

School of Bioscience

WRITTEN EXAMINATION

Course: Molecular Biotechnology

Course code: BV703A

Credits for written examination: 4 hp

Date: 2024-01-11

Examination time: 14.15-19.30

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 \geq 90%, B \geq 80%, C \geq 70%, D \geq 60%, E \geq 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)



UNIVERSITY
OF SKÖVDE

Question 1

Multiple choice questions (1p for correct answer, 0p for no answer, and -1p for incorrect answer) **(4p)**

What is the primary focus of biotechnology?

- A. Mechanical engineering
- B. Utilizing biological systems
- C. Software development
- D. Chemical synthesis

Which area of biotechnology focuses on gene therapy, stem cell research, and genetic engineering in medicine?

- A. Green biotechnology
- B. Red biotechnology
- C. Black biotechnology
- D. White biotechnology

In which biotechnology field are molecular methods used for environmental diagnostics?

- A. Green biotechnology
- B. Blue biotechnology
- C. Grey biotechnology
- D. None of the above

In your course book "An introduction to molecular biotechnology: fundamentals, methods and applications" they describe that the area of biotechnology is divided into four main different types. What are these four types of biotechnology?

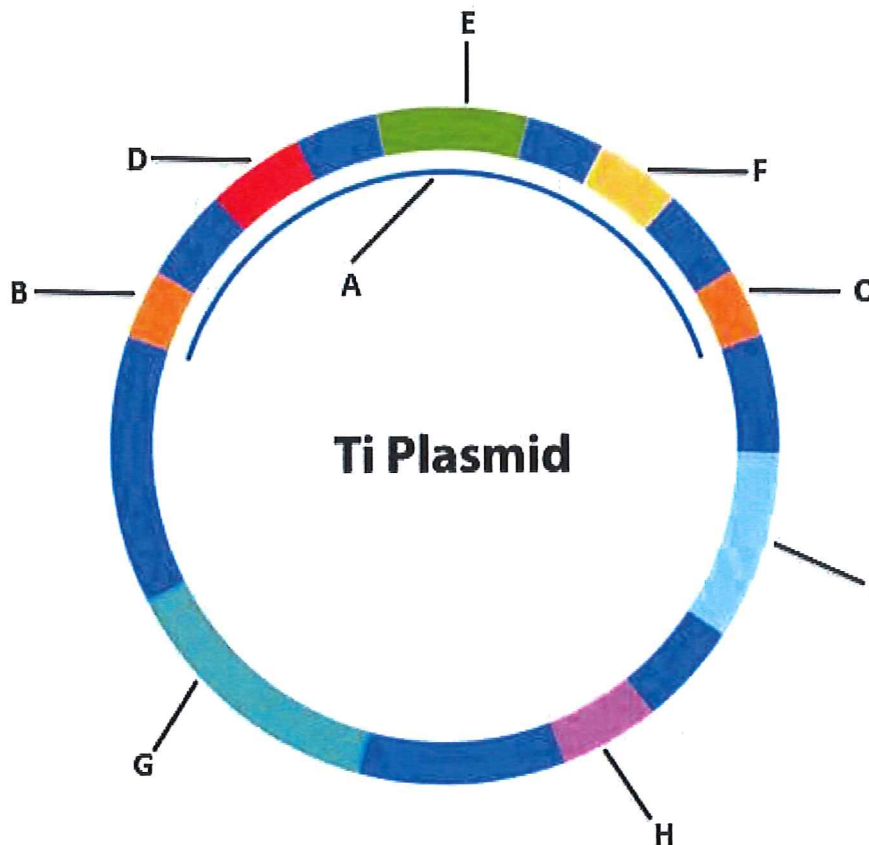
- A. Grey, red, black and white biotechnology
- B. Green, white, blue and red biotechnology
- C. Red, green, white and grey biotechnology
- D. Red, black, green and grey biotechnology

Question 2

What are the differences between traditional plant breeding and genetic engineering? **(3p)**

Question 3

For the map of Ti plasmid shown below, give the name for each feature marked with a letter, A-I. You also need to briefly describe each feature. **(9p)**



Question 4

Describe how selectable marker genes contribute to the transformation of plant cells. Explain the mechanism by which these genes aid in the selection process. **(3p)**

Question 5

Making a knockout mouse can be a difficult task. Two major steps must occur. First, you must get the isolated gene of interest into a germ line cell. Second, you have to get this gene (via the germ line cell) into a mouse, ultimately making an adult mouse homozygous for the gene of interest.

- Describe in detail how you can distinguish random integration from homologous recombination using positive and negative markers? **(9p)**
- What type of cells is originally transformed with the knockout construct? **(1p)**

Question 6

True or false (3p)

- a) The second-generation lentiviral system delivers all essential components through a single plasmid.
- b) The psi sequence in the transfer plasmid is responsible for promoting RNA polymerase III to initiate transcription of viral mRNA.
- c) Adenovirus DNA integrates into the host genome upon entering the host cell.
- d) The expression of adenoviral E1B, E2, E3, and E4 genes has no impact on cellular genes in the host cell.
- e) The AAV genome is a double-stranded DNA molecule.
- f) The AAV genome contains only one gene, which is responsible for encoding structural proteins.

Question 7

Match **one statement to one explanation** below. In your answering sheet it is enough to have number and letter (1p for correct answer, 0p for no answer, and -1p for incorrect answer). **(8p)**

Statement
1. miRNA
2. siRNA
3. Drosha
4. Dicer
5. Gene knockout
6. Gene knockdown
7. antisense RNA
8. RNA interference

Explanation
A) The total removal or permanent deactivation of a gene
B) An enzyme involved in siRNA synthesis
C) A small RNA molecule that regulates gene expression by binding to the 3' end of the target mRNA
D) This type of RNA has been used to produce FlavrSavr tomato
E) The temporarily repression of gene expression
F) An enzyme that cleaves both strands of the primary mRNA transcript
G) A type of regulatory RNA dealing with post-transcriptional regulation of gene expression
H) This type of RNA perfectly binds to the target mRNA and repress gene expression by cleaving the target mRNA
I) An enzyme involved in siRNA synthesis
J) This type of RNA imperfectly binds to the target mRNA and represses gene expression by inhibiting protein synthesis
K) The biological process in which RNA molecules inhibit gene expression
L) A molecule derived from single-strand RNA that is either produced in the cell itself or are delivered into cells experimentally
M) A type of regulatory RNA dealing with post-translational regulation of gene expression

Question 8

- a) What are the differences between dCas9 and Cas9? **(3p)**
- b) What is crRNA and tracrRNA and how are they involved in CRISPR-Cas 9 system? **(4p)**
- c) What is spacer? **(1p)**

Question 9

As a medical doctor, you are currently attending to a six-year-old female patient who are presented with a complex medical profile. The patient is diagnosed with autism spectrum disorder, intellectual disability, visual impairment, and attention deficit hyperactivity disorder (ADHD). Given this array of symptoms, you suspect the presence of a rare syndrome caused by a genetic mutation.

After conducting initial tests targeting specific syndromes, which did not yield conclusive results, the next investigative step is to perform a Single Nucleotide Polymorphism Microarray (SNP-array) to ascertain the underlying cause of the patient's symptoms. In detail describe how DNA Microarray works and how it can be used to find the genetic mutation/s causing the symptoms. **(5 p)**

Question 10

In 2021, a jewelry store in Paris was robbed, and the thieves left behind a glove with traces of DNA. After extensive investigation, authorities finally apprehended a suspect, a 45-year-old art dealer named Marcel, who was linked to the crime through DNA evidence. Describe the process of DNA fingerprinting (DNA profiling) used in criminal investigations to compare a suspect's profile to DNA evidence found at the crime scene. Begin by outlining the steps involved in genetic fingerprinting after the sample from the crime scene, such as the glove, arrives at the laboratory. In your answer you should state what STR stand for and also how and why these sequences are used in criminal investigations. **(7 p)**

Question 11

Describe **in detail** how the following can effect protein expression and what you can do to make protein expression higher. **(6p)**

- Codon usage
- Promoter
- Expression tag

Question 12

Explain why the method of choice and time for induction is critical in many protein expression experiments? **(2p)**

Question 13

Which method(s) can you use for **(2p)**

- Chromatographic separation of by charge
- Chromatographic separation of by size
- Analysis of protein purity
- Assessment of enzyme activity