

BASICS OF NEUROBIOLOGY

NERVE ENDINGS

ZSOLT LIPOSITS

NERVE ENDINGS I.

Effectors and receptors



Basics of Neurobiology: Nerve endings

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

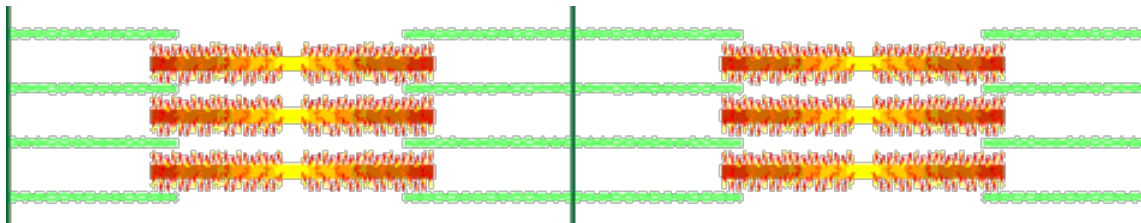
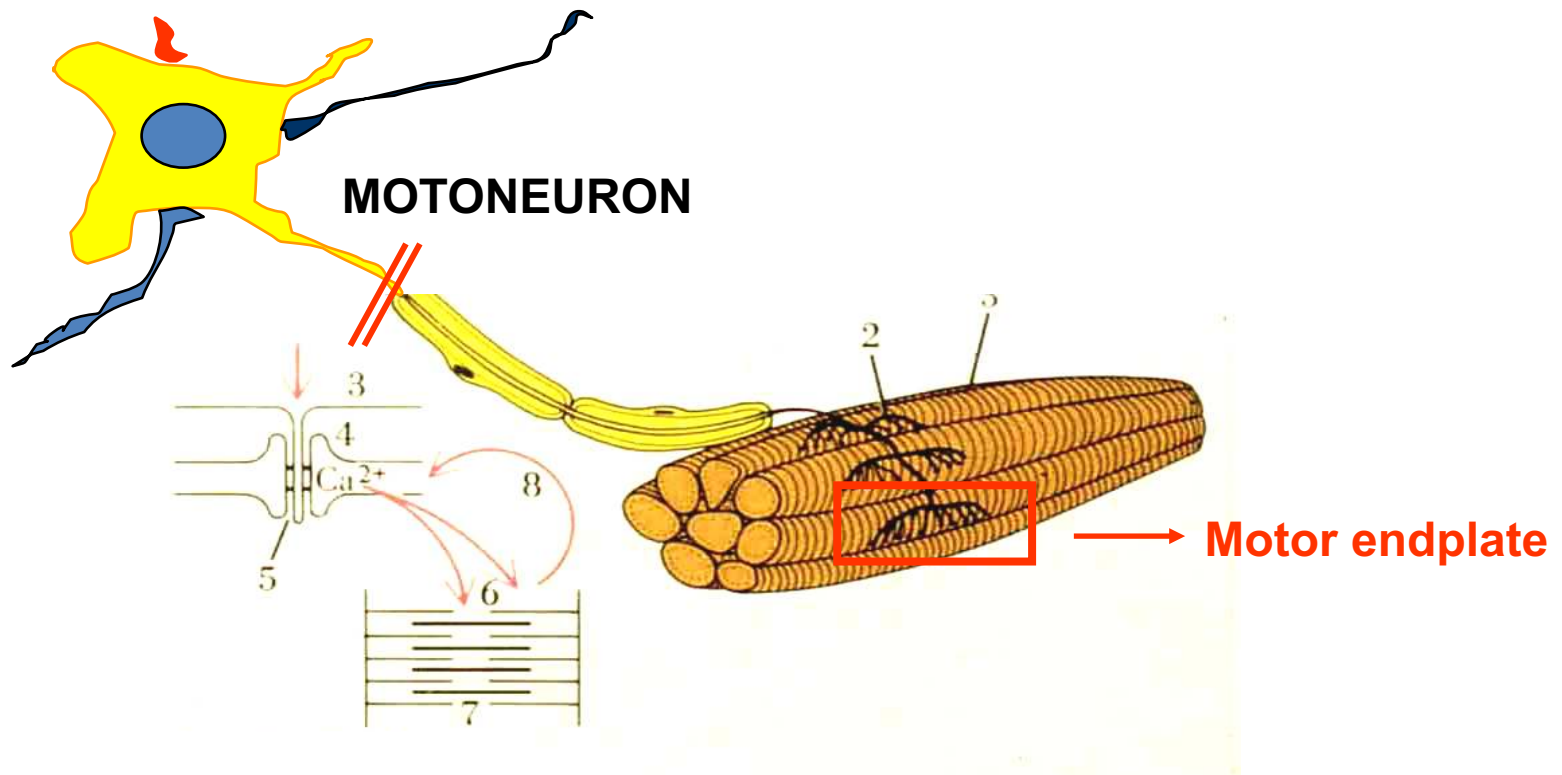
1. CHEMICAL SYNAPSE
2. ELECTRICAL SYNAPSE

EFFECTORS

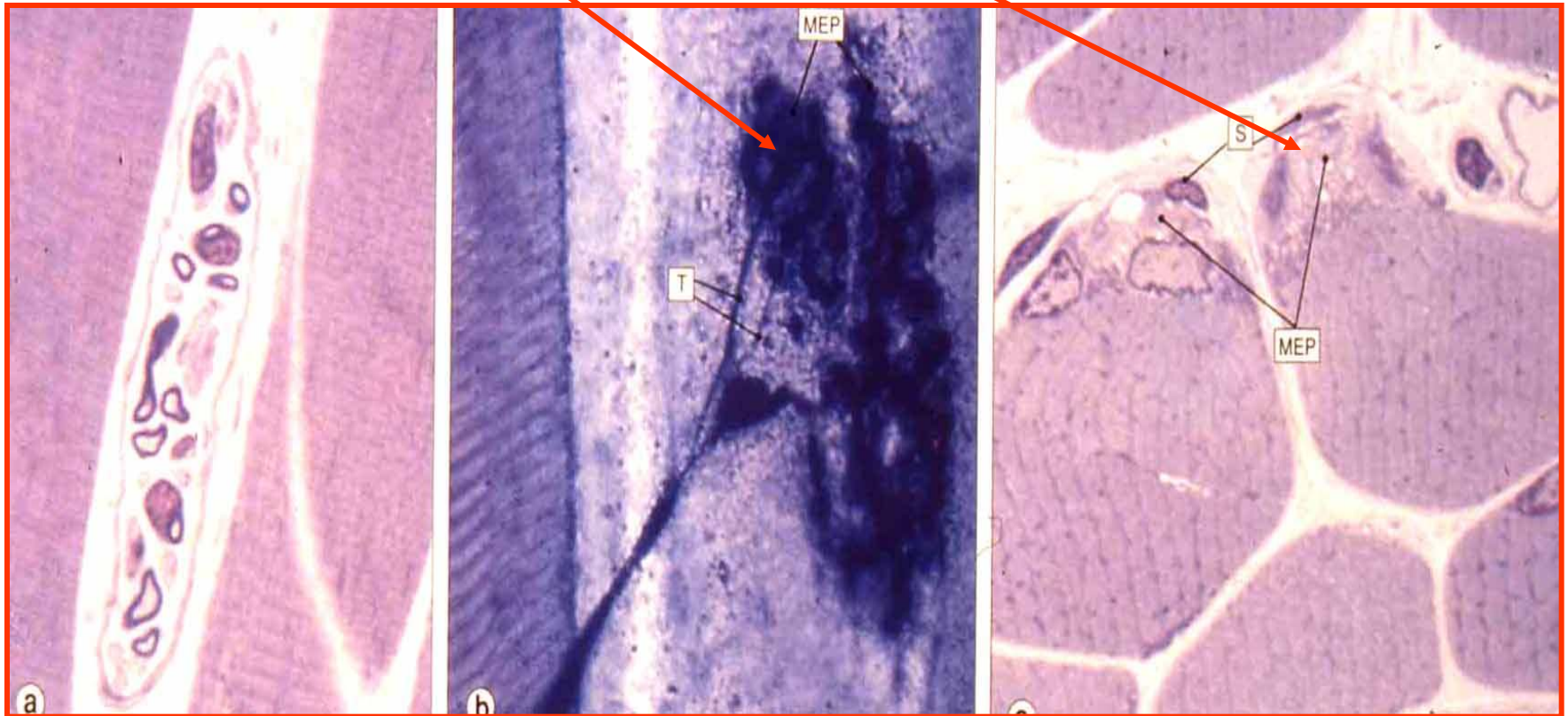
I. MOTOR ENDPLATE

II. AUTONOMIC FIBER PLEXUS

Basics of Neurobiology: Nerve endings

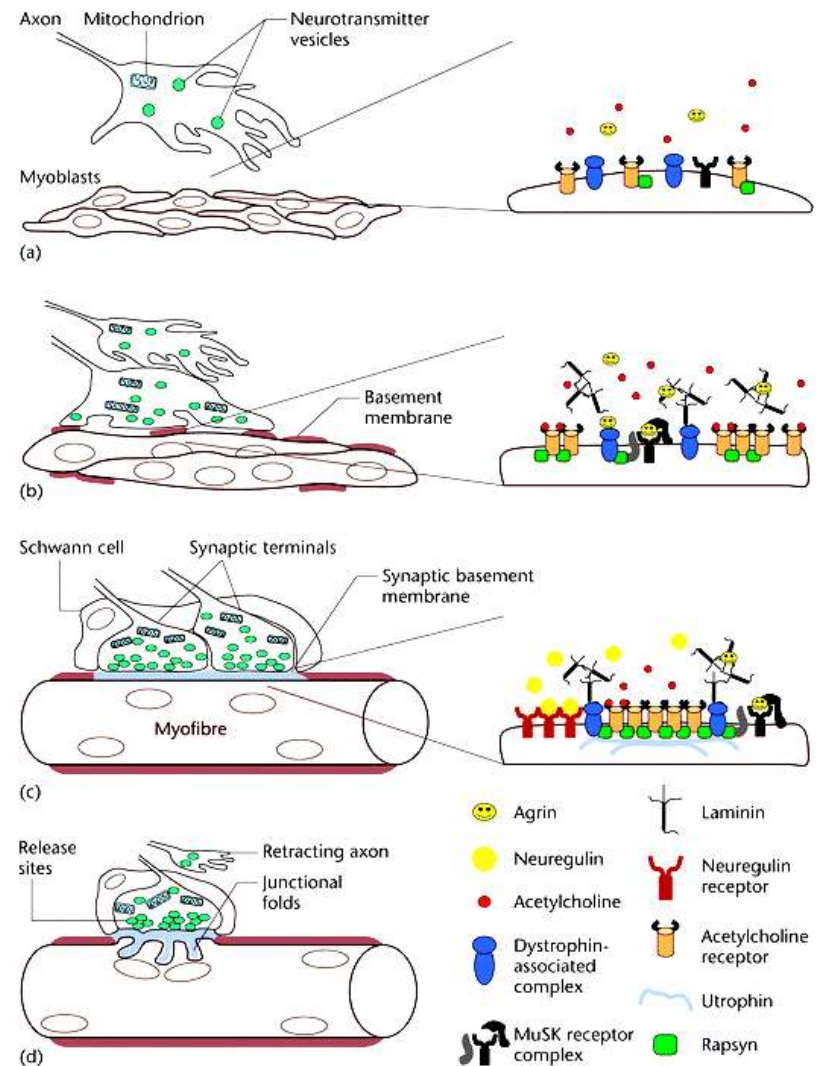


MOTOR ENDPLATE



Basics of Neurobiology: Nerve endings

Development of the motor endplate



Basics of Neurobiology: Nerve endings

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 SARCOLEMMMA, THE MEMBRANE OF THE MUSCLE FIBER

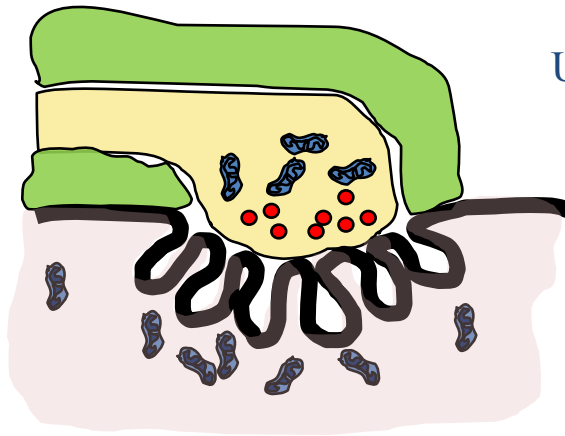
THE AXON TERMINAL CONTAINS SYNAPTIC VESICLES FILLED WITH THE NEUROTRANSMITTER ACETYLCHOLINE

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

Basics of Neurobiology: Nerve endings

MOTOR ENDPLATE

ULTRASTRUCTURAL SCHEME OF THE MOTOR END PLATE



SCHWANN CELL

MOTONEURON AXON TERMINAL

SYNAPTIC VESICLE

SARCOLEMMA

MITOCHONDRION

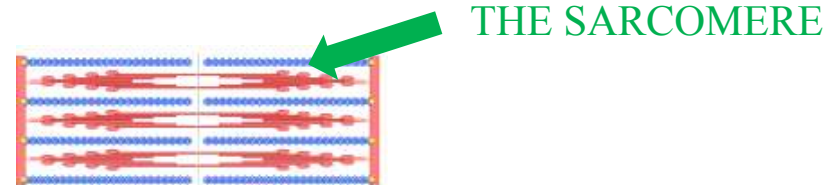
THE MECHANISM OF ACTIVATION OF THE NERVE TERMINAL

FEATURES OF ACETYLCHOLINE RELEASE AND ITS BINDING TO RECEPTORS

INACTIVATION OF THE TRANSMITTER

POSTSYNAPTIC EVENTS

THE CONTRACTION OF THE SARCOMERES



THE SMALLEST FUNCTIONAL UNIT OF A MYOFIBRIL

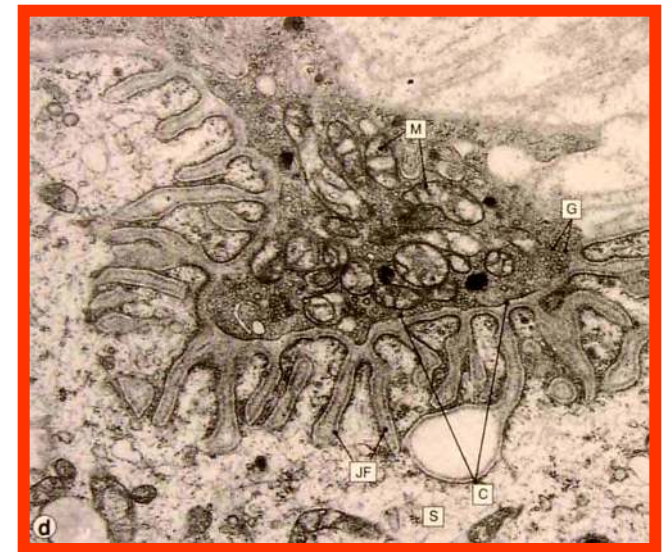
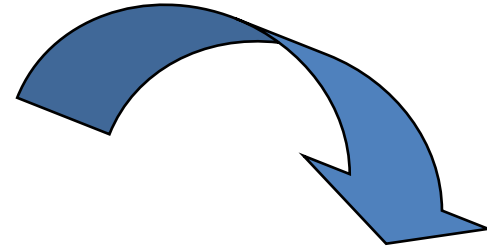
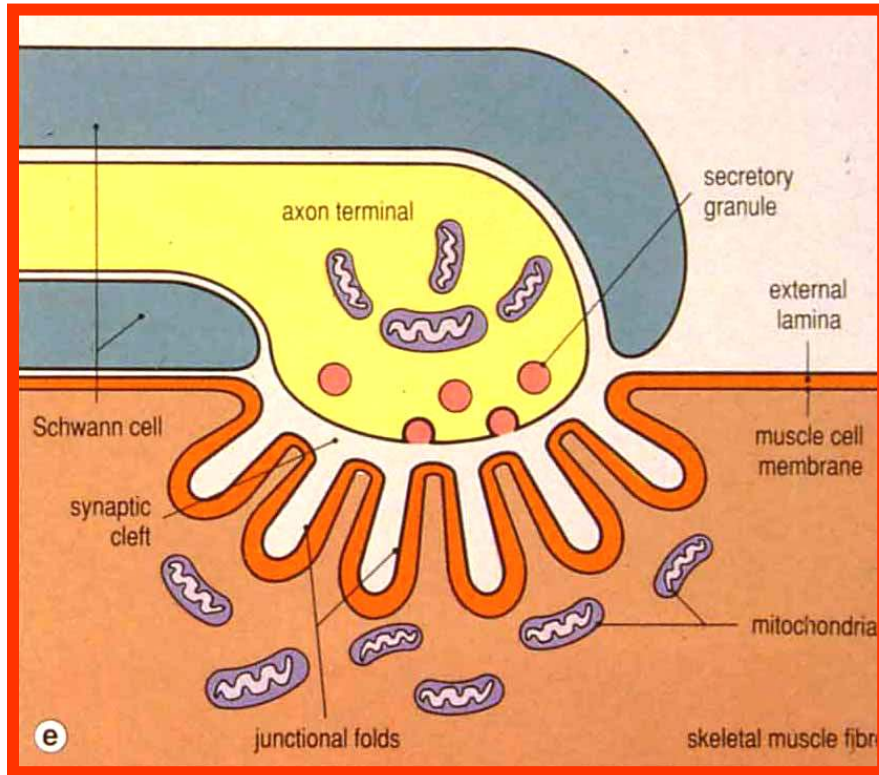
Basics of Neurobiology: Nerve endings

CELLULAR DETAILS OF THE MUSCLE INNERVATION

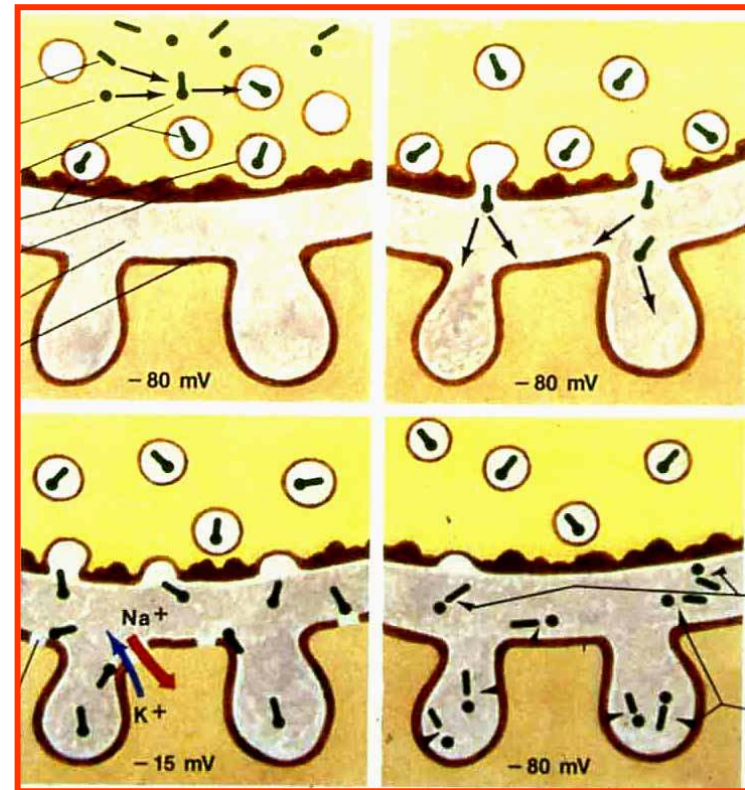
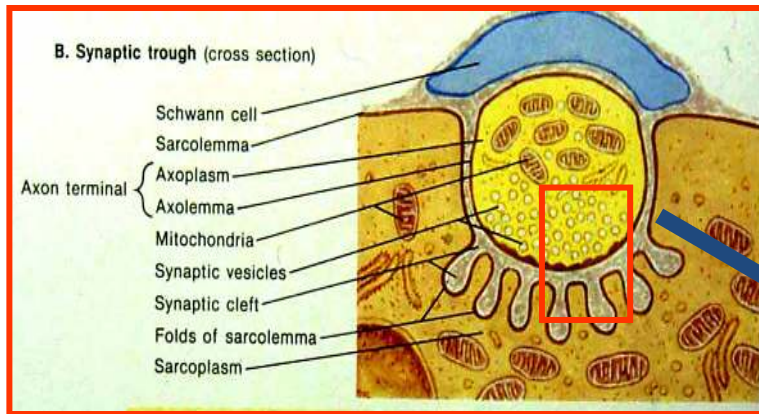


THE SILVER IMPREGNATED AXONS APPEAR IN BLACK. THEY SHOW A REMARKABLE TERMINAL ARBORIZATION. THE THIN, INDIVIDUAL AXON TERMINALS SPREAD OVER AND INNERVATE STRIATED MUSCLE FIBERS SHOWN IN ORANGE. THE NERVES CAN TRANSMIT SENSORY INFORMATION TO THE CNS AND ALSO CONVEY MOTOR COMMANDS FROM THE CNS TO THE MUSCLE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

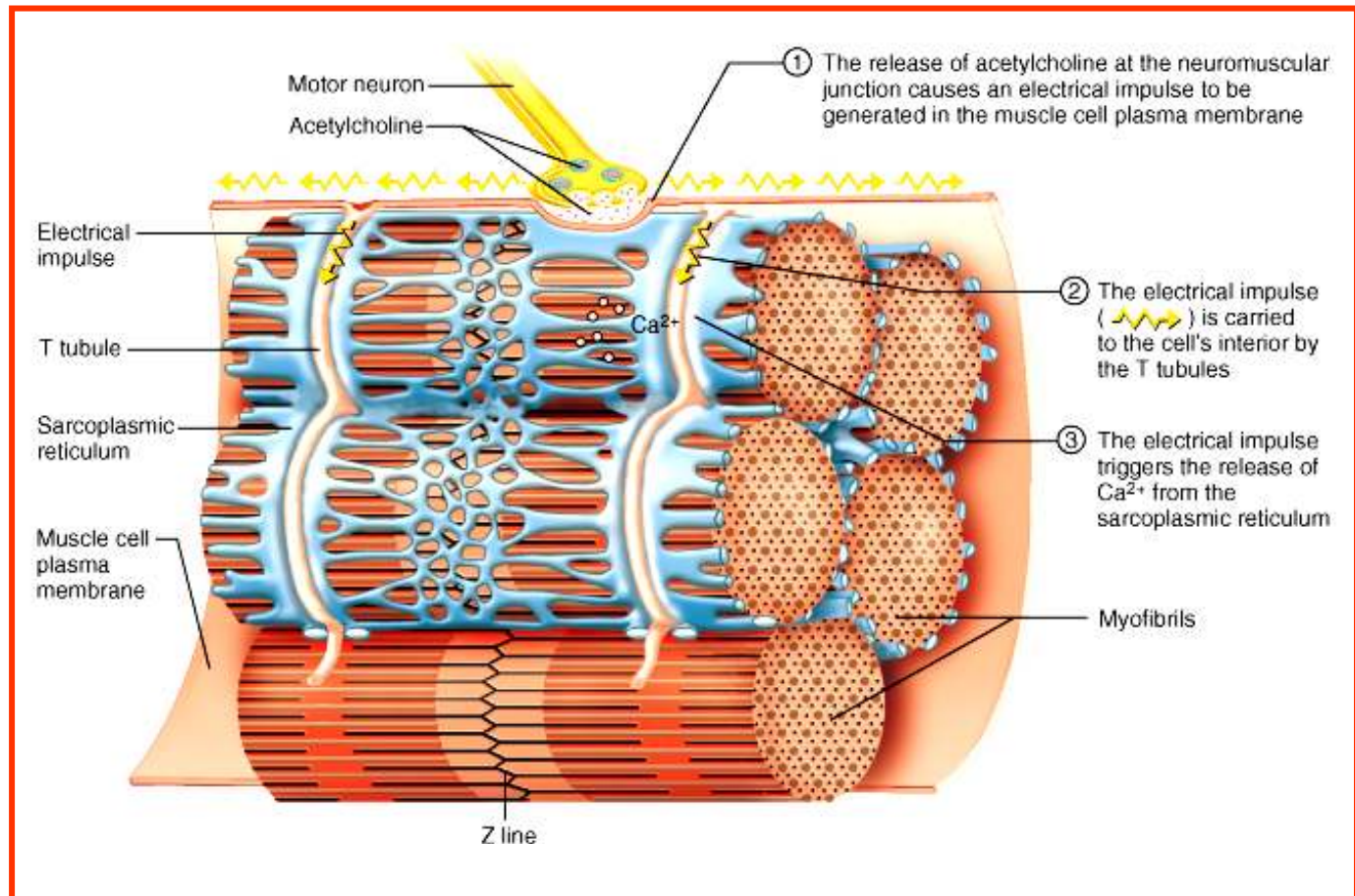
Basics of Neurobiology: Nerve endings



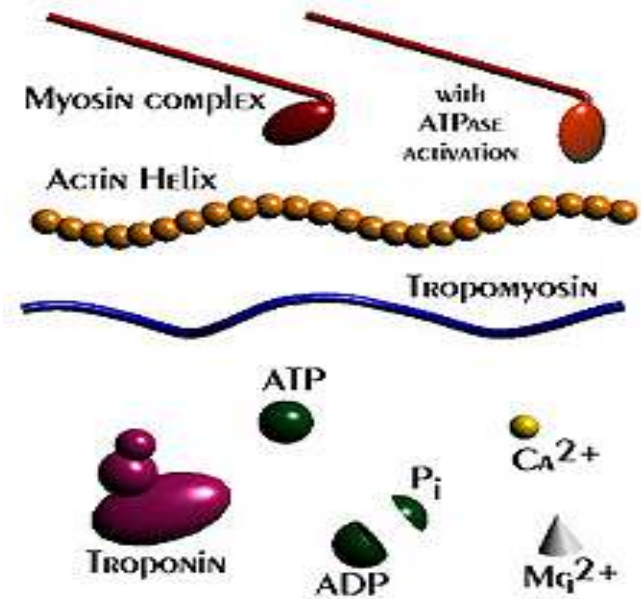
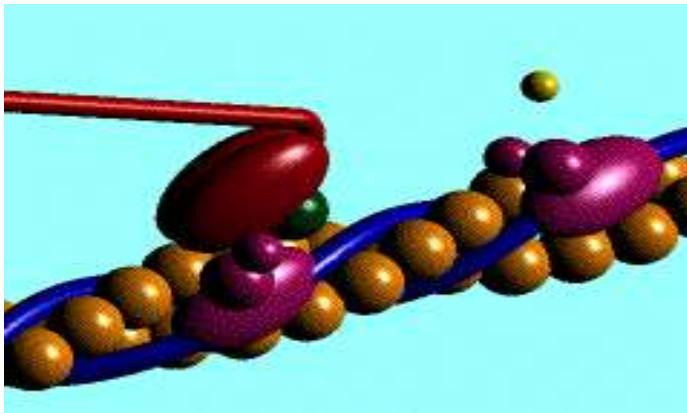
Acetylcholine neurotransmission



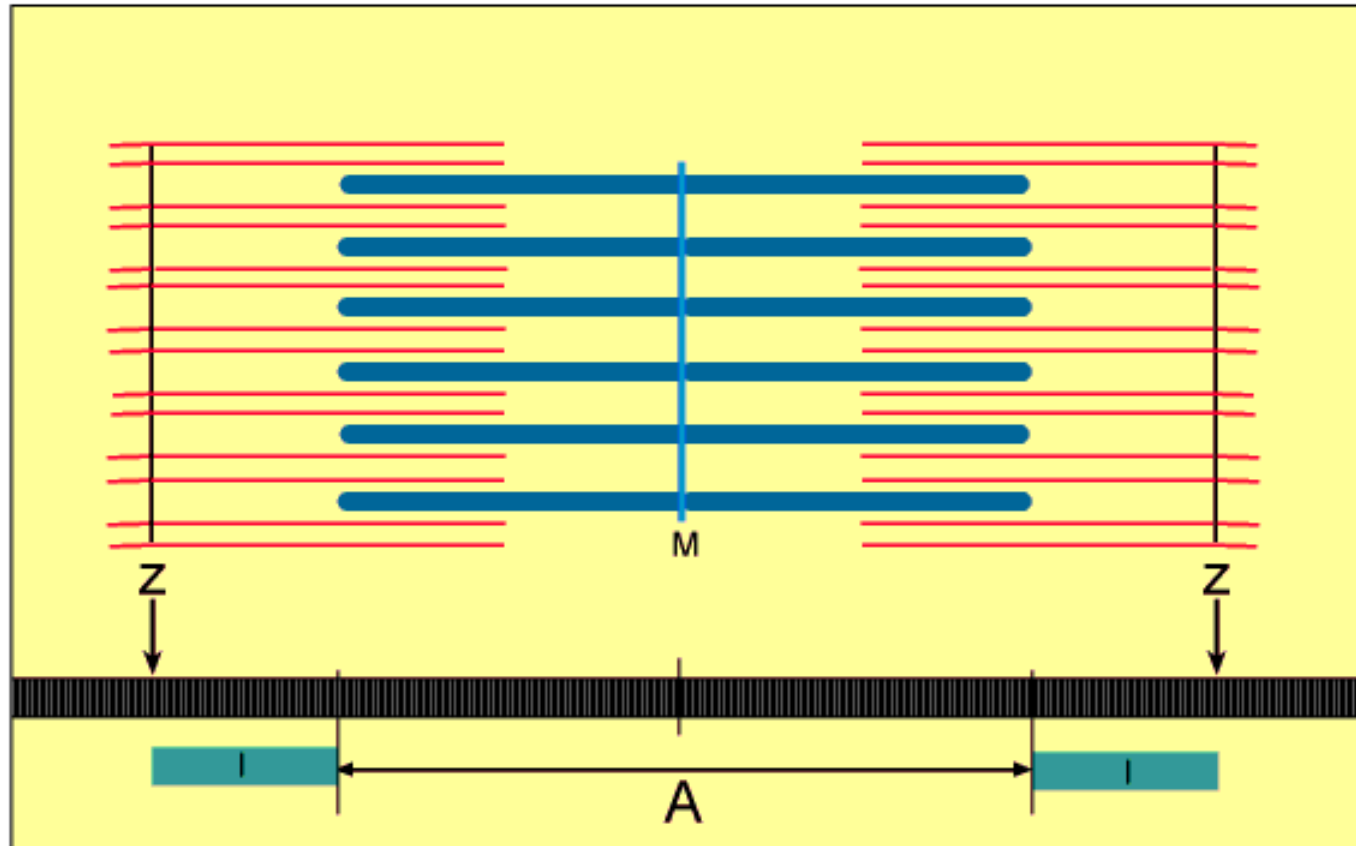
Basics of Neurobiology: Nerve endings



Basics of Neurobiology: Nerve endings



MODEL OF MUSCLE CONTRACTION



Basics of Neurobiology: Nerve endings

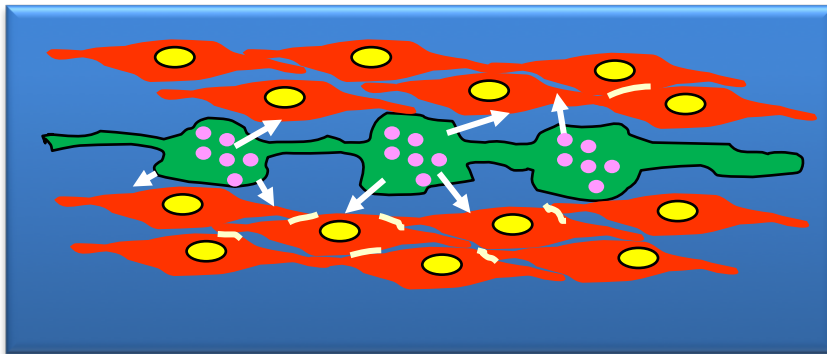
THE AUTONOMIC PLEXUS

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



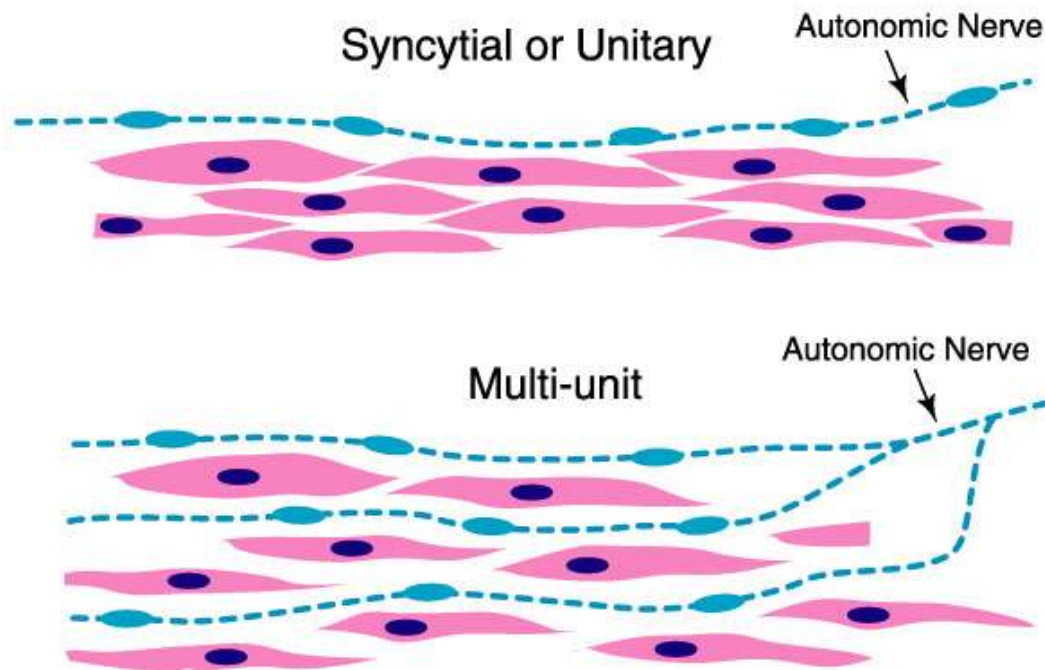
INNERVATION OF SMOOTH MUSCLE CELLS BY AN AUTONOMIC NERVE FIBER. SMOOTH MUSCLE CELLS ARE COUPLED BY GAP JUNCTION, ARROWS INDICATE THE OUTFLOW OF THE TRANSMITTER.

BEADED AXON

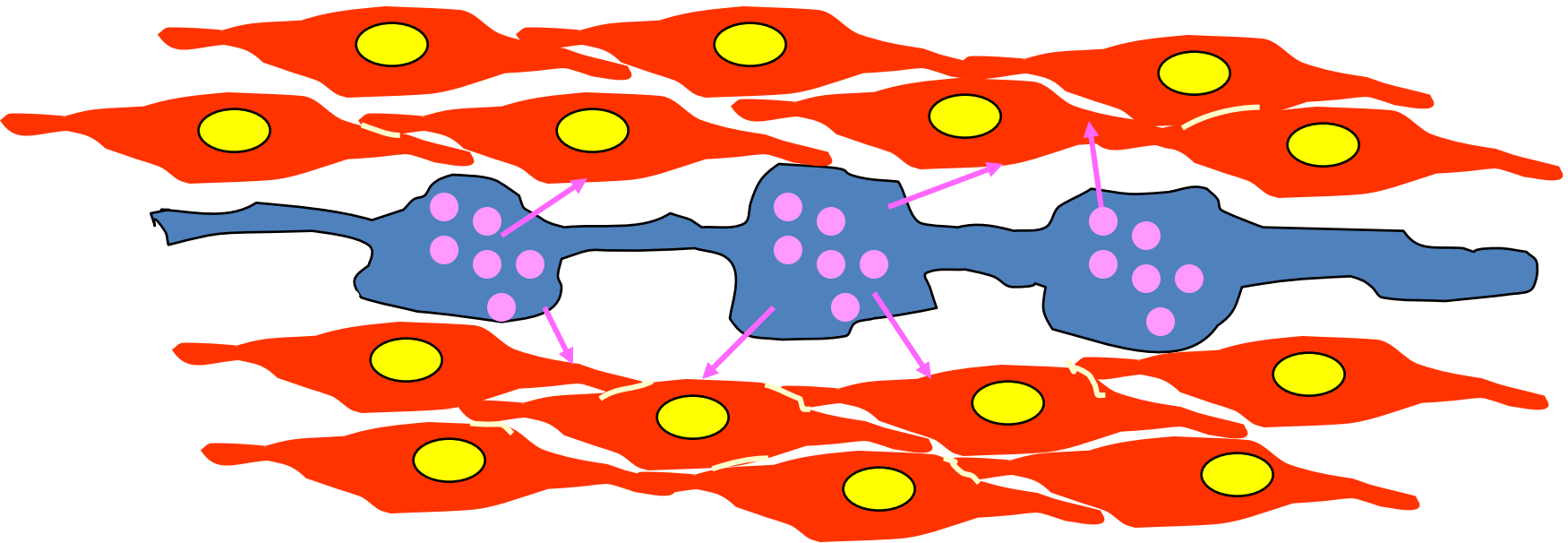
TRANSMITTER-CONTAINING VESICLES

SMOOTH MUSCLE CELLS

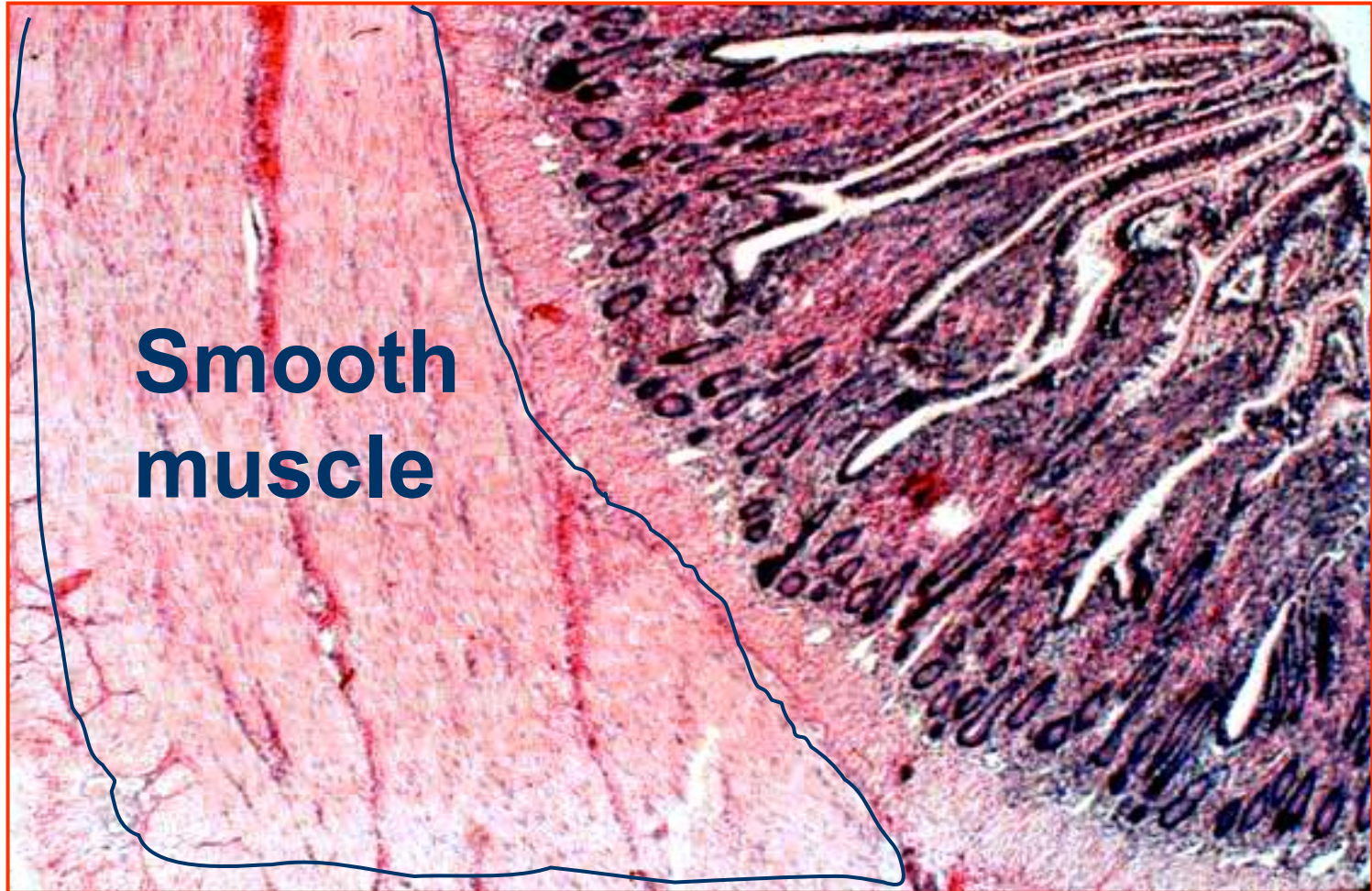
Smooth Muscle Cell Types



Non-synaptic transmitter release



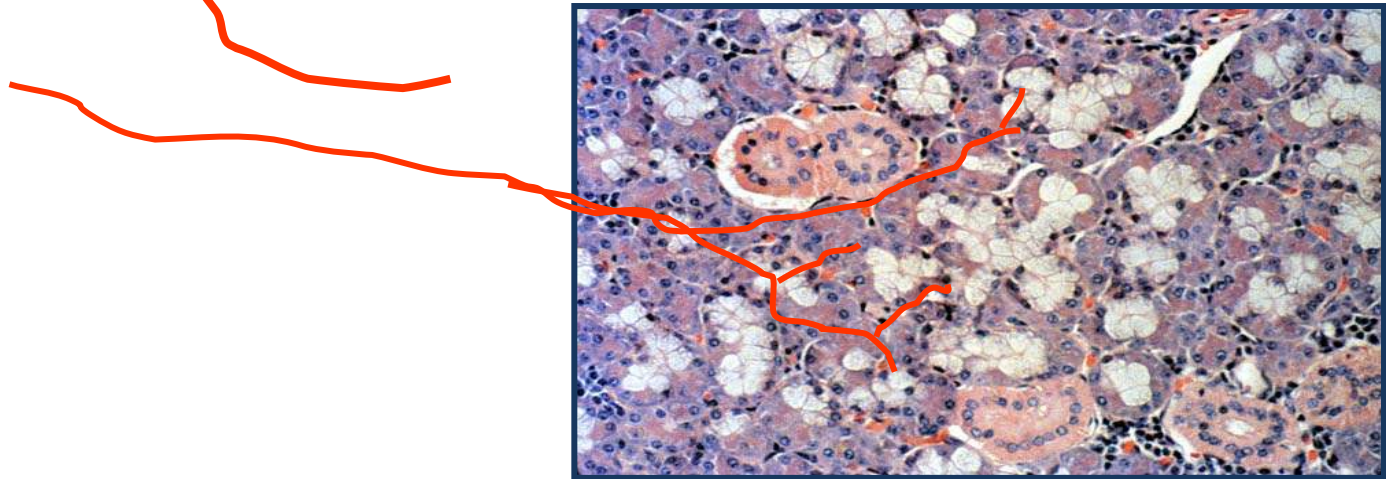
Basics of Neurobiology: Nerve endings



Basics of Neurobiology: Nerve endings



Salivary gland
Innervation



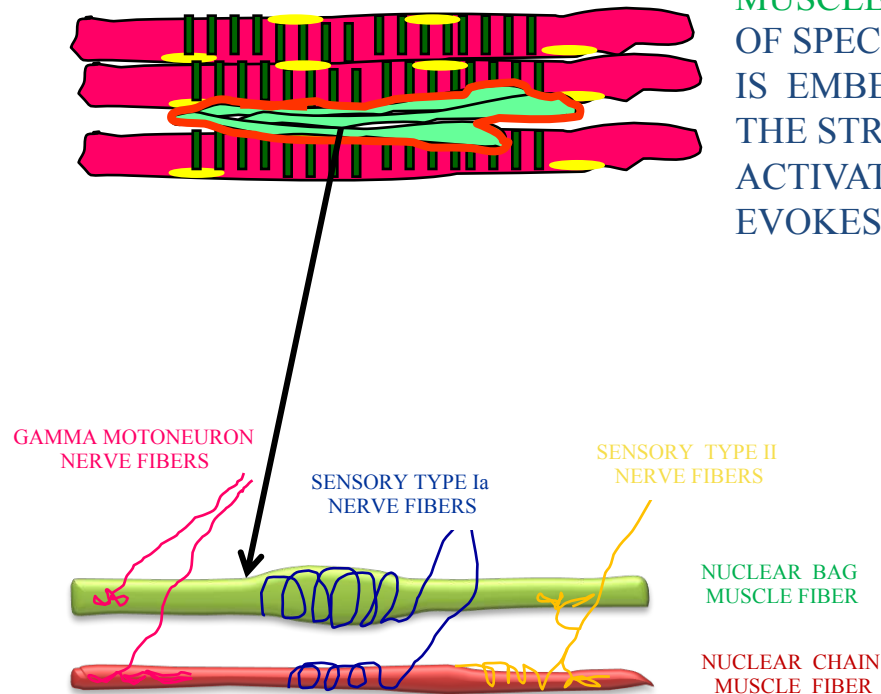
RECEPTORS

Basics of Neurobiology: Nerve endings

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

The stretch reflex

Basics of Neurobiology: Nerve endings

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

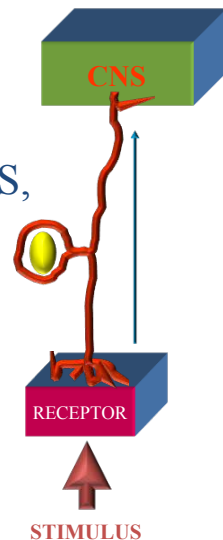
THEY ARE SENSORY RECEPTORS THAT RESPOND TO PRESSURE AND DISTORTION. MECHANORECEPTORS ARE NUMEROUS IN THE SUPERFICIAL AND DEEP LAYERS OF THE SKIN. THEY ARE EITHER FREE OR ENCAPSULATED NERVE ENDINGS. CHARACTERISTIC MEMBERS INCLUDE: FREE NERVE ENDINGS, MEISSNER'S-, KRAUSE'S-, PACINIAN CORPUSCLES, AND RUFFINI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

FEATURES OF RECEPTOR POTENTIALS

AMPLITUDE

SIGNAL INTENSITY

ADAPTATION



Basics of Neurobiology: Nerve endings

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)

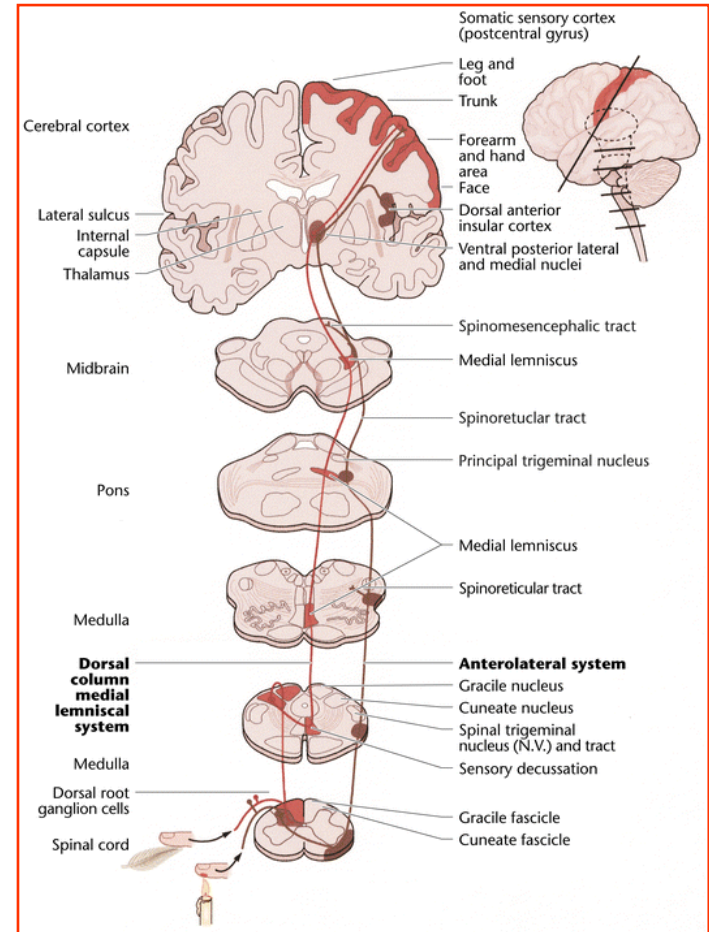
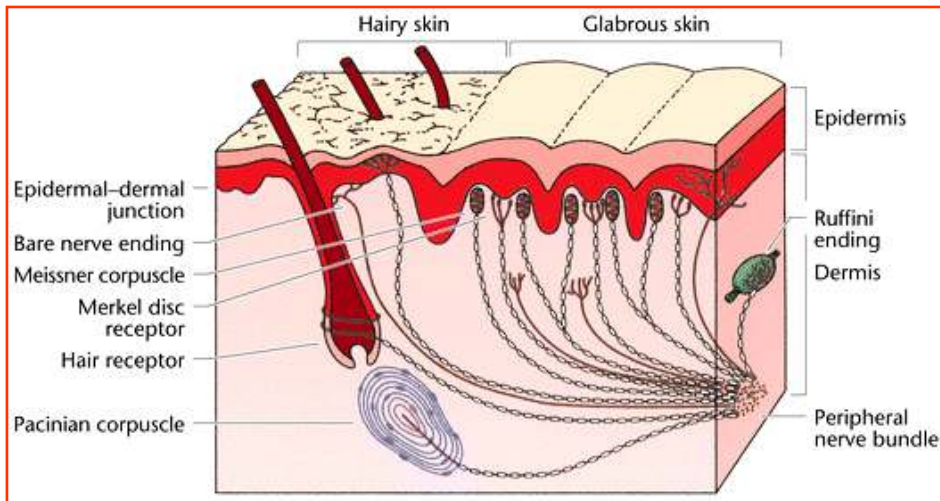
PAIN RECEPTORS

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

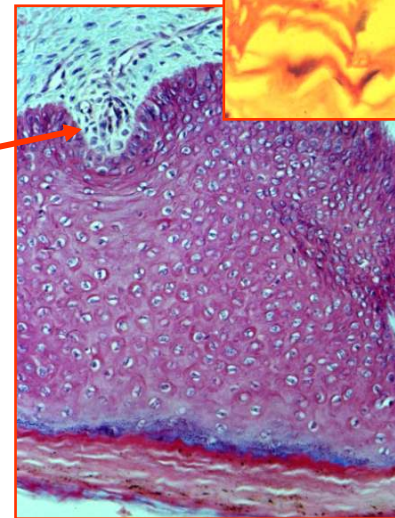
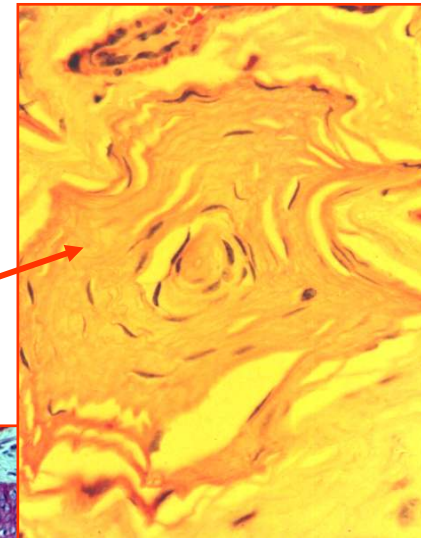
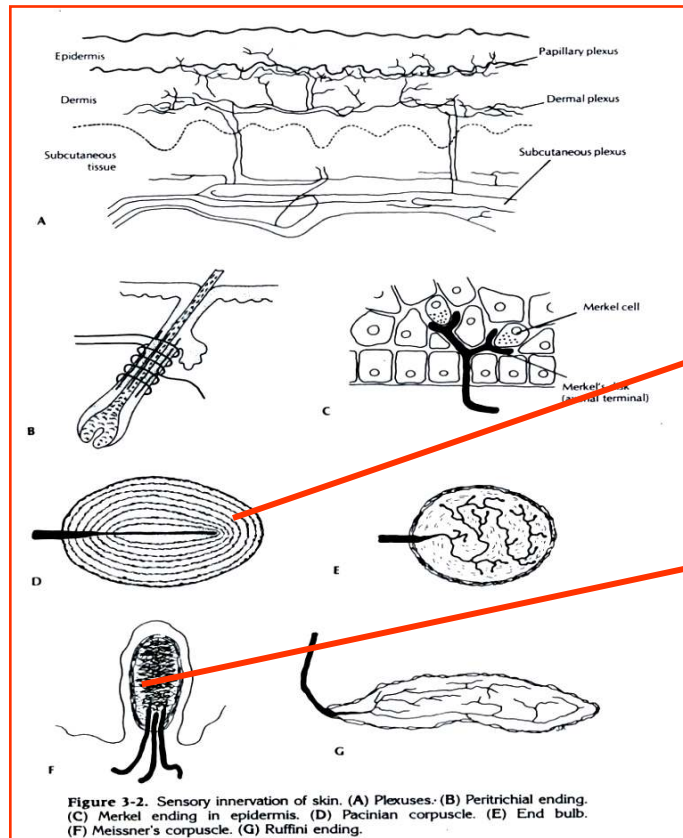
CHEMORECEPTORS

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

Receptors in the skin



Basics of Neurobiology: Nerve endings



Baroreceptors and chemoreceptors

