic diseases? **(2p)**

c) Describe two distinct methods used to identify polygenic diseases, providing a brief explanation of each. **(5p)**

Question 10

Dr Fail is performing a protein expression experiment of a eukaryotic protein in a prokaryotic host. Analysis by qPCR verifies that there is transcript in the cell but SDS-PAGE shows no detectable protein. Give Dr Fail **three** recommendations and describe in detail what he/she can try to increase the amount of protein ***without changing to a eukaryotic expression host***. **(3 x 2p)**

Question 11

Thanks to your recommendations, Dr Fail was lucky and got pure protein. The protein is a receptor that binds a ligand according to the figure below. **Motivate** what technique Dr Fail can use to check that

A) the protein binds the ligand **(2p)**

B) the signal is transmitted and generates the expected cellular response **(2p)**

These are the lab methods available: crystallography, SDS-PAGE, PAGE, Western blot, PCR, RT-qPCR, size-exclusion chromatography, ion-exchange chromatography, affinity chromatography spectrophotometry, DNA sequencing, fluorescence reader.