NORGES IDRETTSHØGSKOLE

**BACHELOR I TRENING, HELSE OG PRESTASJON 2021/2024**

**INDIVIDUAL HOME EXAM**

**IN**

# THP 301- CELL BIOLOGY

## Information

- Start of exam: Wednesday December 13. 2023 at 10.00 p.m
- Final deadline: Wednesday December 13. 2023 at 2.00 p.m. in WISEflow
- Answer in English or Norwegian
- The submission must be in pdf format.
- Exam results will be available within four weeks from the exam date: 11th of January 2024
- Aids: The use of artificial intelligence (AI, such as ChatGPT and others) must be disclosed. You should specify which AI has been used, in which part(s) of the text AI has been used, and how AI has been used.

There are **4 main questions** from 4 of the main topics covered in the Cell Biology Course. Each question contains 2-3 sub-questions (for example a, b and / or c).

Each main question is worth 25 marks (25 marks x 4 questions = 100 Marks in Total).

Exam is graded A-F.

You should spend approximately **1 hour on each main question** (4 hours in total).

All exams will be subject to plagiarism checks.

**Question 1**

**Topic- What is Cellular / Molecular Exercise Physiology? And the 'signal transduction theory' of exercise adaptation?**

a) Provide a short definition for: What is 'molecular exercise physiology'? (3 marks)

b) What is gene transcription (also termed mRNA or gene-expression)? In your answer, briefly explain what process the term 'gene transcription' is describing. (5 marks)

c) Explain, in order, if possible, the stages involved in the overarching molecular response to exercise. From the exercise 'signal' through to changes in the amount of protein produced by the cell. Refer to at least 1 main example for each stage. One example of an exercise 'signal' would be an increase in calcium in the muscle. Therefore, in your answer you may want to explain what causes an increase in this type of exercise 'signal', what are the molecular 'sensors' that detect a change in this signal, and what are the ensuing extracellular/intracellular responses leading to alterations in gene transcription and protein levels. Note- You can use any example of an exercise signal (i.e,. you do not have to use calcium). (17 marks)

**Question 2**

**Topic- Molecular Regulation of Adaptation to Resistance Exercise (and Hypertrophy)**

a) List the main molecular pathways or cellular processes involved in 'positively' effecting muscle mass. (3 marks)

b) List the main pathway/pathways or cellular processes involved in 'negatively' effecting muscle mass. (2 marks)

c) Describe the mTOR pathway and how it activates protein synthesis via its downstream signalling. In your answer then go onto discuss how mTOR 'senses' mechanical load and how it is thought to convert this mechanical signal (e.g. after resistance exercise in humans or mechanical overload in animal models) into a molecular signal. You should use examples from the research literature, using

human resistance exercise studies and/or rodent models (e.g., synergistic ablation) to support your answer. (20 marks)

**Question 3**

**Topic –Molecular Regulation of Endurance Exercise Adaptation**

a) What are the aerobic exercise 'signals' that activate the molecular 'sensors': CAMKII, AMPK and SIRT1? (3 marks)

b) Briefly outline the timeline of endurance exercise adaptation in terms of cell/molecular signalling through to physiological and phenotypic changes. For example, describe the main molecular signal(s) & sensors for endurance exercise. Then what happens to the 'master' regulator PGC1-alpha and associated metabolic/mitochondrial genes. Finally, discuss how PGC1-alpha alters gene expression and how these changes cause adaptation to mitochondria and ultimately endurance performance. You need to use examples from at least 2 original research articles to support your answer referring to exercise intensity and how this may affect the above molecular pathways (22 marks).

**Question 4**

**Topic - Epigenetics of Resistance and Aerobic Exercise (and muscle memory)**

a) What is DNA methylation? Describe the process of DNA methylation, and how DNA methylation regulates gene expression. (3 marks)

b) Describe what is currently known about how DNA methylation may be involved in regulating the response and adaptation to aerobic exercise. For example, what does aerobic exercise do to DNA methylation across the entire genome, what overarching molecular pathways demonstrate altered DNA methylation following acute aerobic exercise or chronic exercise training. Note- you can also use examples from diseased/aged/patient groups as well as those studies in healthy adults. (10 Marks)

c) Describe what is currently known about how DNA methylation may be involved in regulating the response and adaptation to resistance exercise. Discuss what is meant by muscle possessing an **epigenetic 'memory'** referring to original research studies in your answer. Note- you do not need to discuss cell memory or myonuclei retention in your answer as this is not an epigenetic modification. (12 Marks)