Development of Complex Curricula for Molecular Bionics and Infobionics Programs within a consortial* framework**

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**Molekuláris bionika és Infobionika Szakok tananyagának komplex fejlesztése konzorciumi keretben

***A projekt az Európai Unió támogatásával, az Európai Szociális Alap társfinanszírozásával valósul meg.

BASICS OF NEUROBIOLOGY

Neurobiológia alapjai

NERVE ENDINGS

(Idegvégződések)

ZSOLT LIPOSITS

NERVE ENDINGS

NEURONS COMMUNICATE WITH NON-NEURONAL ELEMENTS VIA SPECIALIZED NERVE ENDINGS BELONGING TO EFFECTOR AND RECEPTOR CATEGORIES

I. EFFECTORS

1. MOTOR END-PLATE
2. AUTONOMIC FIBER PLEXUS

II. RECEPTORS

1. MUSCLE RECEPTORS
2. SENSORY EPITHELIAL CELLS
3. MECHANORECEPTORS
4. THERMORECEPTORS
5. PAIN RECEPTORS
6. CHEMORECEPTORS

NEURONS COMMUNICATE WITH OTHER NEURONAL ELEMENTS VIA SPECIALIZED STRUCTURAL AND FUNCTIONAL UNITS

I. SYNAPSES

1. CHEMICAL SYNAPSE
2. ELECTRICAL SYNAPSE

MOTOR ENDPLATE

AXONS OF SOMATIC MOTONEURONS INNERVATE SKELETAL MUSCLE FIBERS

THE JOINT UNITS OF THE NERVE TERMINALS AND MUSCLE FIBERS ARE CALLED MOTOR END PLATES. SYNONYMS: MYONEURAL JUNCTION, NEUROMUSCULAR JUNCTION

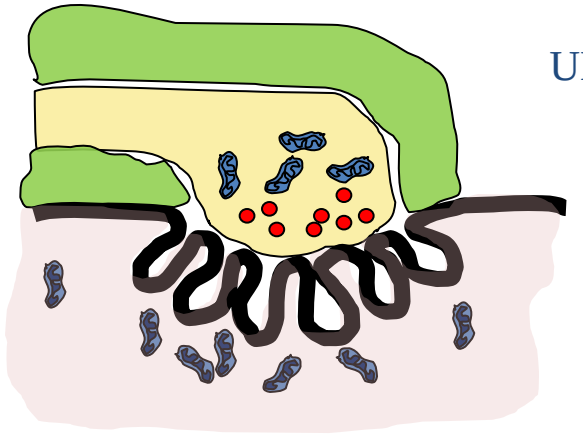
MOTONEURONS PROJECTING FROM THE BRAIN STEM AND SPINAL CORD SEND AXONS TO THE STRIATED MUSCLE FIBERS FOR INNERVATION

THE TERMINAL AXON LOSES ITS MYELIN SHEATH AND THE TERMINAL BOUTONS JUXTAPOSE TO THE SARCOLEMMA, THE MEMBRANE OF THE MUSCLE FIBER

THE AXON TERMINAL CONTAINS SYNAPTIC VESICLES FILLED WITH THE NEUROTRANSMITTER ACETYLCHOLINE

ACTIVATION OF THE NERVE TERMINAL LEADS TO THE RELEASE OF THE TRANSMITTER THAT BINDS TO ITS RECEPTORS EMBEDDED INTO THE MUSCLE MEMBRANE. THE RECEPTOR ACTIVATION EVOKES CASCADE EVENTS RESULTING IN THE CONTRACTION OF THE MUSCLE FIBERS

MOTOR ENDPLATE



ULTRASTRUCTURAL SCHEME OF THE MOTOR END PLATE

SCHWANN CELL
MOTONEURON AXON TERMINAL
SYNAPTIC VESICLE
SARCOLEMMA
MITOCHONDRION

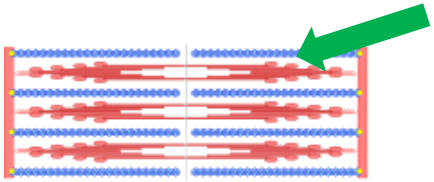
THE MECHANISM OF ACTIVATION OF THE NERVE TERMINAL

FEATURES OF ACETYLCHOLINE RELEASE AND ITS BINDING TO RECEPTORS

INACTIVATION OF THE TRANSMITTER

POSTSYNAPTIC EVENTS

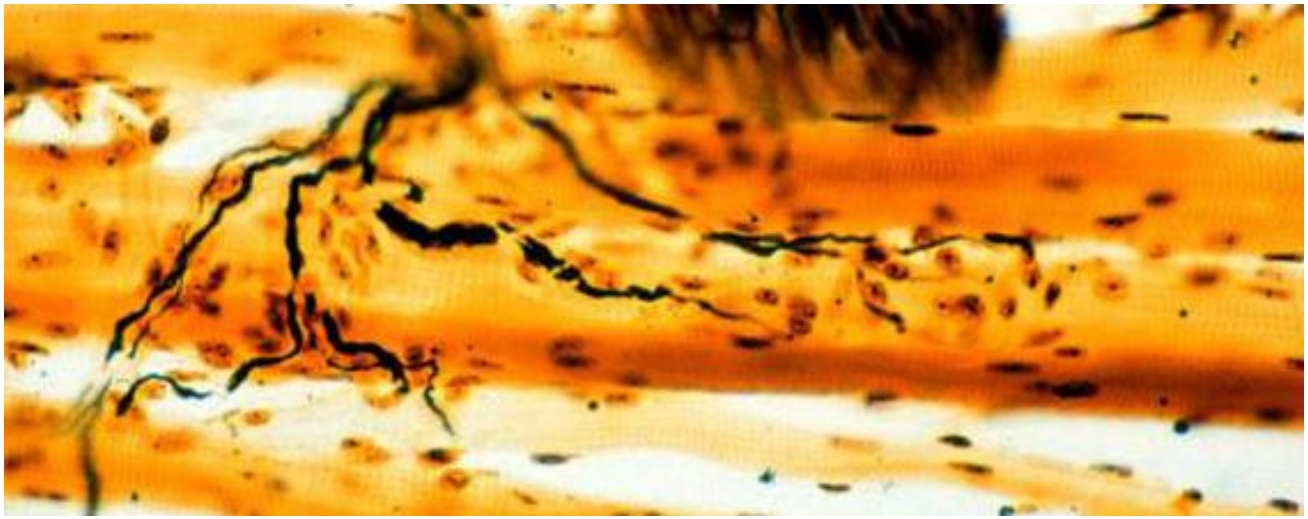
THE CONTRACTION OF THE SARCOMERES



THE SARCOMERE

THE SMALLEST FUNCTIONAL UNIT OF A MYOFIBRIL

CELLULAR DETAILS OF THE MUSCLE INNERVATION



THE SILVER IMPREGNATED AXONS APPEAR IN BLACK. THEY SHOW A REMARKABLE TERMINAL ARBORIZATION. THE THIN, INDIVIDUAL AXON TERMINALS SPREAD OVER AND INNERVATE STRIATED MUSCLE FIBERS SHOWN IN ORANGE. THE NERVES CAN TRANSMIT SENSORY INFORMATION TO THE CNS AND ALSO CONVEY MOTOR COMMANDS FROM THE CNS TO THE MUSCLE FIBERS

THE AUTONOMIC PLEXUS

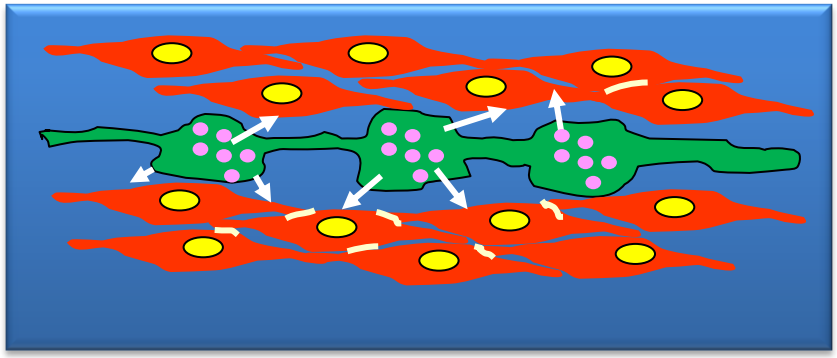
POSTGANGLIONIC NERVE FIBERS OF THE SYMPATHETIC AND PARASYMPATHETIC

BRANCHES OF AUTONOMIC NERVOUS SYSTEM INNERVATE THE CARDIAC MUSCLE, SMOOTH MUSCLE BUNDLES OF VISCERAL ORGANS AND GLANDS

THESE AXONS DO NOT ESTABLISH SYNAPSES WITH THE TARGET CELLS

THEY RELEASE THE TRANSMITTER INTO THE EXTRACELLULAR SPACE FROM THEIR AXON VARICOSITIES

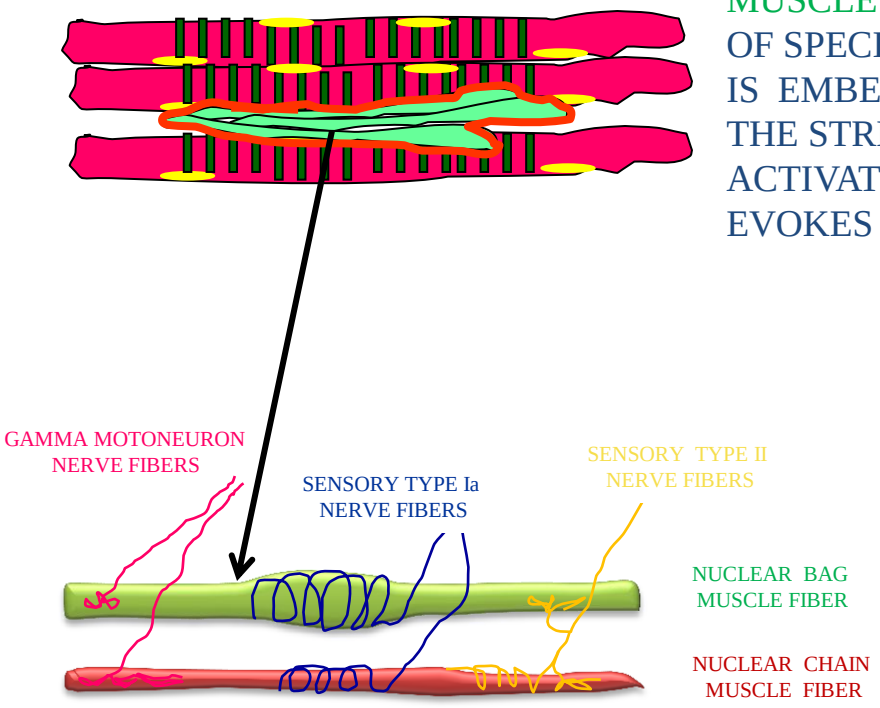
SPECIFIC RECEPTORS OF THE TARGET CELLS PICK UP THE TRANSMITTERS AND INITIATE THE CELLULAR RESPONSES



INNERVATION OF SMOOTH MUSCLE CELLS BY AN AUTONOMIC NERVE FIBER. SMOOTH MUSCLE CELLS ARE COUPLED BY GAP JUNCTION, ARROWS INDICATE THE OUTFLOW OF THE TRANSMITTER.
BEADED AXON
TRANSMITTER-CONTAINING VESICLES
SMOOTH MUSCLE CELLS

MUSCLE RECEPTORS

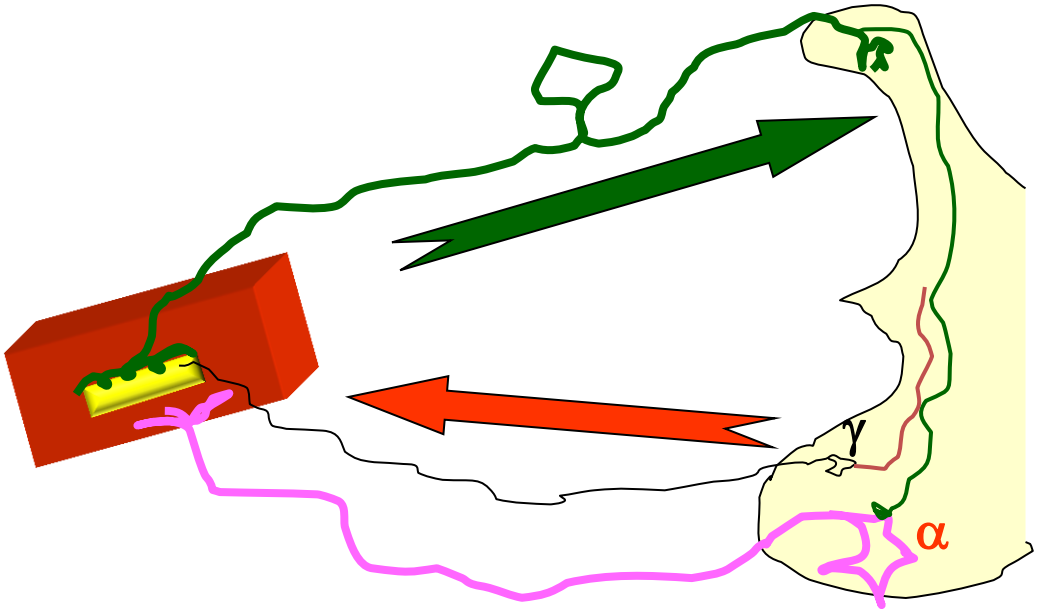
THE ACTUAL STRETCHING STATE OF MUSCLE AND TENDON FIBERS IS CONTINUOUSLY MONITORED BY THE CNS USING THE MUSCLE SPINDLE AND GOLGI TENDON RECEPTORS

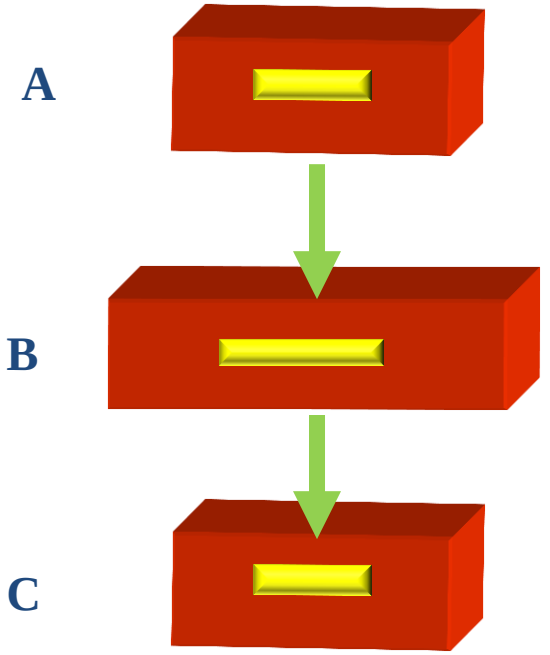


MUSCLE SPINDLE IS A CAPSULATED RECEPTOR COMPOSED OF SPECIAL, THIN STRIATED MUSCLE FIBERS. THE STRUCTURE IS EMBEDDED AMONG EXTRAFUSAL MUSCLE FIBERS. THE STRETCHING OF THE EXTRAFUSAL MUSCLE FIBERS ACTIVATES THE RECEPTOR THAT INFORMS THE CNS AND EVOKES THE COMPENSATORY ACTION, THE CONTRACTION

THE MUSCLE SPINDLE CONSISTS OF NUCLEAR BAG AND NUCLEAR CHAIN MUSCLE FIBERS. BOTH FIBER TYPES RECEIVE MOTOR (GAMMA) AND SENSORY (Ia and II) NERVES

SCHEME OF THE SPINAL STRETCH REFLEX





MUSCLE SPINDLES ARE THE RECEPTORS OF THE SPINAL STRETCH REFLEX. IT RECEIVES MOTOR AND SENSORY INNERVATIONS . THE EXTRAFUSAL MUSCLE FIBERS ARE INNERVATED BY ALPHA MOTONEURONS

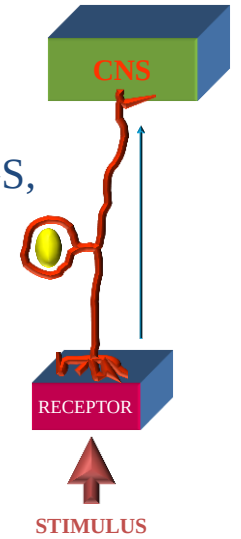
IT IS A MONOSYNAPTIC REFLEX PROVIDING AUTOMATIC REGULATION OF SKELETAL MUSCLE LENGTH

SENSORY EPITHELIAL CELLS

SENSORY EPITHELIAL CELLS ARE CAPABLE OF SENSING SPECIAL STIMULI (ODOR, FLAVOR, LIQUID MOVEMENT). THEY ARE RELATED TO THE SPECIAL SENSE ORGAN SYSTEM. PRIMARY SENSORY CELLS CONVEY THE INFORMATION TO THE CNS BY THEIR OWN PROCESSES, SECONDARY SENSORY CELLS FORWARD THE INFORMATION BY THE PERIPHERAL PROCESSES OF SENSORY GANGLION NEURONS

MECHANORECEPTORS

THEY ARE SENSORY RECEPTORS THAT RESPOND TO PRESSURE AND DISTORSION. MECHANORECEPTORS ARE NUMEROUS IN THE SUPERFICIAL AND DEEP LAYERS OF THE SKIN. THEY ARE EITHER FREE OR ENCAPSULATED NERVE ENDINGS. CHARACTERISTIC MEMBERS INCLUDE: FREE NERVE ENDINGS, MEISSNER'S-, KRAUSE'S- , PACININIAN CORPUSCULES, AND RUFFINI BODIES



FEATURES OF RECEPTOR POTENTIALS

- AMPLITUDE
- SIGNAL INTENSITY
- ADAPTATION

THERMORECEPTORS

SENSORY RECEPTORS THAT CODE ABSOLUTE AND RELATIVE CHANGES IN TEMPERATURE. THEY ARE FREE-NERVE ENDINGS OF UNMYELINATED AND THIN MYELINATED FIBERS. THERE ARE COLD AND WARM SENSITIVE TYPES

THE COLD RECEPTOR: TRANSIENT RECEPTOR POTENTIAL ION CHANNELS (TRPM8)

PAIN RECEPTORS

SENSORY RECEPTORS THAT RESPOND TO TISSUE DAMAGING NOXIOUS STIMULI.

THEY ARE ALSO ADDRESSED AS NOCICEPTORS. THEY PLAY A PIVOTAL ROLE IN AVOIDING THE HARMFUL INSULTS OF THE ENVIRONMENT AND HELP TO PRESERVE THE INTEGRITY OF THE BODY. THE ACTIVATION OF NOCICEPTORS ALARMS THE BODY. THEY HAVE FAST AND SLOW CONDUCTING SYSTEMS. THEY ARE INTEGRATED WITHIN THE NOCICEPTOR REFLEX ARC

CHEMORECEPTORS

SENSORY RECEPTORS THAT MONITOR CHANGES IN THE CHEMICAL COMPOSITION OF THE CIRCULATING BLOOD. THEY SENSE OXYGEN, CARBON DIOXIDE SATURATION AND pH. THEY CONTRIBUTE TO THE REGULATION OF RESPIRATION AND CIRCULATION