



KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI

UNIA EUROPEJSKA
EUROPEJSKI
FUNDUSZ SPOŁECZNY



BIOPHYSICS

**Prezentacja multimedialna współfinansowana przez
Unię Europejską w ramach
Europejskiego Funduszu Społecznego w projekcie pt.
*„Innowacyjna dydaktyka bez ograniczeń - zintegrowany
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Politechnika Łódzka

Politechnika Łódzka, ul. Żeromskiego 116, 90-924 Łódź, tel. (042) 631 28 83
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Lecture 6

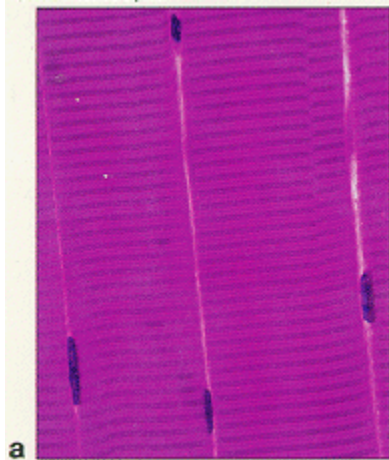
MUSCULAR TISSUE (6)

Bogdan Walkowiak

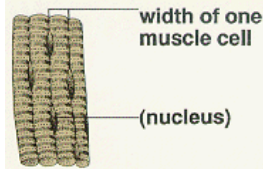
*Department of Biophysics
Institute of Materials Science and Engineering
Technical University of Lodz*



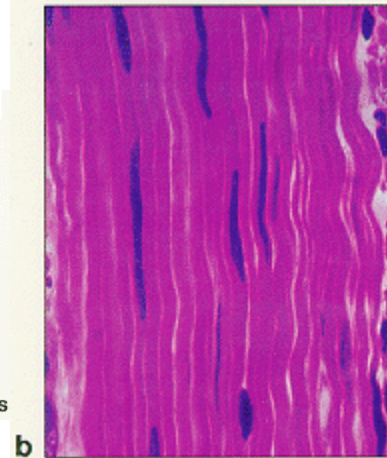
Three Types of Muscles



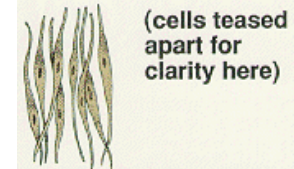
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TYPE: Skeletal muscle
DESCRIPTION: Long, striated cells with multiple nuclei
COMMON LOCATIONS: In skeletal muscles
FUNCTION: Contraction for voluntary movements

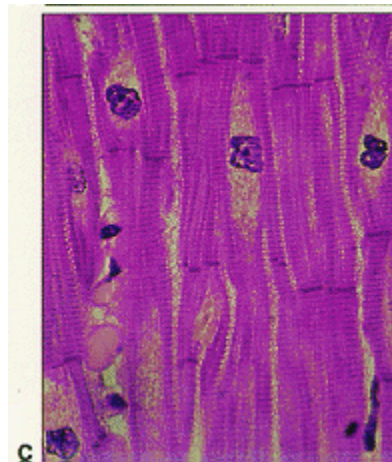


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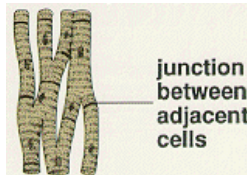


(cells teased apart for clarity here)

TYPE: Smooth muscle
DESCRIPTION: Long, spindle-shaped cells, each with a single nucleus
COMMON LOCATIONS: In hollow organs (e.g., stomach)
FUNCTION: Propulsion of substances along internal passageways



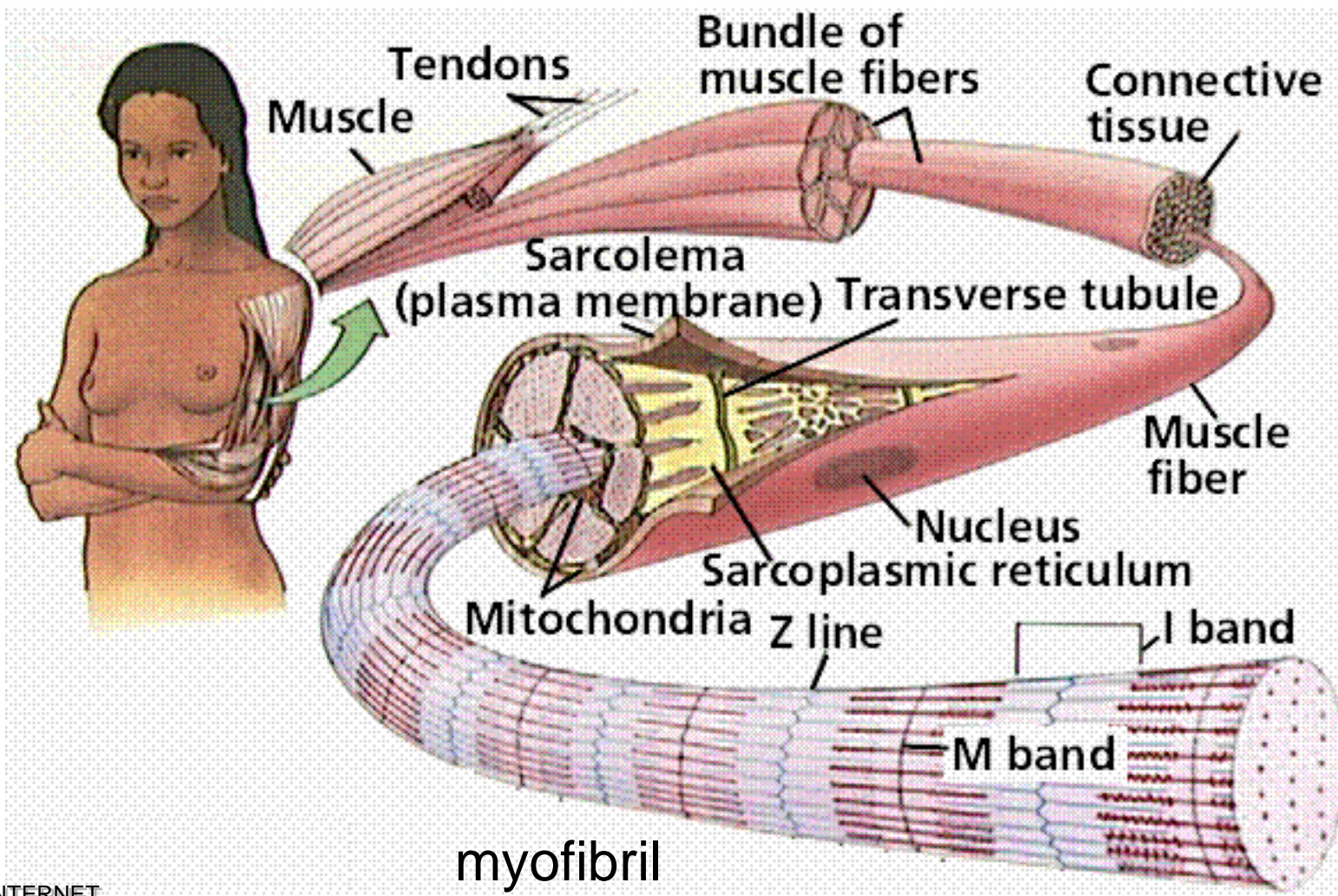
©1992 Wadsworth, Inc.



TYPE: Cardiac muscle
DESCRIPTION: Branching, striated cells fused at plasma membranes
COMMON LOCATIONS: Wall of heart
FUNCTION: Pumping of blood in the circulatory system



Tissue of Skeletal Muscles

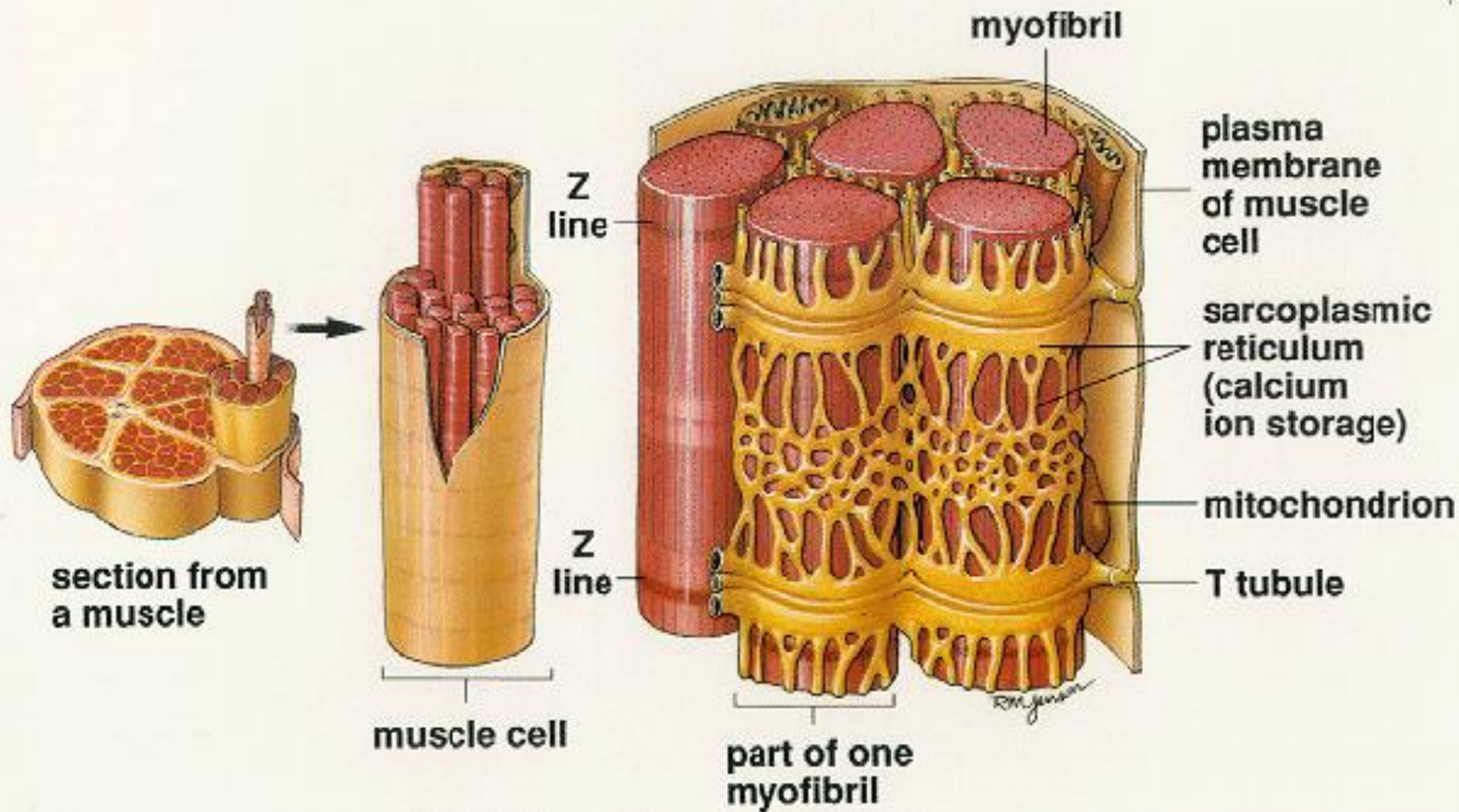


Source: INTERNET





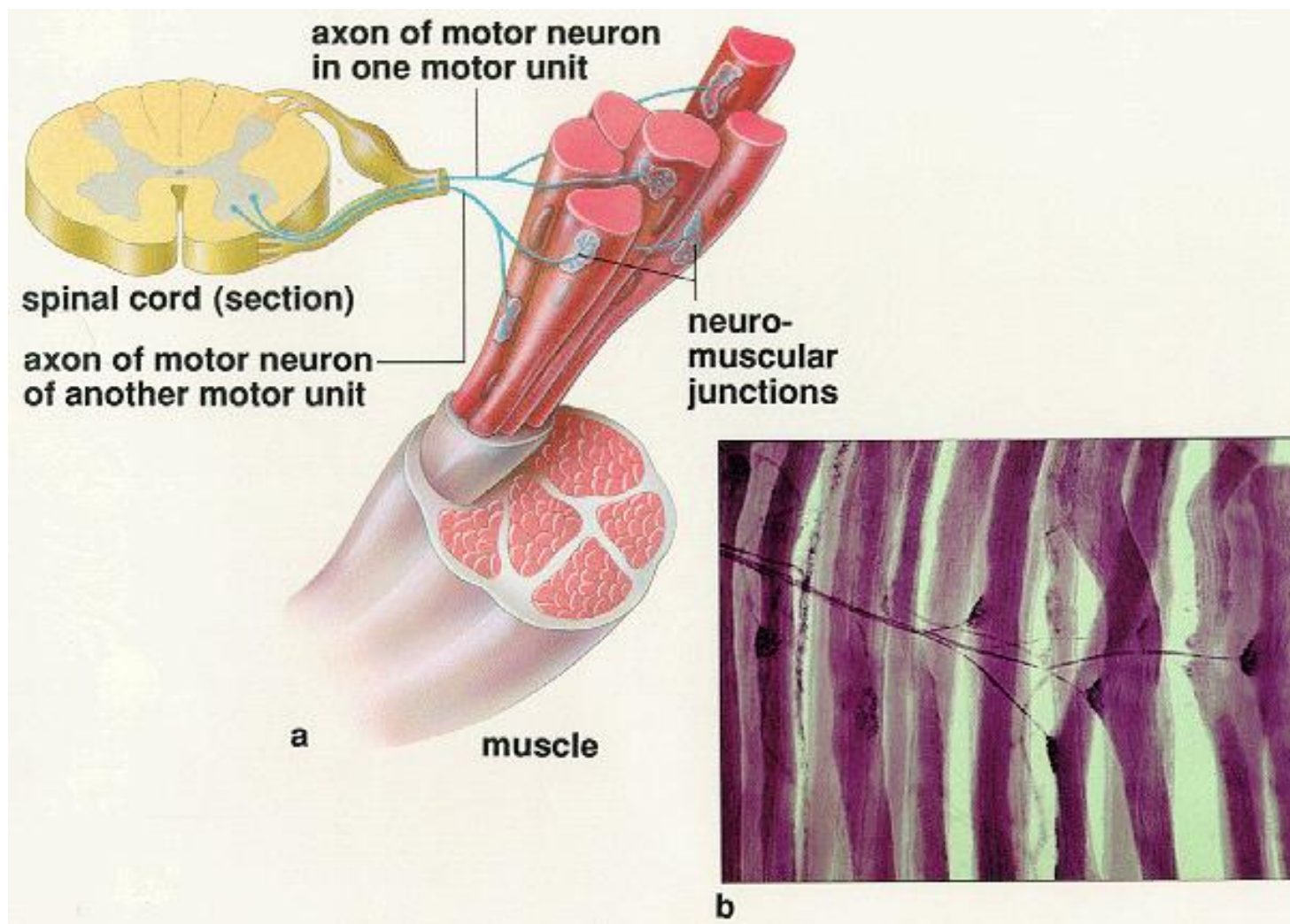
Skeletal Muscles



Source: INTERNET



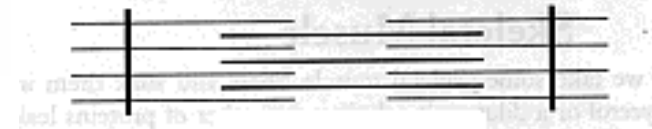
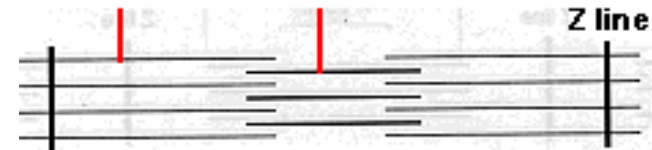
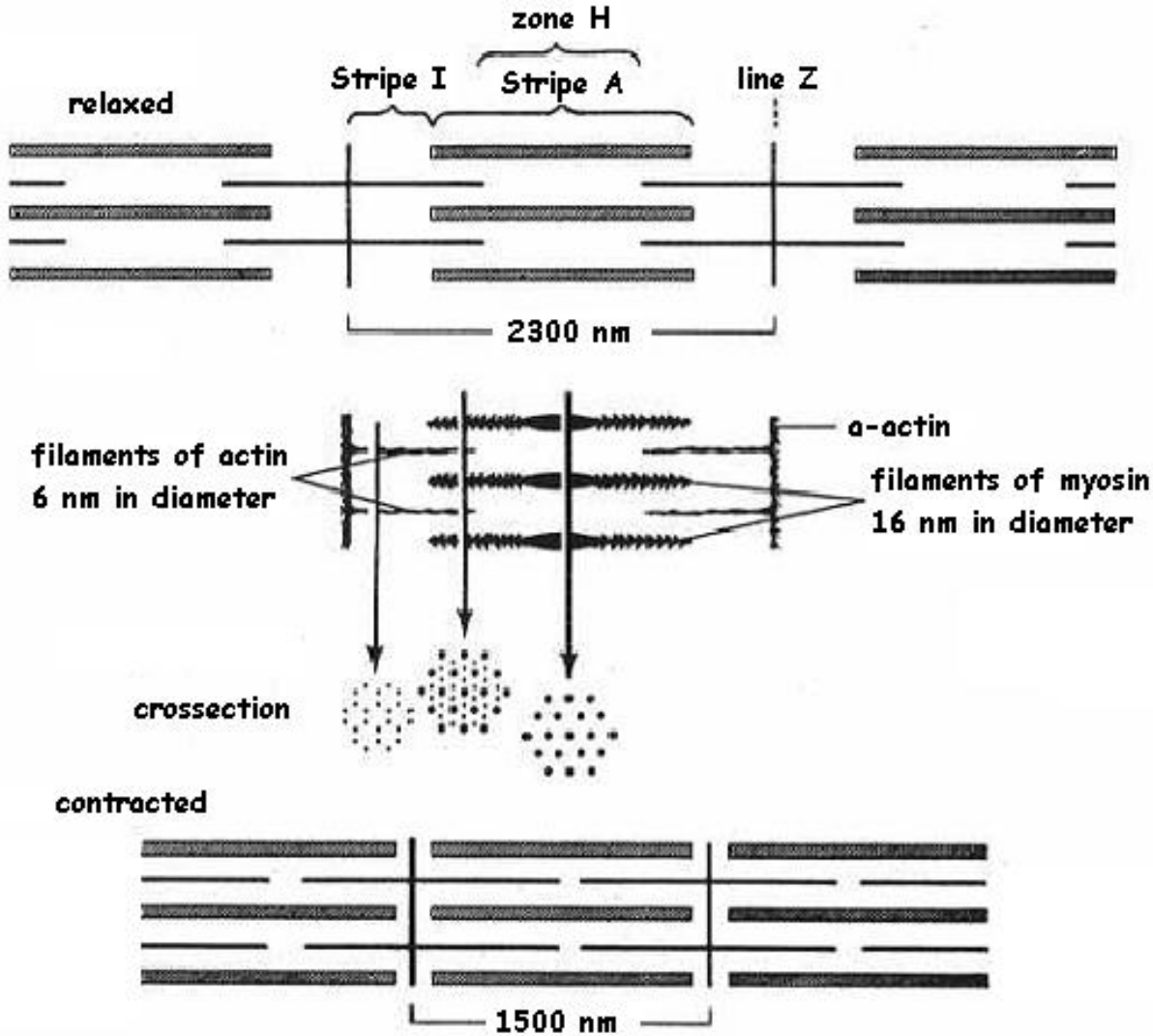
Muscle Activation



Source: INTERNET



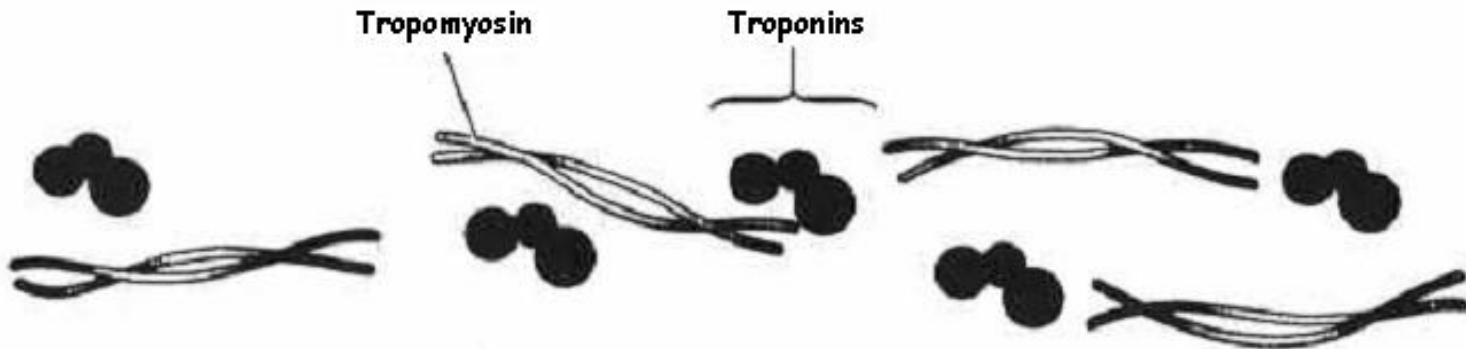
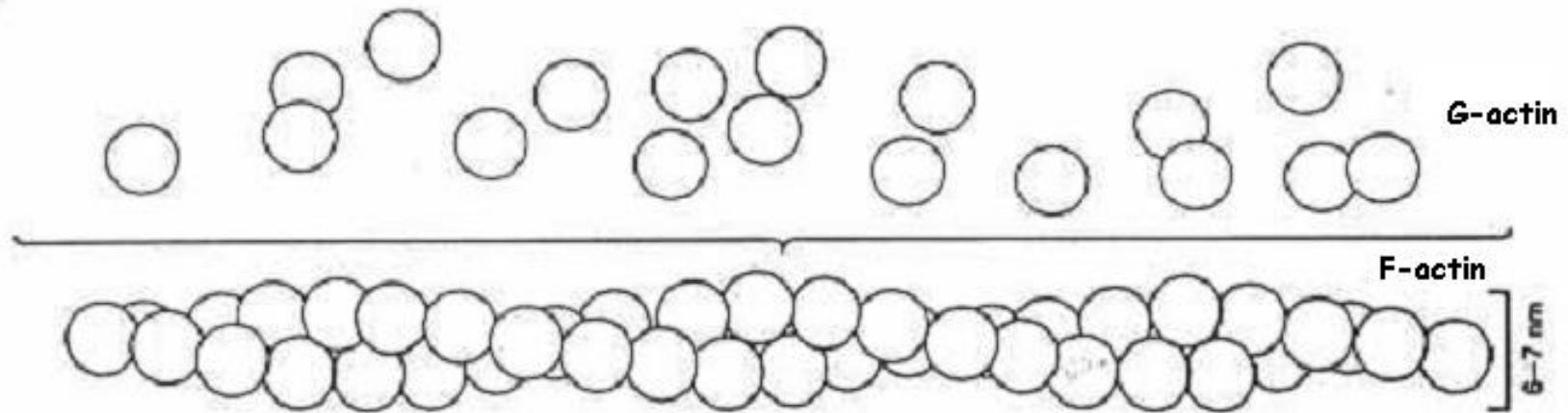
Myofibril Organization



Source: A. Piławski Podstawy Biofizyki



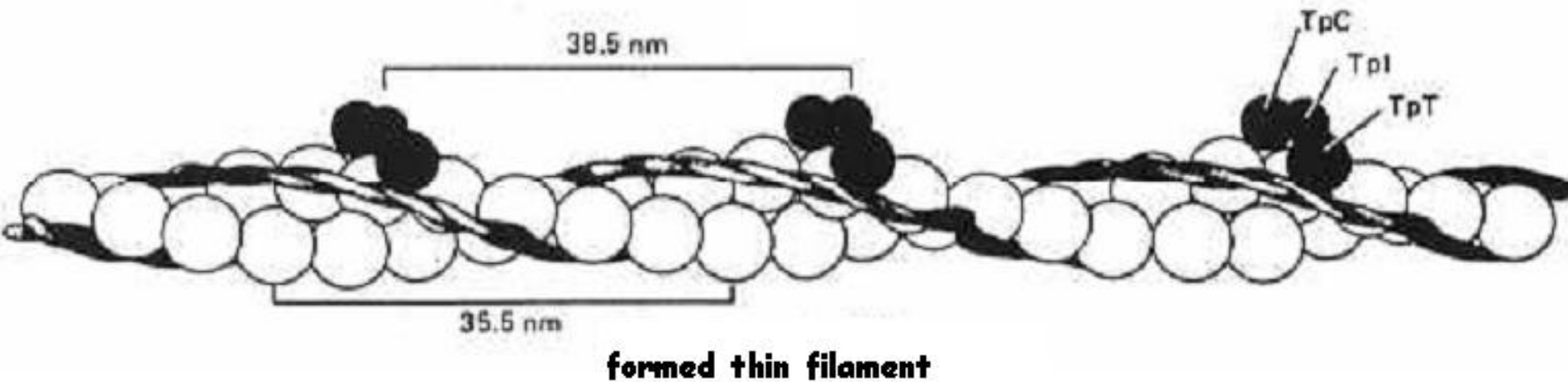
Actin, Tropomyosin and Troponins



Source: A. Piławski Podstawy Biofizyki



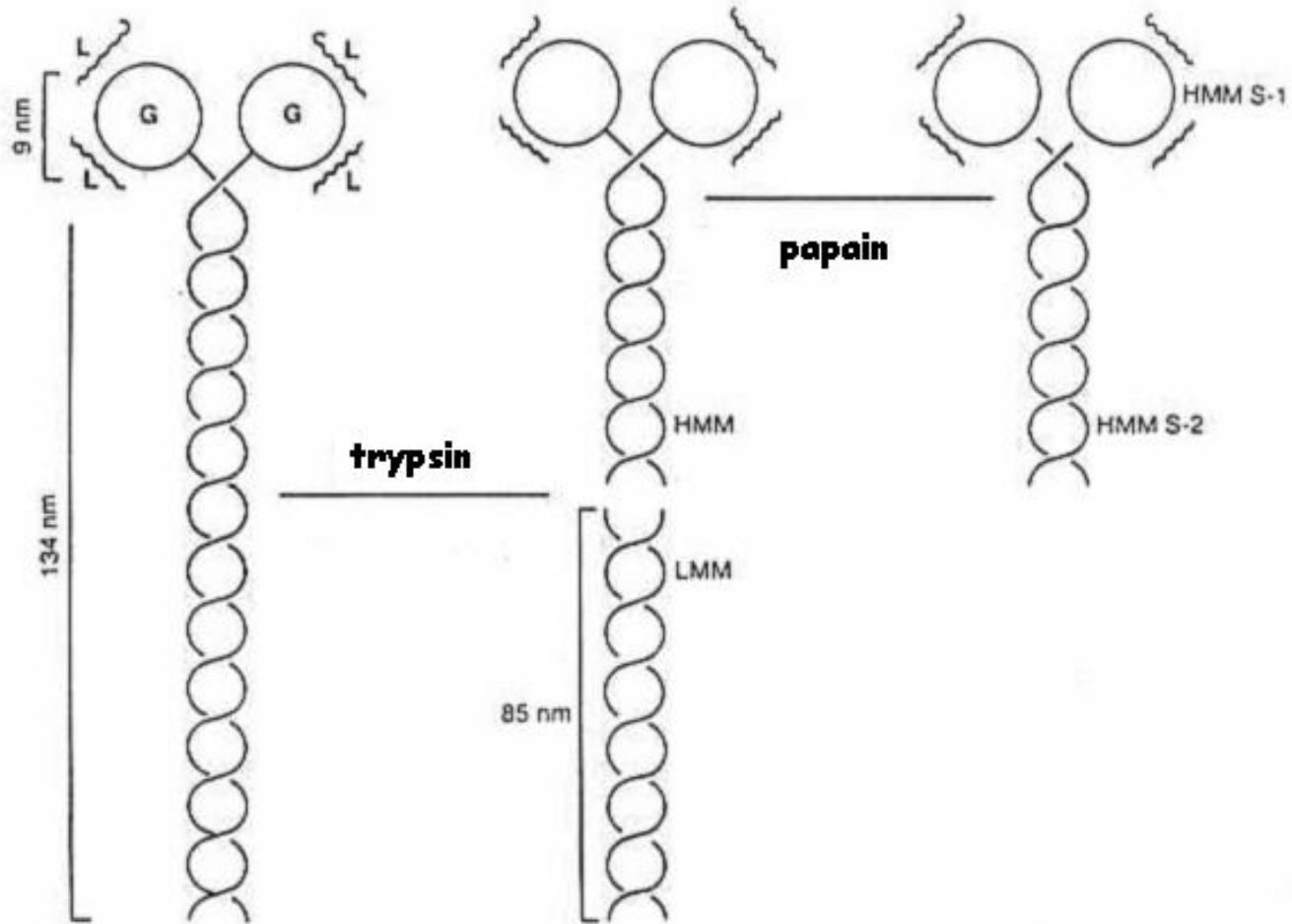
Actin, Tropomyosin and Troponins



Source: A. Piławski Podstawy Biofizyki



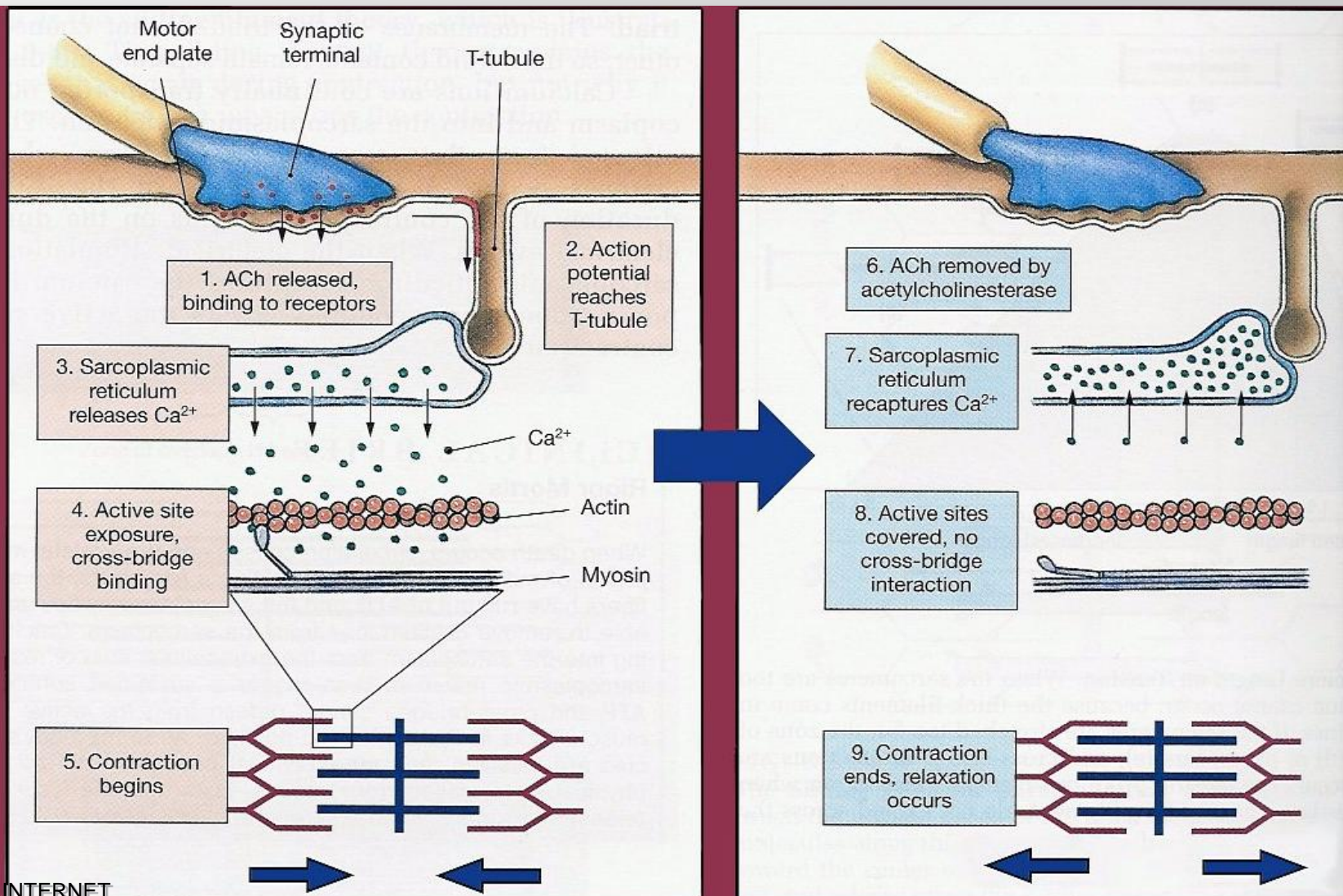
Myosin



Source: A. Piławski Podstawy Biofizyki

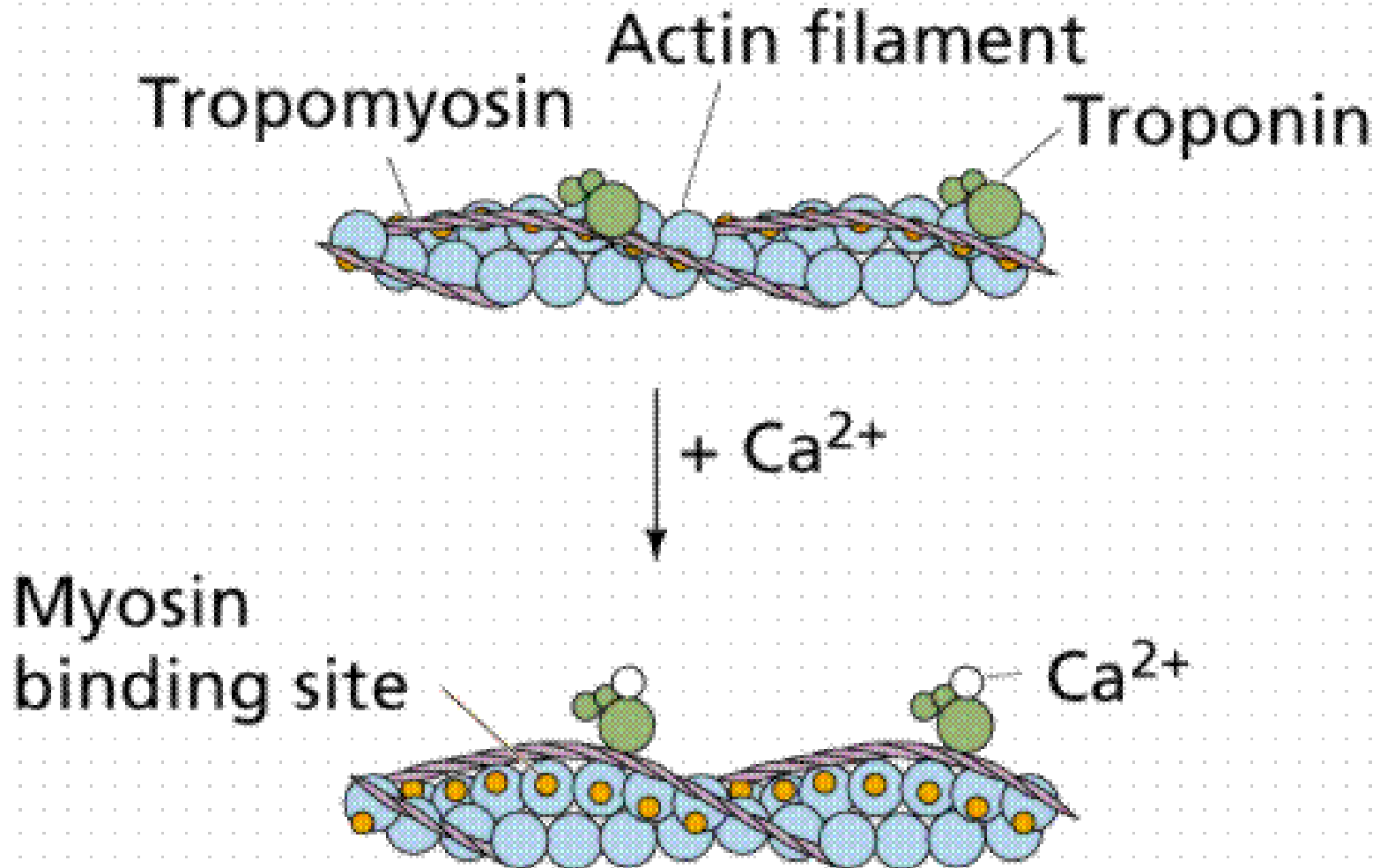


Muscle Activation



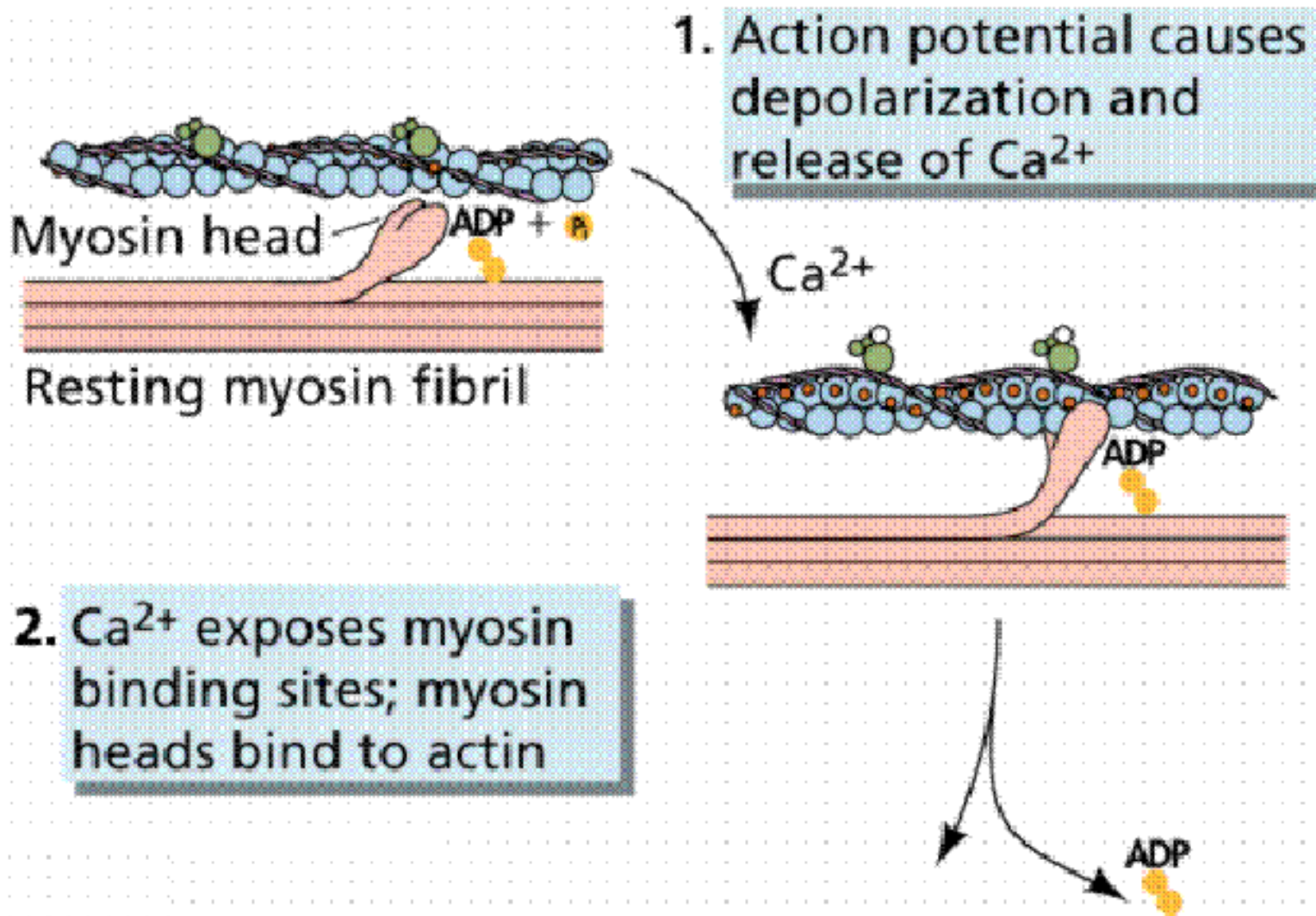
Source: INTERNET

Role of Ca^{2+} in Muscle Contraction



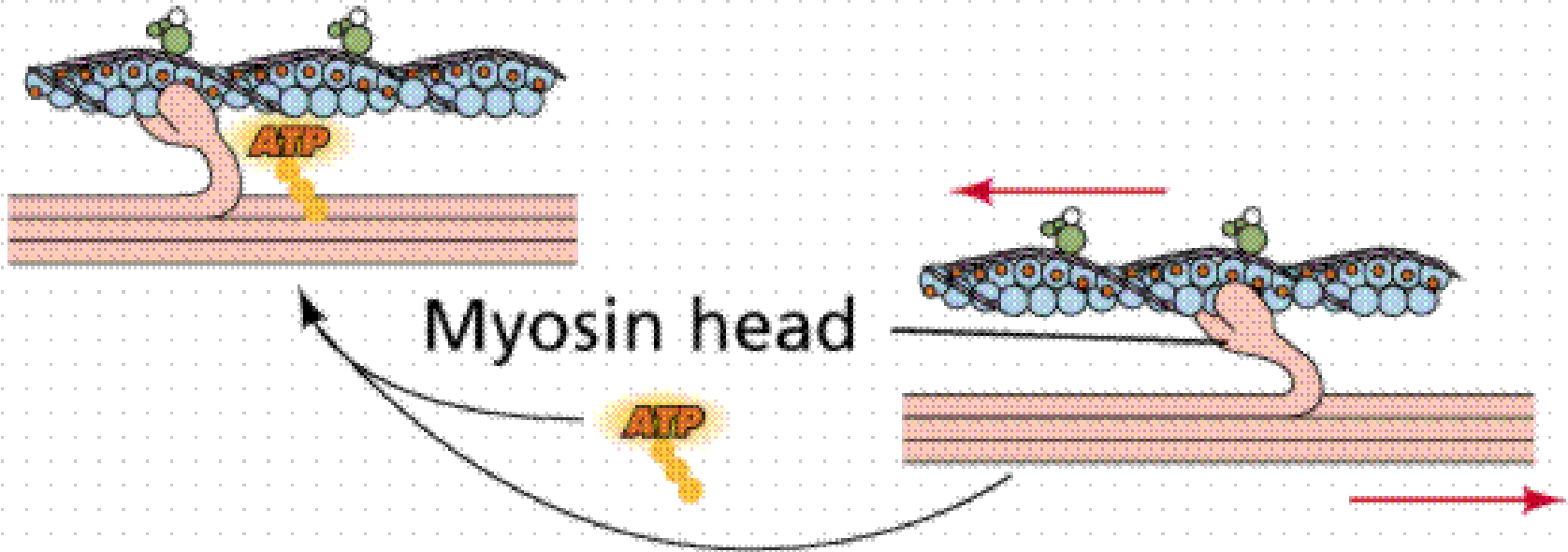
Source: INTERNET

Mechanism of Muscle Contraction



Source: INTERNET

Mechanism of Muscle Contraction



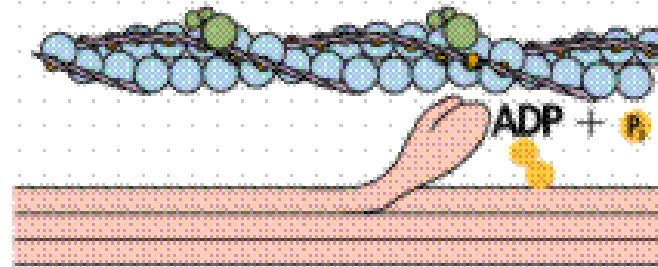
4. ATP binds to myosin, causing it to release actin

3. Power stroke; filaments slide past one another

Source: INTERNET

Mechanism of Muscle Contraction

5. ATP is hydrolyzed and myosin heads return to resting position



6. If Ca^{2+} is returned to sarcoplasmic reticulum, muscle relaxes

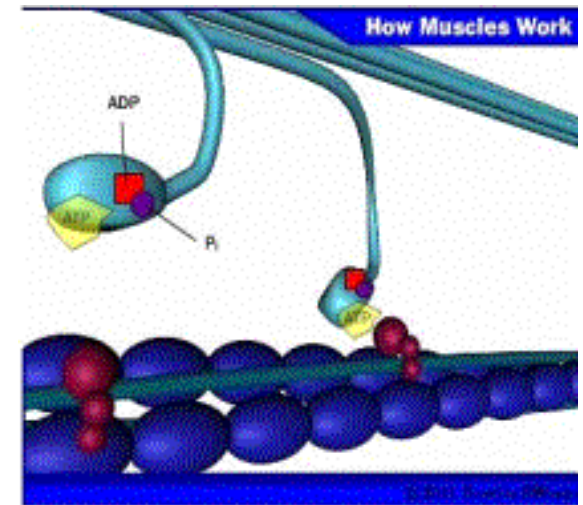
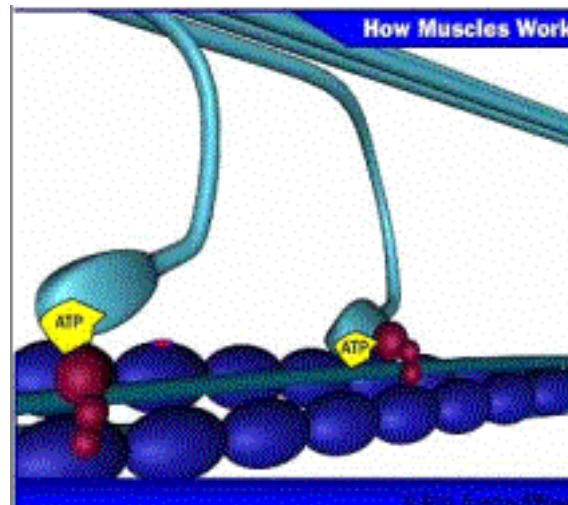
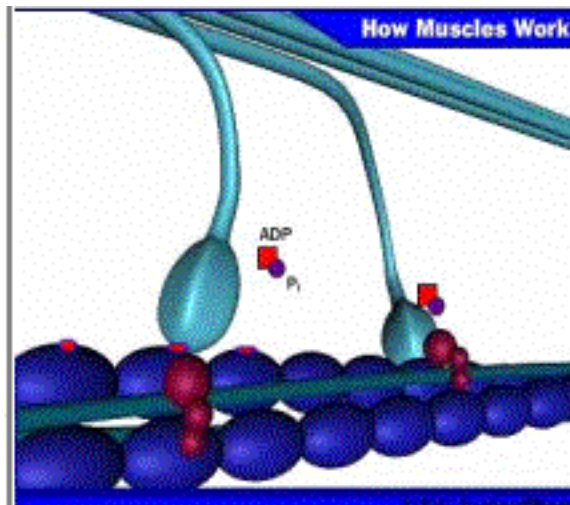
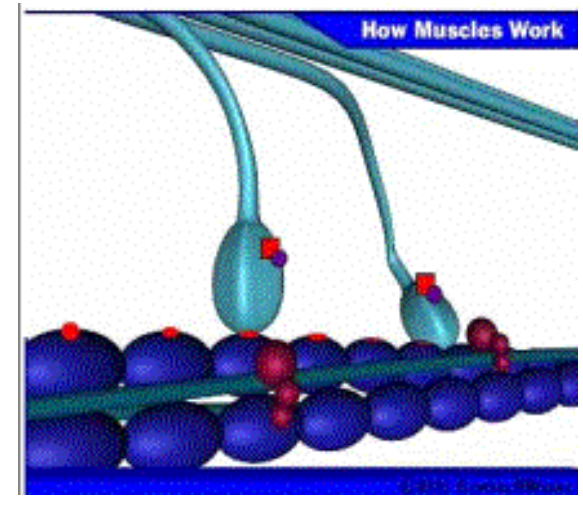
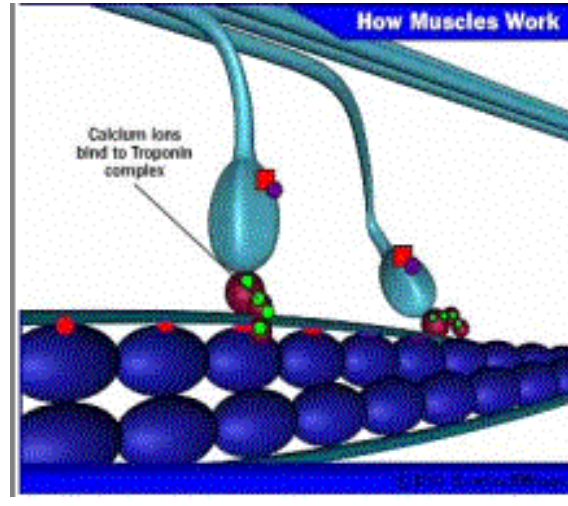
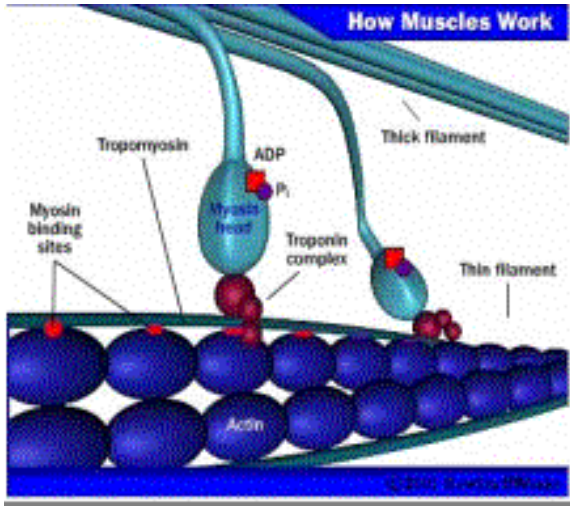


7. If Ca^{2+} remains available, the cycle repeats and muscle contraction continues

Source: INTERNET



Mechanism of Muscle Contraction



Source: INTERNET





Red and White Fibers

Skeletal muscles contain two types of fibers, which differ in the mechanism they use to produce ATP; the amount of each type of fibre varies from muscle to muscle and from person to person.

- Red ("slow-twitch") fibers have more mitochondria, store oxygen in myoglobin, rely on aerobic metabolism, and are associated with endurance; these produce ATP more slowly. Marathoners tend to have more red fibers.
- White ("fast-twitch") fibers have fewer mitochondria, are capable of more powerful (but shorter) contractions, metabolize ATP more quickly, and are more likely to accumulate lactic acid. Weightlifters and Sprinters tend to have more white fibers.



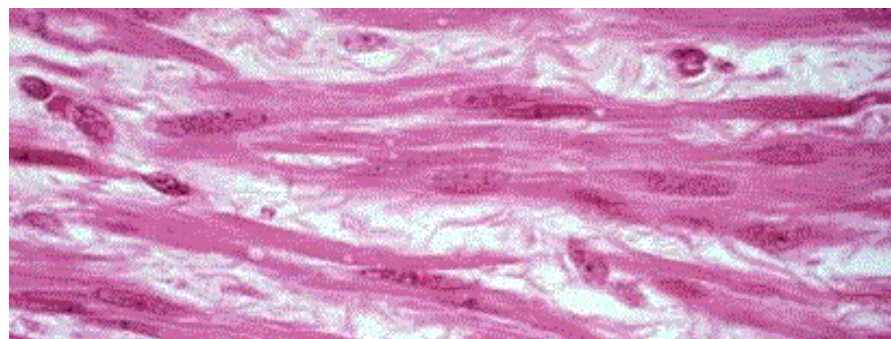
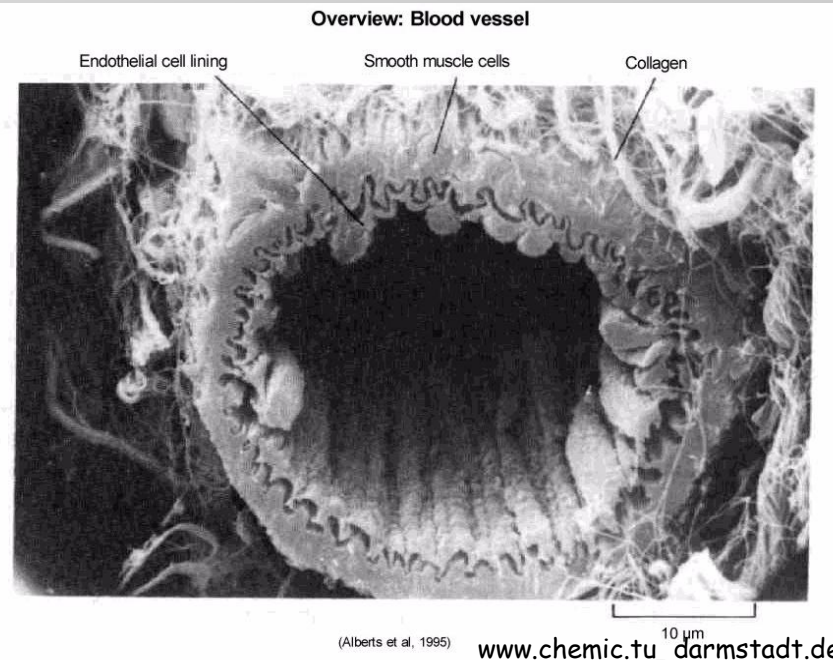
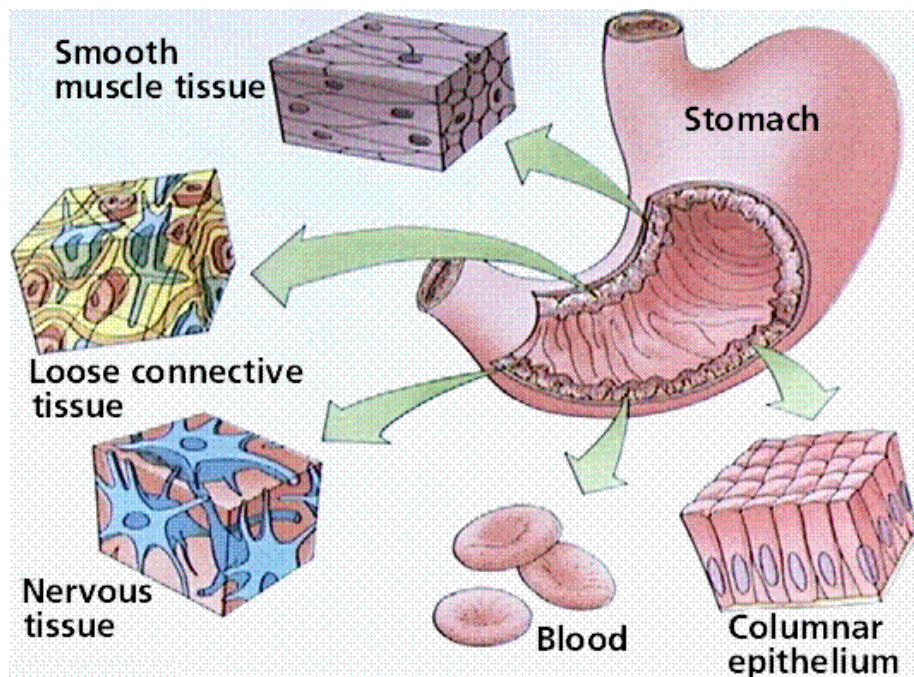
Characteristics of Skeletal Muscle Types

Fibre Type	Type I fibres	Type II A fibres	Type II X fibres
Contraction time	Slow	Fast	Very Fast
Size of motor neuron	Small	Large	Very Large
Resistance to fatigue	High	Intermediate	Low
Activity Used for	Aerobic	Long term anaerobic	Short term anaerobic
Force production	Low	High	Very High
Mitochondrial density	High	High	Low
Capillary density	High	Intermediate	Low
Oxidative capacity	High	High	Low
Glycolytic capacity	Low	High	High
Major storage fuel	Triglycerides	Glycogen	Glycogen





Smooth muscles

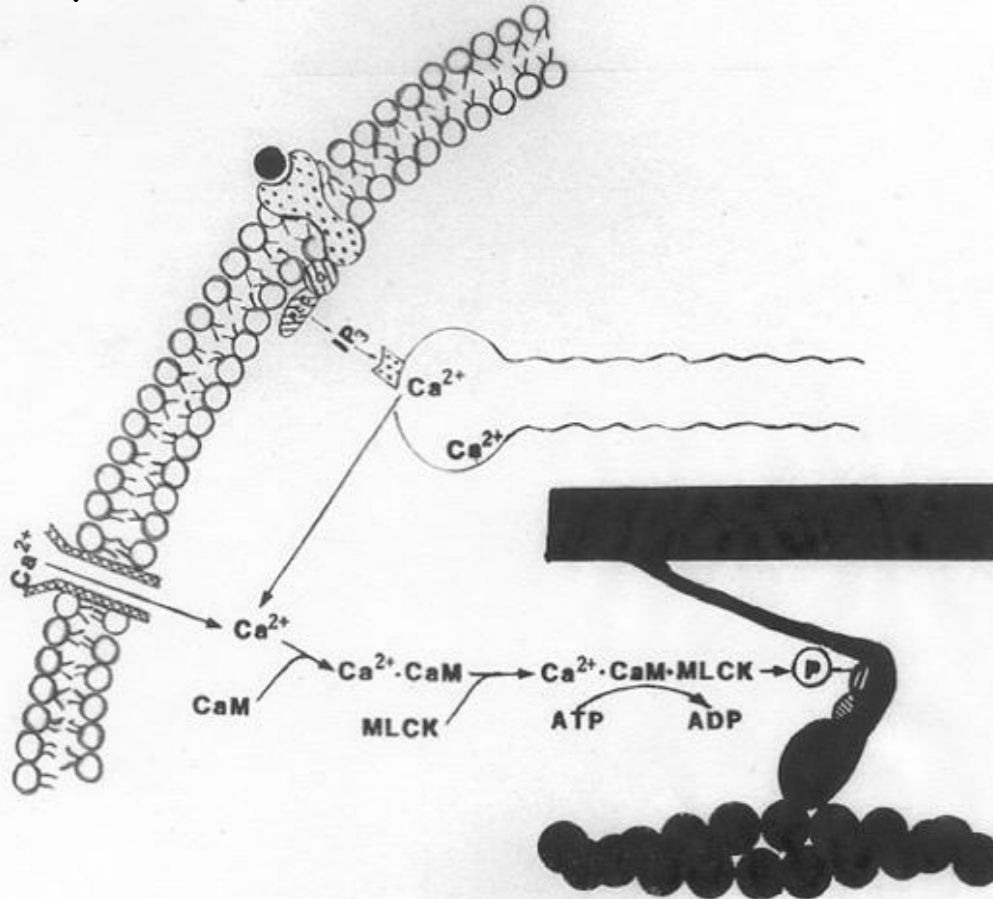


Source: INTERNET



Mechanism of Smooth Muscle Action

Smooth muscle cell action is controlled by interaction of Ca^{2+} with calmodulin



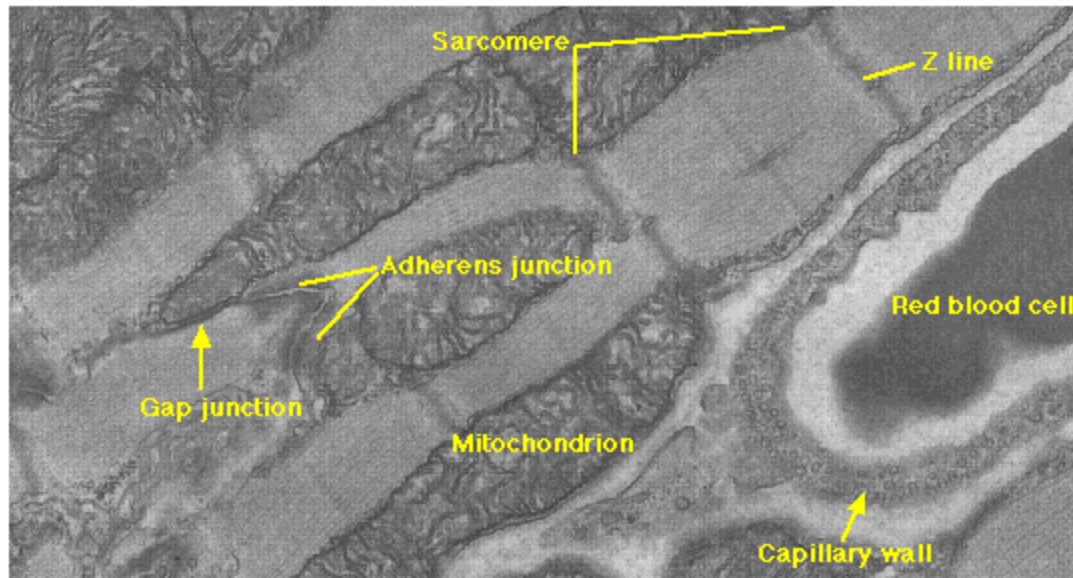
Smooth muscle does not depend on motor neurons to be stimulated. However, motor neurons (of the autonomic system) reach smooth muscle and can stimulate it — or relax it — depending on the neurotransmitter they release (e.g. noradrenaline or nitric oxide, NO)).

Source: INTERNET



Cardiac Muscle

Cardiac or heart muscle resembles skeletal muscle in some ways: it is striated and each cell contains sarcomeres with sliding filaments of actin and myosin.



- The myofibrils of each cell (and cardiac muscle is made of single cells — each with a single nucleus) are branched.
- The branches interlock with those of adjacent fibers by adherens junctions. These strong junctions enable the heart to contract forcefully without ripping the fibers apart.

Source: INTERNET



Cardiac Muscle

- The action potential that triggers the heartbeat is generated within the heart itself. Motor nerves (of the [autonomic nervous system](#)) do run to the heart, but their effect is simply to modulate — increase or decrease — the intrinsic rate and the strength of the heartbeat. Even if the nerves are destroyed (as they are in a transplanted heart), the heart continues to beat.
- The action potential that drives contraction of the heart passes from fiber to fiber through [gap junctions](#).
- The **refractory period** in heart muscle is **longer** than the period it takes for the muscle to contract (systole) and relax (diastole).
- Cardiac muscle has a much richer supply of mitochondria than skeletal muscle. This reflects its greater dependence on cellular respiration for ATP.
- Cardiac muscle has little glycogen and gets little benefit from glycolysis when the supply of oxygen is limited. Thus anything that interrupts the flow of oxygenated blood to the heart leads quickly to damage — even death — of the affected part. This is what happens in [heart attacks](#).



Work of Muscle

$$dE = dW + dQ$$

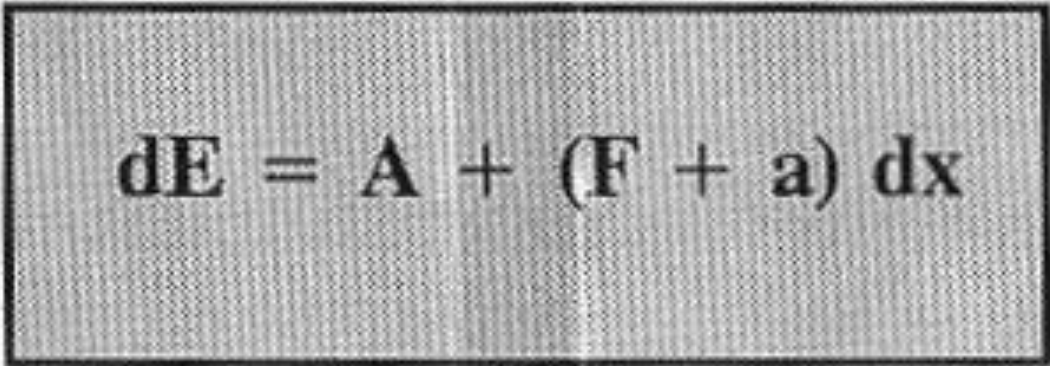
$$dQ = A + q$$

$$q = a dx$$

$$dW = F dx$$

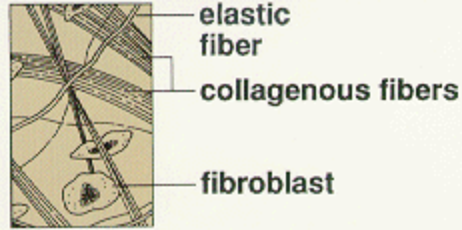
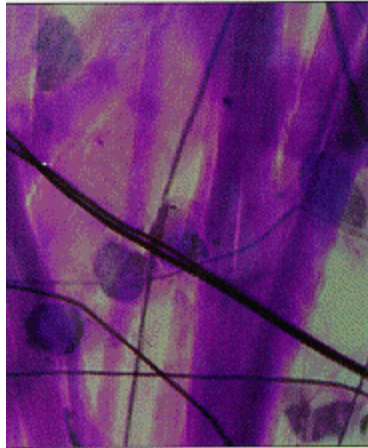
A – a heat of activation

q – a heat of contraction

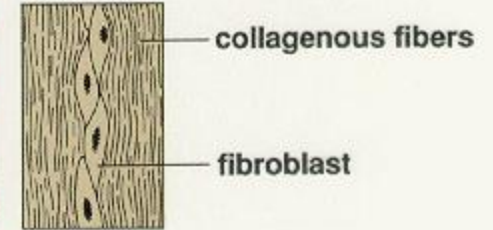
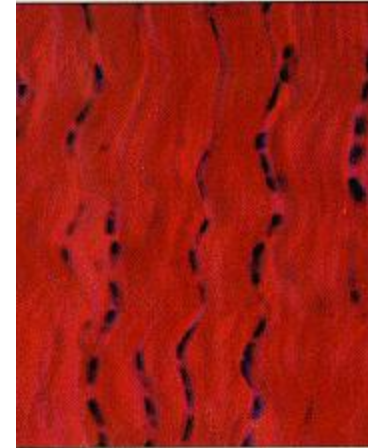

$$dE = A + (F + a) dx$$



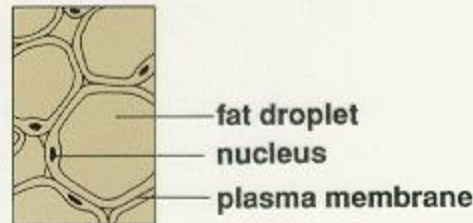
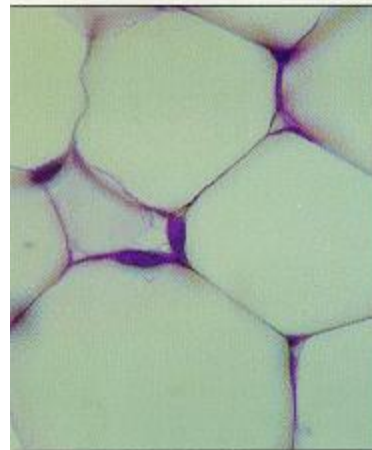
Connective Tissue



TYPE: Loose
COMMON LOCATIONS: Under skin, most epithelia
FUNCTION: Support, elasticity



TYPE: Dense, regular
COMMON LOCATIONS: Tendons, skin, kidney capsule
FUNCTION: Support, elasticity

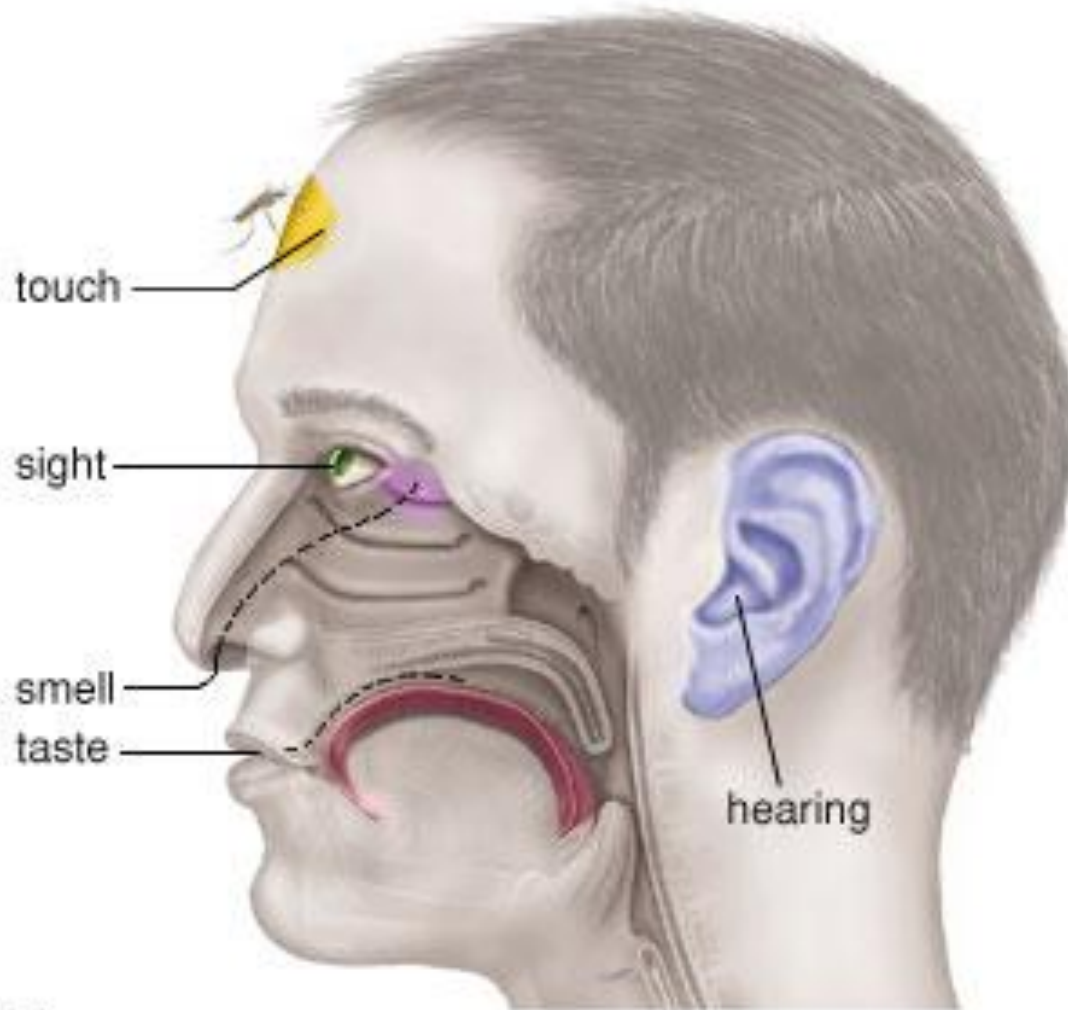


TYPE: Adipose
COMMON LOCATIONS: Under skin, around kidneys, heart
FUNCTION: Energy reserve, insulation, padding

Source: INTERNET



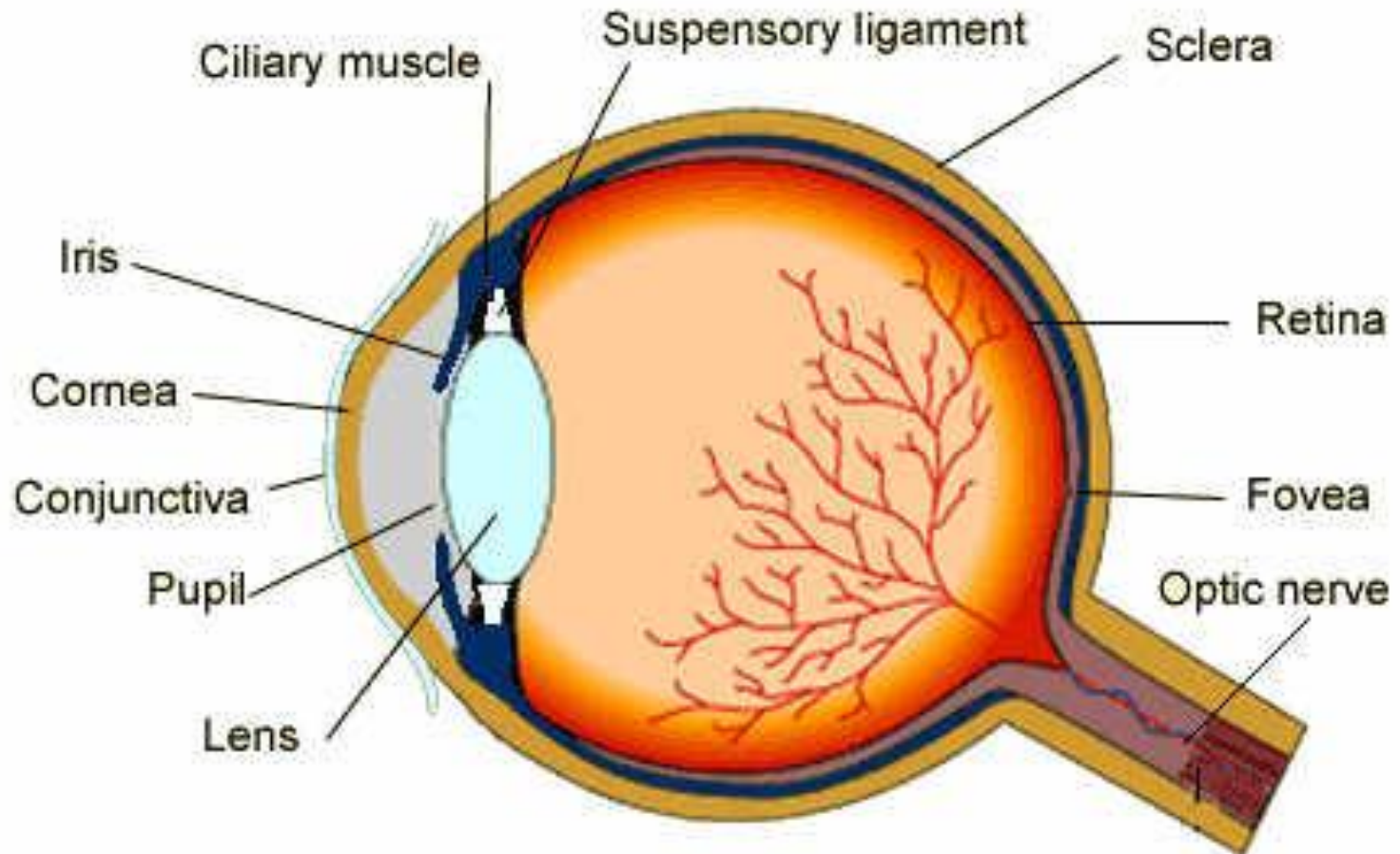
Human Senses



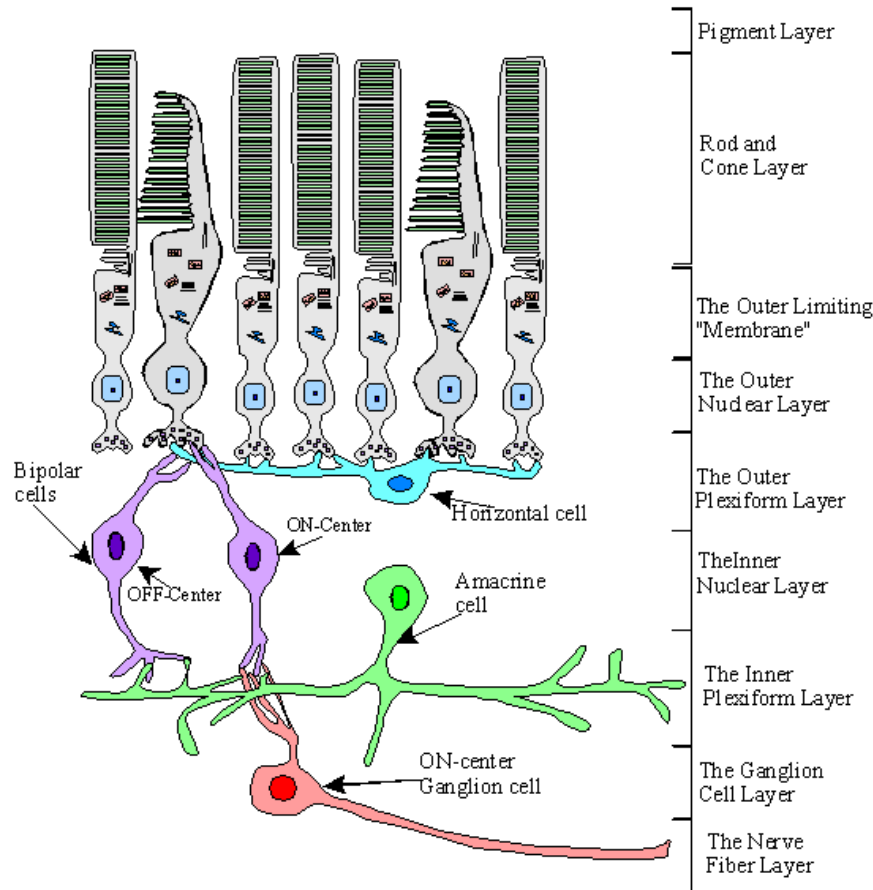
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Human Senses - Sight



<http://www.scientificpsychic.com/workbook/chapter2.htm>



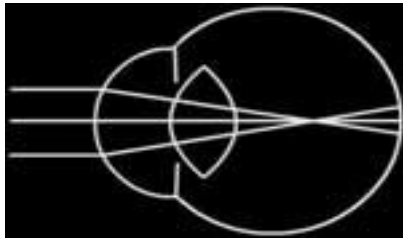
www.csulb.edu/~cwallis/482/visualsystem/eye.html



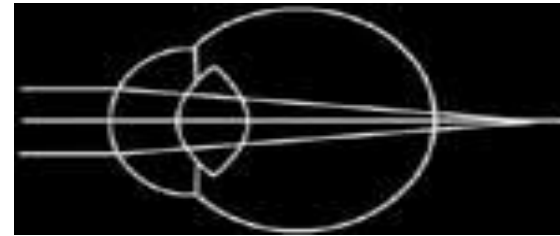


Sight Defects

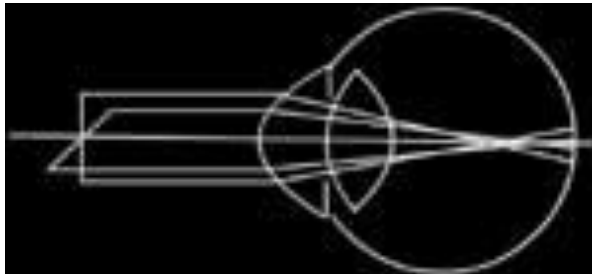
Some sight defects can be corrected with glasses or contact lenses:



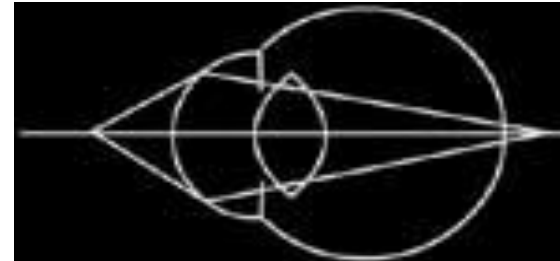
myopia



ipermetropy



astigmatism

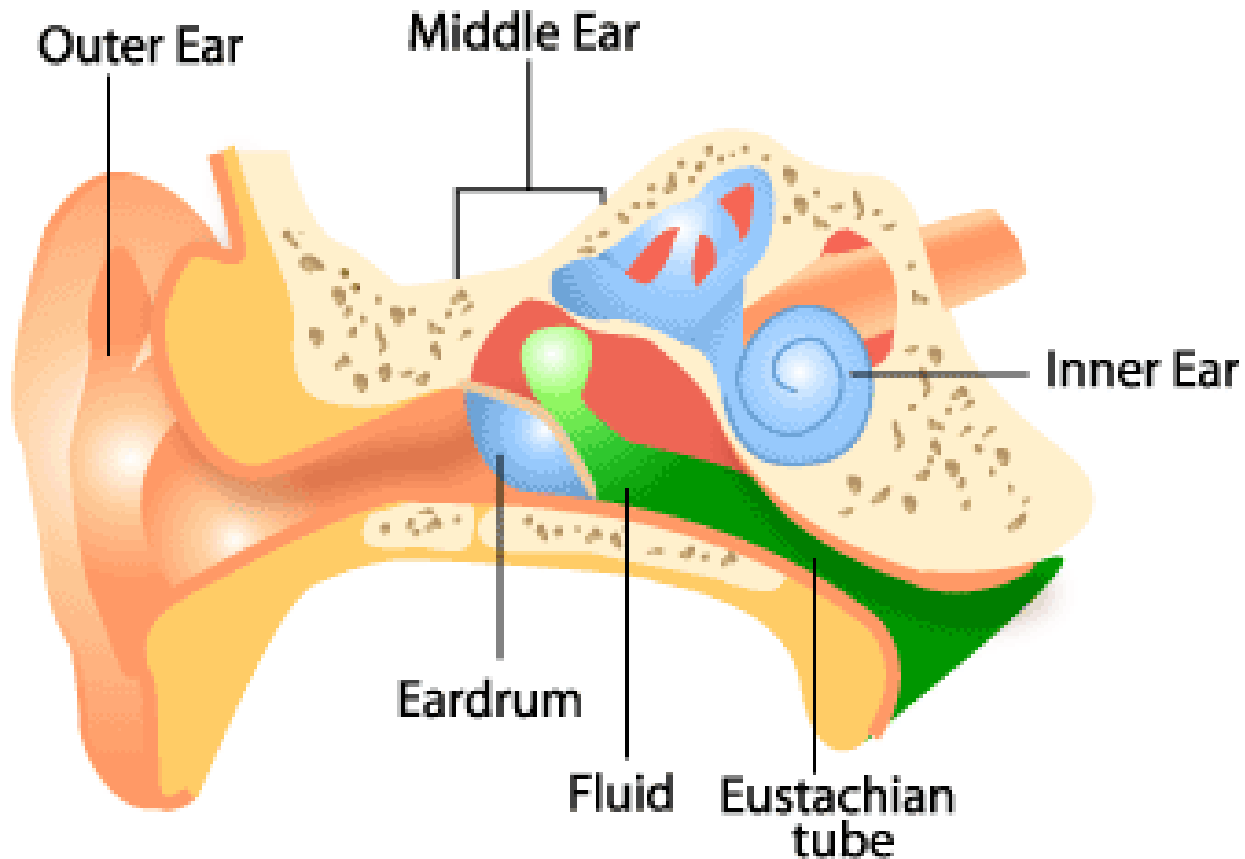


presbyopia



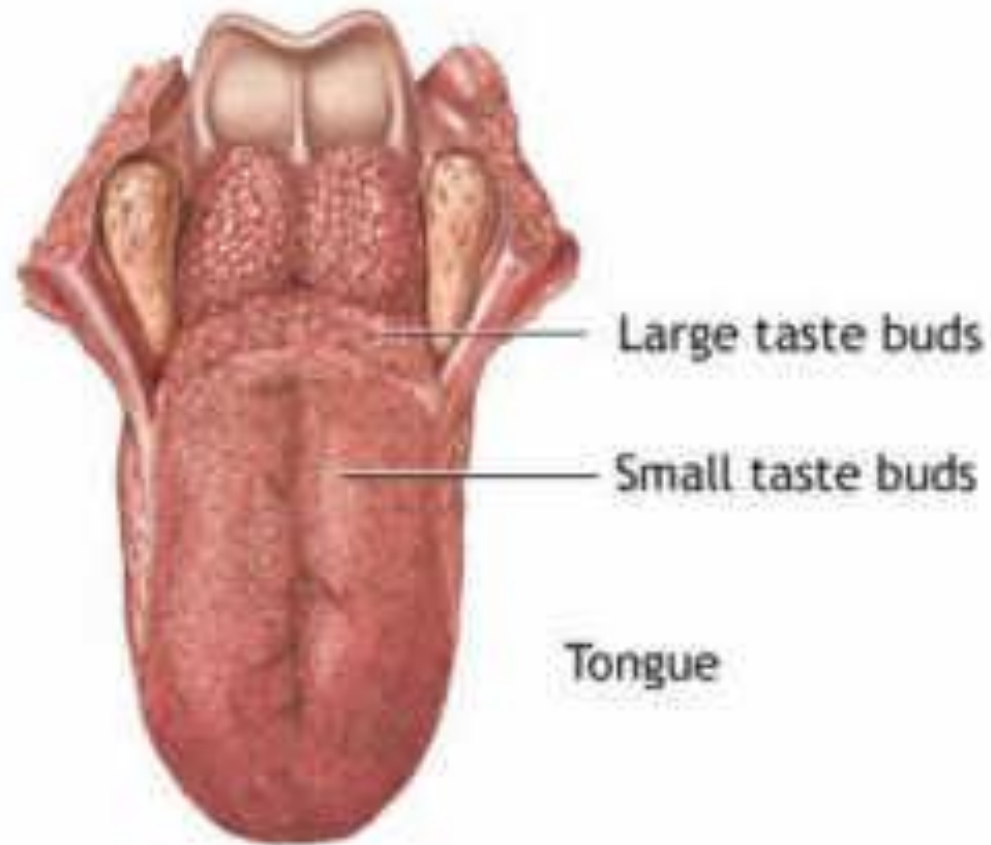


Hearing



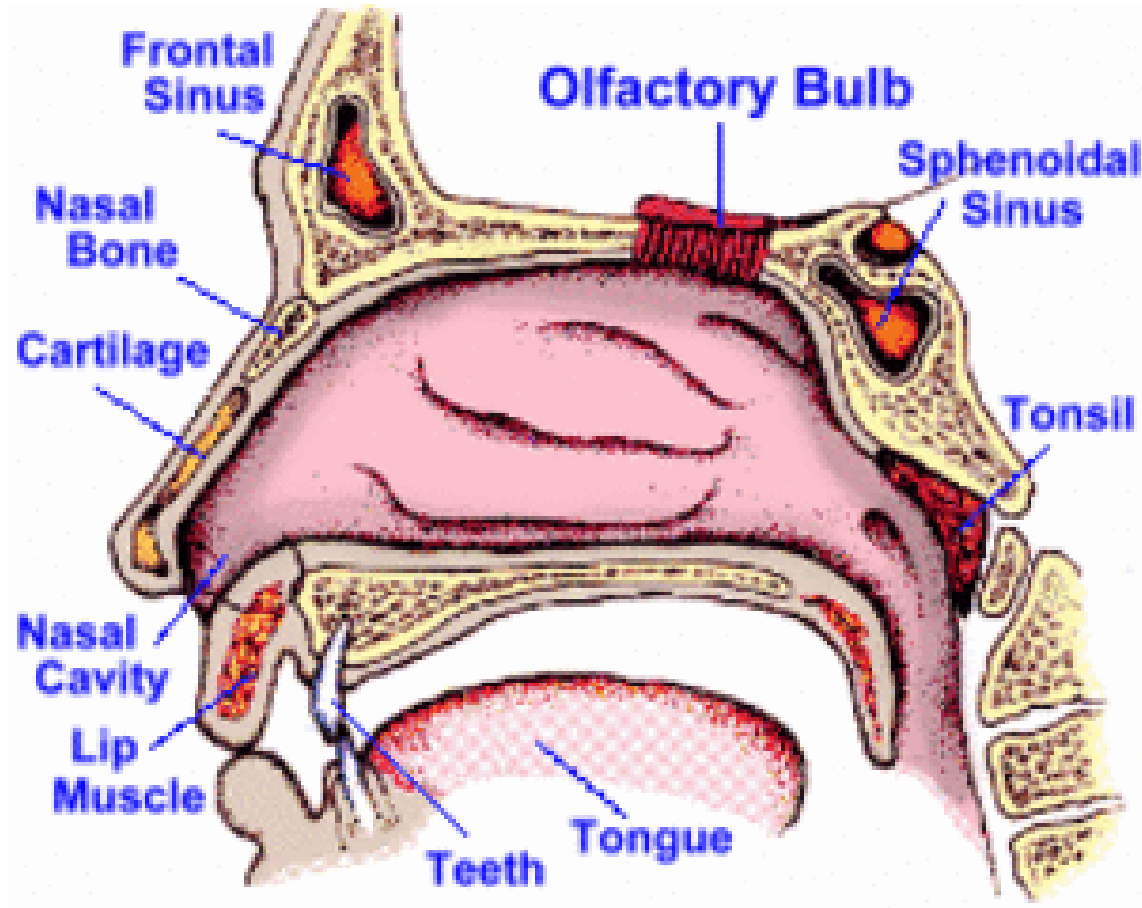
<http://www.scientificpsychic.com/workbook/chapter2.htm>



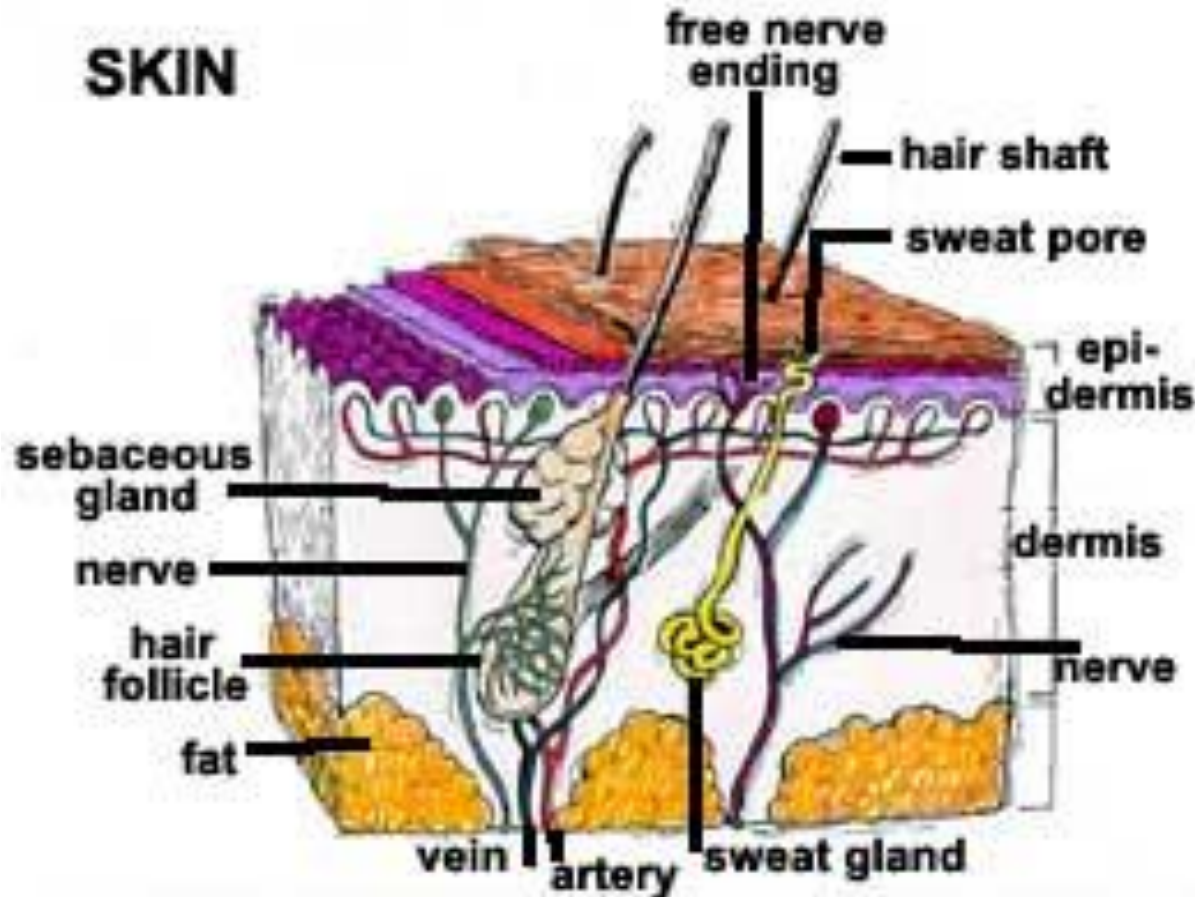


<http://www.scientificpsychic.com/workbook/chapter2.htm>





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