Preparation for the written exam within the aptitude test

M.Sc. Sport and Exercise Science

Content

General information

The test in written form lasts 90 minutes. The date of the test will be announced by the commission at least one week in advance. The test takes place twice per application phase. There is a regular date and a subsequent date. Participation in the subsequent date is only possible in proven justified exceptional cases.

The content of the test covers the following topics with approximately the specified distribution:

- Physiology/Anatomy (35%)
- Research Methods (30%)
- Biomechanics (20%)
- Exercise Science, Human Movement Science, Sociology and Sports Psychology (15%)

In the following, you will find the respective learning objectives, main topics, literature references and one sample question for the individual topics to help you prepare for the test.

Physiology/Anatomy

Expected skills

Students are able to:

- describe molecular mechanisms of adaptation to exercise
- explain genetics of sport and exercise-related traits
- reproduce musculoskeletal anatomy and physiology
- understand the structure, development and function of the human body as well as individual specific organ systems, describe them and furthermore apply them to specific issues of biomedicine of the body
- describe the general production of action potentials, conduction and synaptic transmission of nerve cells
- understand pathogenesis, manifestations, therapy and prognosis of common, individually and economically significant clinical pictures of general medicine and orthopedics
- name the major joints of the human body and the muscles of the large joints and their function in Latin
- understand preventive and rehabilitative measures in the field of orthopedics
- describe injuries and diseases of the spine and name possible forms of therapy (names, epidemiology and present mechanism)
- describe diagnostic testing, injuries and diseases of the knee, hip and shoulder joints (names and present mechanism)
- describe basic conservative treatment options for individual injuries and diseases (examples for operative techniques: Anterior cruciate ligament rupture can be treated with autografts taken from the tendon of the semitendinosus muscle or the patellar tendon)

Subjects

- Genes associated with sport and exercise-related traits such as MSTN.
- Adaptations to endurance and resistance exercise (e.g. AMPK, mTORC1)
- Cardiac output, maximal oxygen uptake
- Excitation-contraction coupling, muscle fibre types
- Neural conduction and synaptic transmission within the nervous system
- Functional anatomy e.g. of injuries (e.g. unhappy triad)
- Basic anatomical terms (planes and axes, direction of motion, positional designations)
- Structure and functioning of the cell and tissues
- Structure and function of the musculoskeletal system and physiological functioning
- Structure and function of the cardiovascular system (heart and blood vessels), blood and defense system, lymphatic system, respiratory tract
- Structure and functioning of the endocrine system, digestive system, genitourinary system, central nervous system
- Common clinical pictures, pathophysiology, diagnostics and therapy in internal medicine, general medicine and orthopedics
- Biochemical basis of metabolism
- Fluid hormones, macronutrient structures and functions, digestion and absorption, major nutrient-related metabolic pathways
- Injuries, diseases, diagnostic testing and forms of treatment of the musculoskeletal system

Recommended Literature

Wackerhage. Molecular Exercise Physiology, Routledge, 2014 [Chapters on adaptation and genetics]

McArdle, Katch & Katch, Exercise Physiology, 2014 [Chapters on cardiovascular exercise physiology]

Purves, et al., Neuroscience, 6th edition, 2020, Sinauer Associates, New York

Abrahamson, Comfort (eds), Sports rehabilitation and injury prevention, Chichester, West Sussex, UK, Hoboken, NJ: Wiley-Blackwell; 2010

Sample question

“Lactate accumulates in the muscles under high physical strain. Which statement (s) about lactate is / are wrong?

1) Lactate is supplied to the liver via the Cori-Cycle, where it is converted into glucose.
2) The fast-twitch type II muscle fibers cannot release lactate into the blood and therefore tire quickly.
3) Lactate is transported out or in the cells via monocarboxylate transporters.
4) Lactate can be broken down in tissues with high aerobic capacity in the mitochondria.
5) Lactate is a metabolic end product and is fed into the enterohepatic circulation to be broken down for excretion.”

A. Only 3 is wrong
B. All of the answers are wrong
C. Only 2 and 5 are wrong
D. Only 1 is wrong
E. Only 3 and 4 are wrong

Research Methods

Expected skills

Students are able to:

- understand the theoretical foundations of empirical science, especially the concepts of operationalization, reliability, validity and bias
- describe the different empirical research designs
- describe and interpret descriptive statistical measures
- describe and interpret simple association measures
- describe sampling strategies and understand the rationale of random sampling
- understand basics of probability theory, the concept of random variables and important distributions.
- understand and apply parametric and non-parametric tests for the examination of differences and associations and to understand the limitations of these concepts
- apply basic concepts of linear regression and interpret regression results
- understand and apply basic operations on the above-mentioned statistical topics

Subjects

1. Statistics
    - Absolute and relative frequencies
    - Measures of location and scale
    - Measures of association
    - Basics in probability theory and random variables
    - Epidemiological measures
    - Confidence intervals
    - Statistical hypothesis testing
    - ANOVA
    - Linear regression
2. Experimental Design
    - Basics of philosophy of science
    - Measuring and operationalization
    - Reliability and validity
    - Research process
    - Confounding
    - Research designs
    - Sampling
    - Data collection
    - Study design
    - Bias and Confounding
    - Experimental design
    - Study protocol
3. Further issues related to research methods
    - Good scientific practice
    - Sound scientific conduct
    - Data sources in research
    - Interpretation of research findings

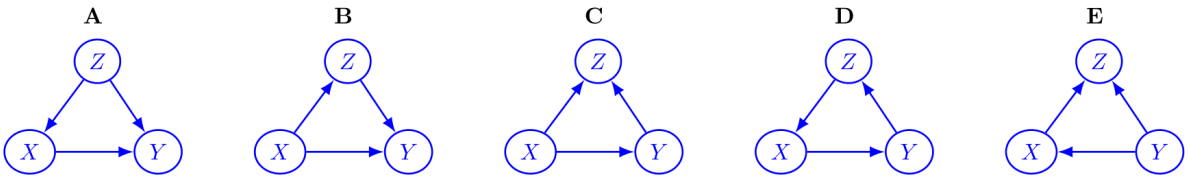
Recommended Literature

Heumann, C., Schomaker, M., Shalabh: Introduction to Statistics and Data Analysis, Springer, 2016 (https://link.springer.com/book/10.1007/978-3-319-46162-5)

Celentano D, Szklo M.: Gordis Epidemiology. Elsevier, 2018, 6. Edition (https://www.elsevier.com/books/gordis-epidemiology/celentano/978-0-323-55229-5)

Sample question

“In the following schematic drawings, the causal relationships between three variables X, Y and Z are illustrated. An arrow from X to Z for example means that variable X has a causal effect on variable Z. In which of the following situations would Z be a confounder for the causal effect of X on Y.”



A. Situation A
B. Situation B
C. Situation C
D. Situation D
E. Situation E

Biomechanics

Expected skills

Students are able to:

- understand the structure, development and function of the human body from the biomechanical point of view
- describe anthropometric, kinematic, dynamic and electromyographic methods in sports
- understand biomechanical graphs and pictures for motion analysis
- understand and calculate with biomechanical parameters and formulas for load analysis
- understand preventive and rehabilitative measures in the field of biomechanics in sports and health
- name the major rules and formulas for a mathematical biomechanical movement analysis
- describe diagnostic testing for performance analysis with Jumps and Strength tests

Subjects

- Basic mechanical and biomechanical terms (planes and axes, direction of motion, positional designations, Newton's laws, fundamental of kinematics, dynamics biomechanical approach)
- Injuries in sports
- Behavior of the body under load
- Cinematography and video analysis
- Force platforms and external force measurement for applied situations
- Forces acting on a body segment in two dimensions
- Aspects of biomechanical analysis of sports performance (anthropometry, kinematics, dynamics, electromyography)
- Biomechanical optimization of sports techniques
- Mathematical models and formulas of sports motion
- Introduction to modelling (e.g. muscle-tendon modelling, inverse dynamic modelling)
- Diagnostic testing and forms of treatment of the musculoskeletal system

Recommended Literature

Whiting, W.C.; Zernicke, R.F.: Biomechanics of Musculoskeletal Injury. Human Kinetics, Champaign, USA 1988

Bartlett, R.: Sports Biomechanics-Reducing Injury and Improving Performance, London, E&F Spon, 1999

Bartlett, R.: Introduction to Sports Biomechanics, London, E&F Spon, 1999

Sample question

"Video analysis: Which of the following statements is correct?

1) Increasing the resolution, increases the possible capture volume.
2) Increasing the resolution decreases the possible capture volume.
3) Increasing the resolution, increases the measurement error.
4) Increasing the resolution, decreases the measurement error.
5) The resolution does not affect capture volume or measurement error."

A. Only answers 1) and 4) are correct

B. Only answers 2) and 4) are correct
C. Only answers 2) and 3) are correct
D. No answer is correct
E. Only answer 5 is correct

Exercise Science, Human Movement Science, Sociology and Sports Psychology

Expected skills

Exercise Science:

Students are able to:
- recall basics of resistance and endurance training
- explain performance-limiting factors for e.g. strength and endurance
- recall fundamental knowledge in the systematics and definitions of central concepts of training science
- explain basic training methods for the training of endurance, strength, agility, flexibility, coordination, techniques and tactics.
- understand selected elements of scientific training interventions like aims, methods, exercises as well as the concepts of planning and control in training.

Human Movement Science:

Students are able to:
- understand rules of motor control and their application to motor activities
- describe neuronal control of movement
- explain models of motor programming and motor learning
- describe the development of the sensory and motor system
- understand the sensorimotor effects of aging

Sociology:

Students are able to:

define and describe key terms from sociology (e.g. race, class, gender, dis-/ability)
understand and describe how and during which socio-historical context sociology was developed as a scientific field and its main research focus

Sports Psychology:

Students are able to:
- define and describe key terms from psychology
- explain different types of memory systems and describe the major theories of behavioral learning
- describe and compare key terms and theories of motivation and self-regulation
- identify common theories that connect arousal to performance in sports and apply them to an applied sports setting.
- differentiate types of goals relevant for sports performance and apply them to an applied sports setting.

Subjects

Exercise Science:

- Performance-limiting factors for a 2 h Marathon
- Polarised training
- Resistance training for hypertrophy
- Classification of sports
- Fundamentals of exercise physiology
- Systematics, determinants, training methods and application fields of endurance, strength, speed, agility, coordination, technique and tactics

- Fundamentals of performance diagnostics
- Models of training management
- Research strategies in training science

Human Movement Science:

- Abilities and skills – coordination
- Peripheral and central nervous system in the control of movement
- Motor program and feedback
- Motor learning
- Development and aging

Sociology:

- Sociological key terms and concepts (e.g. race, class, gender, dis-/ability)
- Development of sociology as a field for research and main research focus

Sports Psychology:

- What is psychology?
- Fundamentals of neurophysiology
- Individual differences and personality
- Learning
- Memory
- Motivation and self-regulation
- Goal-setting
- Identifying and defining different types of goals
- Principles of goal-setting
- Arousal, anxiety and performance
- Definitions of arousal and anxiety
- Being able to connect arousal and anxiety to performance
- Theories of arousal, anxiety and performance

Recommended Literature

Exercise Science:

McArdle, Katch & Katch, Exercise Physiology, 2014 [Chapters on endurance and resistance training]

English terms: https://www.brianmac.co.uk/

Human Movement Science:

Abilities & Skills, e.g.: https://www.brianmac.co.uk/skills.htm

Peripheral & central nervous system, e.g.: https://www.ndsu.edu/faculty/pavek/Psych486_686/chapterpdfs1stedKolb/kolb_10.pdf (Chapter 10, “Somatosensory Receptors and Sensory Perception”, S. 28, Figure 10-23)

http://samples.jbpub.com/9781449694425/94425_ch03_pass1.pdf (Chapter 3, “The Spinal Cord”)

Motor control and Learning, e.g.: https://www.physio-pedia.com/Motor_Control_and_Learning

Models, e.g. Power Law of Practice, e.g.: https://en.wikipedia.org/wiki/Power_law_of_practice

Performance in older age, source, e.g. https://motorimpairment.neura.edu.au/motor-performance-decline-aging/

Newell, K.M. Motor skill acquisition. Annual Reviews Psychology. 1991; 42: 213-237

Sociology:

Anthony Giddens et al. (2020). Introduction to Sociology. https://wwnorton.com/books/9780393538021 (Part I & Part III)

Sports Psychology:

Gerrig, R. J., & Zimbardo, P. G. (2018/2020), *Psychology and Life*, Pearson Higher Education
Chapter 1: Psychology and Life
Chapter 7: Learning and Behavioral Analysis
Chapter 8: Memory
Chapter 12. Motivation
Chapter 14. Understanding Human Personality

Weinberg, R. S., & Gould, D. (2020). Foundations of Sport and Exercise Psychology (7th ed.). Human Kinetics.
Chapter 5 - Arousal, Stress and Anxiety (Weinberg & Gould, 2020)
Chapter 16 – Goal Setting (Weinberg & Gould, 2020)

Sample questions

Exercise Science:

"What is polarised training?"

A. A combination of high volume low intensity and high intensity interval training (HIIT) with little training at the anaerobic threshold
B. A training model where most volume is performed at the anaerobic threshold
C. A training that focusses on the polar opposites of high volume low intensity training and resistance training
D. A combination of high intensity interval training (HIIT) and anaerobic threshold training
E. A form of training where high intensity interval training (HIIT) and resistance training are combined in a glycogen-depleted state

Human Movement Science:

"Which measure or which measures quantify movement variability during repeated aiming movements with the hand from a start position to a target?

1) Maximum speed
2) Range of velocity peaks
3) Standard deviation of movement times
4) Normality of Gaussian distribution of velocity peaks
5) Mean movement time"

A. Only 1 is correct
B. Only 3 is correct
C. Only 4 is correct
D. Only 1 and 5 are correct
E. Only 2 and 3 are correct

Sociology:

"Which category is not part of the so-called "horizontal inequalities"?

A. Race
B. Dis-/ability
C. Gender
D. Age
E. Income

Sports Psychology:

“Topic: Goal Setting in Sports
What is an advantage of process goals?”

A. They are useful for competitions, because they help avoid anxiety.
B. They are most likely to facilitate short-term motivation.
C. They cannot be adjusted easily and therefore lead to higher motivation.
D. In comparison to other goal types, they are easy to measure, which makes them very effective for goal-setting.
E. They are usually based on comparisons with one’s own performance.