

MUSCLE

General points

- main muscle types, chief features and their importance
- characteristics of the macro- and microstructure in skeletal muscle, cell organelles of the skeletal myofiber
- characteristics of the macro- and microstructure in cardiac muscle
- characteristics of the macro- and microstructure in smooth muscle
- ultrastructure of striated muscle myofibrils: the sarcomeric structure (bands, lines), filaments
- the essence of „sliding“ filament“ model

Composition and main components of the striated muscle

- general composition (organic and inorganic components)
- water-soluble proteins (enzymes - examples, myoglobin), membrane proteins (examples)
- struktural proteins (groups: contractile and regulatory proteins; main cytoskeletal proteins)
- molecular features of myosin, ATPase activity, binding sites; thick filaments
- α -actin; G-actin, F-actin; connections of F-actin
- characteristics of tropomyosin its function
- members of the troponin complex, functions
- structure of the thin filament, its components and formation

Contraction of the striated muscle

- basic mechanism of muscle contraction, formation of crossbridges, „power stroke“
- steps of striated muscle contraction (contraction-relaxation cycle)
- importance of Ca^{2+} ion concentration in the sarcoplasm, its value in resting muscle, and before contraction
- importance of troponin complex and tropomyosin in the initiation of contraction

Excitation – contraction coupling („EC coupling“)

- basics of direct/mechanical coupling and its steps *in skeletal muscle*
- importance and functioning of nikotinic acetylcholine receptor
- localization and functioning of dihydropyridine receptor (DHP-R) and ryanodine receptor (RyR)
- the sarcotubular system: structure and importance of T-tubules and the sarcoplasmic reticulum; localization and function of triades
- Ca^{2+} -induced Ca^{2+} release: essence and steps *in cardiac muscle*
- effect of β -adrenergic stimulation and role of phospholamban in heart
- ❖ the effects of β -adrenergic blockers, β -adrenergic agonists, (plasma membrane) Ca^{2+} -channel blockers and digitalis on the function of cardiac muscle
- excitation – contraction coupling in *smooth muscle*, role of PLC signalling
- basis of smooth muscle contraction: myosin phosphorylation and its regulation

Mechanism of relaxation in striated muscle

- steps of relaxation
- importance and functioning of acetylcholinesterase
- importance and functioning of SR - Ca²⁺ ATPase (SERCA)
- storage of Ca² in the sarcoplasmic reticulum

Muscle differentiation and regeneration

- main steps of skeletal muscle development
- basis of skeletal muscle regeneration: satellite cells

Mechanics of muscle action

- dynamics of muscle stretching (stimuli – latent period – contraction – peak - relaxation)
- factors influencing muscle stretching (number of motor units, Ca²⁺ concentration, temperature, pH, basic stretched state: role sarcomer length)
- muscle contraction in case of repeated stimuli, according to frequency of stimuli (separate contractions, complete and incomplete tetanus)
- isotonic and isometric contractions

Energy need for muscle contraction

- ATP sources and their usage in muscle
- immediate energy supply: creatine phosphate, myokinase, myoglobin
- short-term energy supply: role of glycogen
- long-term energy supply: role of aerobic glycolysis
- adaptation of respiratory and cardiovascular system during exercise for improved energy supply

Types of muscle fibers

- characterization of fast, glycolytic fibers
- characterization of slow, oxidative fibers
- characterization of fast, oxidative fibers
- muscle plasticity
- special metabolism of heart muscle

Adaptation of muscle metabolism

- metabolic basis of muscle fatigue
- comparison of sprinter and marathon runner
- metabolic consequences of short-term, intensive training
- metabolic consequences of long-term, endurance training
- muscle fever
- endurance
- oxygen debt

Muscle disorders

Ion channel diseases (channelopathies)

- ❖ malignant hyperthermia (detailed characterization)
- ❖ myotonic states (e.g.: hypo-/hyperkalemic periodic paralysis, congenital myotonia)
- ❖ muscular dysgenesis (deficiency of dihydropyridin-receptor)
- ❖ Brody-disease (SERCA1-deficiency)

Diseases affecting the neuromuscular junction

- ❖ myasthenia gravis (detailed characterization)

Diseases affecting the cytoskeletal system

- ❖ progressive muscle dystrophies, Duchenne dystrophy (detailed characterization)