School of Biosciences

WRITTEN EXAMINATION

Course: Biomarkers in Molecular Medicine

Sub-course

Course code: BV705A

Credits for written examination 4 hp

Date: 6/3 2026

Examination time: 8:15 – 12:30

Examination responsible: Andreas Tilevik

Teachers concerned

Aid at the exam/appendices

Write your answers directly in the exam sheets!

No negative points for the multiple choice questions will be given. You can only get two or zero points on these questions. To get points on these questions, all correct statements must be selected and all incorrect statements must be unselected.

Grade points 40 p.

Examination results should be made public within 18 working days

Good luck!

Describe how biomarkers are currently used in medicine, drug discovery and environmental health (23 p)

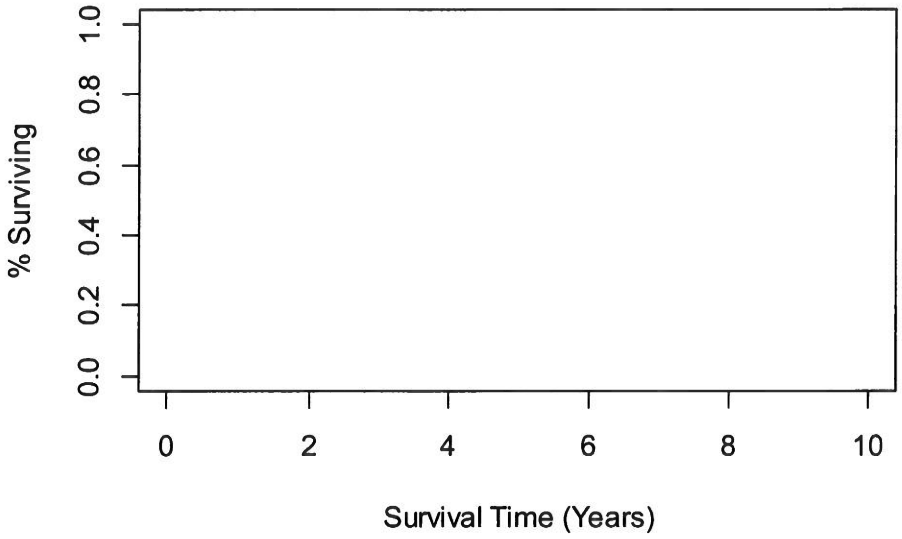
1. What is the difference between ctDNA and cfDNA? (2p)

2. Name one predictive biomarker and explain how it is used. (2p)

3. Explain how creatinine can be used as a biomarker for kidney function. (3p)

4. Draw a survival curve in the plot below based on the data in the following table. (4p)

Patient ID	Survival time (years)	Event (0=censored, 1 = event)
1	2	1
2	4	1
3	5	1
4	10	0
5	10	0
6	10	0



5. Which of the following statements are correct regarding biomarkers for kidney failure (zero, one or several statements can be correct)? (2p)

☐ Creatinine level is high in serum during kidney failure
☐ Creatinine level is very high in urine during kidney failure
☐ Albumin level is high in urine during kidney failure
☐ A certain allele of the APOE gene can be used to predict kidney failure

6. Which of the following statements are correct regarding the following biomarkers (zero, one or several statements can be correct) (2p)?

☐ The IgA antibody from blood samples is a common marker for allergy
☐ The skin prick test or ELISA can be used to tell which allergens the patient reacts to.
☐ Exhaled nitric oxide from a patient can be used as a biomarker for asthma.
☐ The exhaled nitric oxide from a patient can tell which allergens the patient reacts to.

7. Which of the following statements are correct regarding the following biomarkers (zero, one or several statements can be correct)? (2p)

☐ The risk of developing Alzheimer's disease can be predicted based on the type of allele the person has for the BRCA1 or BRCA2 gene
☐ The B-type natriuretic peptide (BNP) is released from myocytes in response to increased wall stress
☐ A high level of bilirubin in the serum is an indication of an HIV infection
☐ Total and phosphorylated tau proteins are common markers for kidney failure

8. Which of the following statements are correct regarding the biomarker discovery (zero, one or several statements can be correct)? (2p)

☐ The identification phase usually involves large scale analysis of a few individuals
☐ The qualification phase usually involves many more individuals than the identification phase
☐ The validation phase usually involves many more individuals than the qualification phase
☐ The validation phase is usually the last stage during the biomarker discovery

9. Which of the following statements are correct regarding the biomarker CRP (zero, one or several statements can be correct)? (2p)

☐ CRP can be detected from a blood sample.
☐ The CRP level is usually higher in patients with viral infections compared to patients with bacterial infections.
☐ CRP can differentiate between all types of autoimmune diseases with high accuracy.
☐ CRP is a general biomarker for detecting inflammatory diseases such as autoimmune diseases and sepsis.

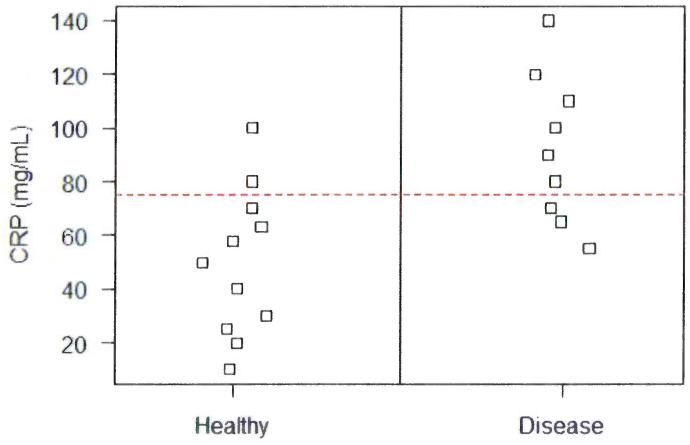
10. Which of the following statements are correct regarding biomarkers for Alzheimer's (zero, one or several statements can be correct)? (2p)

☐ Biomarkers collected from the cerebrospinal fluid show better accuracy than biomarkers collected from blood
☐ Creatinine and APOE levels in serum are commonly used as biomarkers for Alzheimer's
☐ The concentration of Amyloid-beta proteins and Tau proteins in cerebrospinal fluid are used as biomarkers for Alzheimer's
☐ A certain allele of the APOE gene can be used as a risk biomarker for Alzheimer's

Describe how bioinformatics tools can be used for biomarker discovery (17 p).

1. Explain in detail how the hold-out method works as a validation method. (3p)

11. In a study, one has evaluated the blood CRP concentration as a biomarker for a certain autoimmune disease. In total, 11 healthy controls and 9 patients with the disease were included in the study. The research group decided to use a cutoff value of 75. Values above this cutoff value are associated with a positive test result, whereas values below this cutoff are associated with a negative test result. (8p)



a) How many false negative results are there? (1p)

b) How many true positive results are there? (1p)

c) How many false positive results are there? (1p)

d) Given the cutoff value, what is the specificity of the test? (1p)

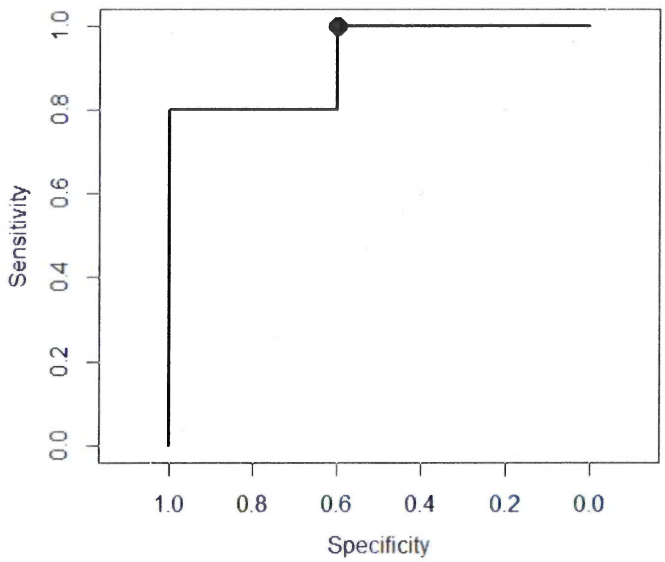
e) Given the cutoff value, what is the accuracy of the test? (1p)

f) Given the cutoff value, what is the positive predictive value? Assume the same prevalence as observed in the sample. (1p)

g) What is the positive likelihood ratio (LR+)? (1p)

h) What is the negative likelihood ratio (LR-)? (1p)

12. Study the ROC curve below. Which of the following statements are correct regarding this curve (zero, one or several statements can be correct)? (2p)



☐ The area below the ROC curve is greater than 0.5
☐ The point on the curve (marked with a filled circle) tells us that the cutoff value, associated with this point, results in a sensitivity of 60% and a specificity of 100%
☐ The point on the curve (marked with a filled circle) tells us that the cutoff value, associated with this point, results in a sensitivity of 0% and a specificity of 60%
☐ The area below the diagonal line (the reference line in grey color) is 0.5

13. Which of the following statements are correct regarding the negative/positive predictive value (NPV/PPV) and accuracy (zero, one or several statements can be correct)? (2p)

☐ The PPV is the probability that you have the disease, given a positive test result
☐ The accuracy is the fraction of incorrect predictions by the test
☐ The accuracy is the sum of the true positives divided by all negative results
☐ The NPV is the probability that you are healthy given a negative test result

14. Which of the following statements are correct regarding computational methods that can combine biomarkers (zero, one or several statements can be correct)? (2p)

☐ LDA combines variables in a way that maximizes the separation between the groups
☐ The KNN is based on the distance between the unknown (new) observation and data points with a known class (e.g., known disease or healthy)
☐ ANOVA is a common approach to combine biomarkers
☐ LDA can combine several different biomarkers when it predicts the class of the unknown (new) observation