School of Biosciences

WRITTEN EXAMINATION

Course: Biomarkers in Molecular Medicine

Sub-course

Course code: BV705A

Credits for written examination 4 hp

Date: 15/1 2026

Examination time: 8:15 – 12:30

Examination responsible: Andreas Tilevik

Teachers concerned

Aid at the exam/appendices: calculator

Write your answers directly in the exam sheets and use extra pages only if you run out of space!

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. Study the two different definitions about biomarkers below:

   "A biomarker is a biological molecule found in blood, other body fluids, or tissues that can be used as a sign for the presence of a disease"

   "A biomarker, or biological marker, is a measurable indicator of some biological state or condition"

   Describe at least two distinct differences between these two definitions. (2p)

2. One can use the clinical skin prick test to detect allergies against certain allergens. Explain the molecular and cellular process that needs to take place in order to generate a red spot on the skin within a few minutes. (4p)

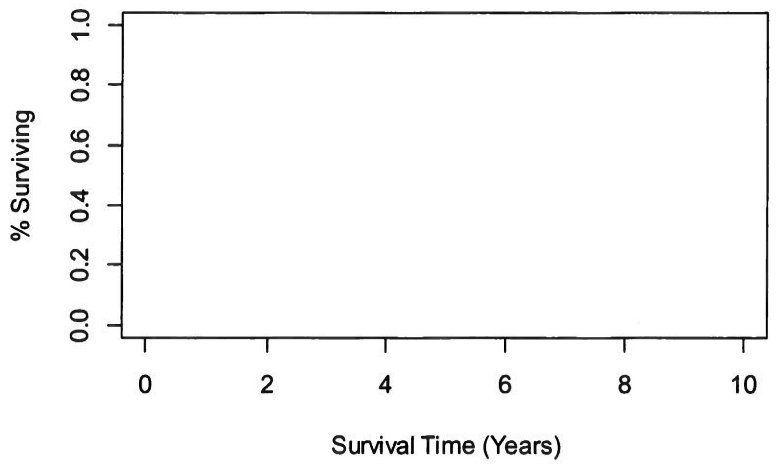
3. Explain what ctDNA is and how it can be used to guide cancer treatments. (2p)

4. Name one predictive biomarker and explain what it can be used for. (1 p)

5. Explain how the erythrocyte sedimentation rate (ESR) test works as an indication of inflammation. (2p)

6. Draw an approximate 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	3	1
2	6	1
3	6	1
4	8	1
5	10	0



7. 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.

8. 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.

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

☐ The proteins gp120 and gp41 are common biomarkers for breast cancer.
☐ Procalcitonin (PCT) is a biomarker for detecting inflammatory diseases such as sepsis.
☐ The human chorionic gonadotropin (hCG) is a common biomarker for kidney failure.
☐ The serum carcinoembryonic antigen (CEA) can be used as a prognostic biomarker for non-small cell lung cancer.

10. Which of the following statements are correct regarding the use of ctDNA as a predictive biomarker for lung cancer (zero, one or several statements can be correct)? (2p)

☐ ctDNA is very sensitive because it can detect the presence of a few cancer cells.
☐ ctDNA can be detected from a liquid biopsy.
☐ By detecting specific mutations in the EGFR gene, one can predict drug resistance.
☐ An increased amount of ctDNA over time is an indication that the tumor is growing in size.

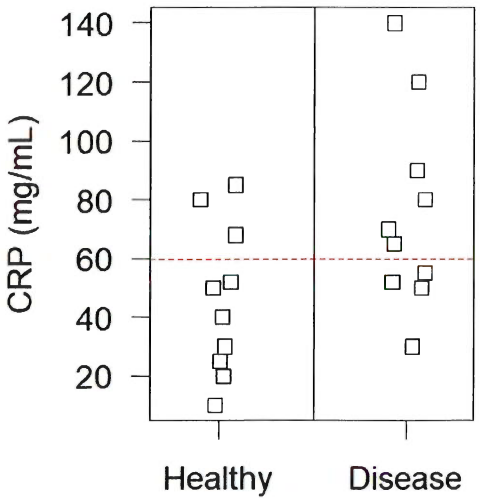
Describe how bioinformatics tools can be used for biomarker discovery (17 p).

1. Imagine that you have measured the concentration of PSA to detect prostate cancer. You have collected the following data: (3p)

Subject	State	PSA concentration (ng/ml)
1	Healthy	1
2	Healthy	2
3	Healthy	3
4	Prostate cancer	3
5	Prostate cancer	4

Show the calculation that you need to do for the first round of iteration when using the Leave-One-Out Cross-validation method. You therefore only need to show the calculations of the cutoff values and the prediction you make when you leave the first person out.

2. In a study, one has evaluated the blood CRP concentration as a biomarker for a certain autoimmune disease. In total, 10 healthy controls and 10 patients with the disease were included in the study. The research group decided to use a cutoff value of 60. Values above this cutoff value are associated with a positive test result, whereas values below this cutoff are associated with a negative test result.



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

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

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

d) Given the cutoff value, what is the sensitivity of the test? **Show your calculations.** (1p)

e) Given the cutoff value, what is the specificity of the test? **Show your calculations.** (1p)

f) Given the cutoff value, what is the negative predictive value? Assume the same prevalence as observed in the sample. **Show your calculations.** (1p)

g) What is the positive likelihood ratio (LR+)? **Show your calculations.** (1p)

h) What is the accuracy of the test? **Show your calculations.** (1p)

3. Explain the hold-out method to validate the performance of a biomarker (2p)

4. 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 negative test result.
☐ The accuracy is the sum of the true negatives divided by the sum of all positives and negatives.
☐ The accuracy is calculated like this: (TP + TN)/(TP + TN + FP + FN).
☐ The NPV is the probability that you are healthy, given a positive test result.

5. Which of the following statements are correct regarding the ROC curve and the area under such curve (zero, one or several statements can be correct)? (2p)

☐ An ROC curve shows the relationship between the sensitivity and accuracy.
☐ The maximum area below the ROC curve is 0.05.
☐ A good biomarker should result in an ROC curve that is close to the top left corner.
☐ The area below the ROC curve for the biomarker PSA to diagnose prostate cancer is around 0.96.