

Introduction: There are questions from 7 seminars. All parts count equally. Manage your time. The answer must be written in English, Norwegian, Swedish or Danish.

Seminar 1: Running Economy (10 points)

- 1) Define running economy and explain how it can be measured.
- 2) Describe some of the key spatiotemporal variables that can be measured during running.
- 3) Which mechanisms may explain associations between spatiotemporal variables and running economy?

Seminar 3: Biomechanics of overuse injuries (10 points)

1. Describe the different types of loading that the lower limb bones, for example the tibia, may experience during running. How can the loading influence bone remodelling?
2. What are important factors to consider when designing a research study to assess biomechanical risk factors for running overuse injury?

Seminar 4: Performance analysis in Team sport (10 points)

1. Explain how match analysis can be used to support coaching and performance improvement (4 points)
2. A team shows reduced high-speed running in one match compared with previous matches. Identify factors that could explain this result without indicating reduced performance (6 points)

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Seminar 6: Integrated performance analysis (10 points)

1. During a 15-km individual-start cross-country skiing competition, oxygen demand and oxygen uptake interact dynamically as athletes navigate varying terrain (uphill, flat, and downhill sections).
 - a. How do changes in terrain influence the relationship between oxygen demand and oxygen uptake? Describe what happens during uphill sections and immediately after, in a downhill section.
 - b. Explain how skiers use this interplay between oxygen demand and uptake to optimize pacing, tactics, and overall performance.
2. Pacing is a critical determinant of performance in middle- and long-distance running events held on level ground, such as track races (800 m to 5000 m) and road races (half-marathon and marathon).
 - a. Describe pacing patterns that are considered optimal for performance in the 800 m, 5000 m, and marathon.
 - b. Explain the tactical challenges related to pacing faced by a runner with comparatively lower physical capacity in a competitive field.

Seminar 7: Ergogenic aids (10 points)

A male cross-country skier comes to you with a question whether he would benefit from using caffeine for performance in the Birkebeiner race (53 km).

1. Give an overview of the proposed ergogenic mechanisms, quality of scientific evidence and relevance for use of caffeine supplementation in context of this race.
2. Provide concrete advice for him with respect to supplementation protocol (type, amount and timing) and discuss on how factors that can determine whether he responds to the supplement.

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Seminar 8: Sex differences in oxygen transport and utilization during exercise (10 p)

1. Describe what arterial oxygen saturation (SO_2) is and how SO_2 impacts maximum oxygen uptake (VO_{2max}).
2. What is the difference in SO_2 between the following individuals and situations, and why? (precise numbers are not essential, but the directional change and a description of mechanisms are paramount)
 - a. Compare SO_2 between individuals that are untrained (VO_{2max} : under 45 ml/min/kg) and well-trained (VO_{2max} : over 75 ml/min/kg) during maximum exercise (> 95% of maximum heart rate)
 - b. Compare SO_2 at sea level and at 2500 meters above sea level during maximum exercise
 - c. Compare SO_2 when an untrained individual inhale a higher oxygen gas fraction than normal air (for instance, 26% oxygen) vs normal air during maximum exercise
 - d. Compare SO_2 when a well-trained individual inhale a higher oxygen gas fraction than normal air (for instance, 26% oxygen) vs normal air during maximum exercise

Seminar 9: Strength training (10 points)

1. Describe how mechanical tension during resistance exercise can sensed by muscle fibres and translated into intracellular signalling cascades stimulating muscle protein synthesis!
2. Explain how this knowledge can be used to design effective resistance training interventions, considering load and volume variables!