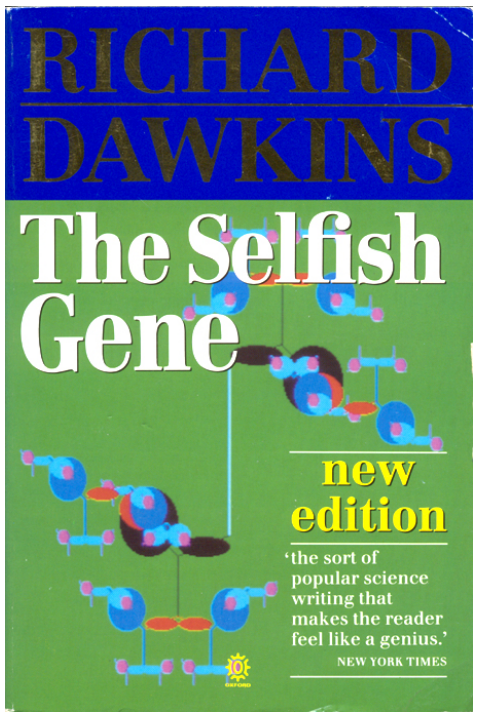
The human body is an electrochemical machine

- Inputs: oxygen, water, ions, complex organic molecules
- Outputs: maintenance, movement, heat, carbon dioxide, water, simple organic molecules

"A chicken is just an egg's way of making more eggs."

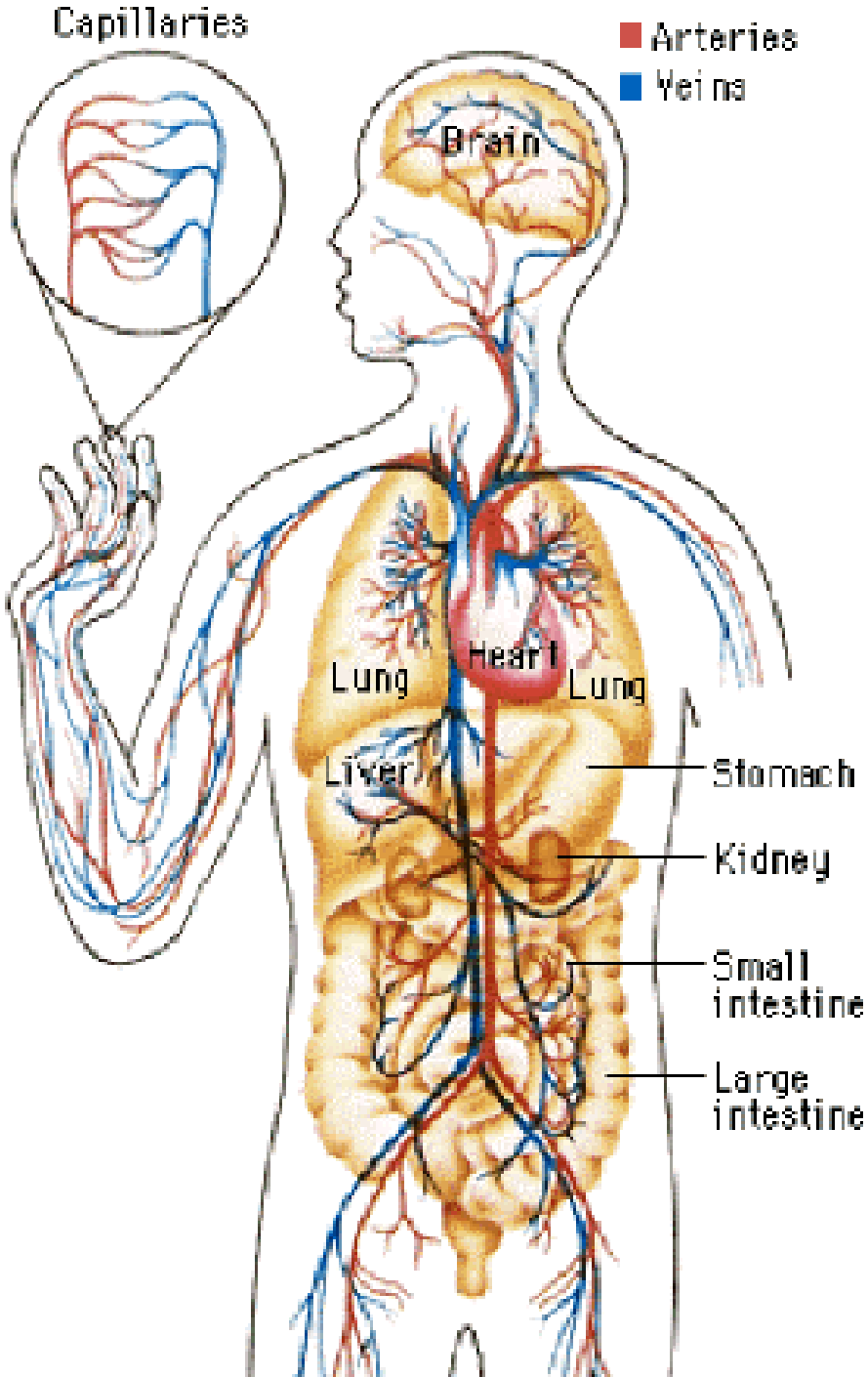
Dawkins describes biological organisms as "vehicles" used by their genes for making more copies of those genes.

Genes that tend to help the organisms they are in to survive and reproduce also help themselves.



Most textbooks describe 11 interacting systems:

- Circulatory: moving materials around
- Digestive: absorbing & processing organic chemicals
- Endocrine: slow, general control
- Excretory: removing waste products
- Immune: defending against invasion
- Integumentary: keeping insides in & outsides out
- Muscular: movement
- Nervous: fast, precise control
- Reproductive: passing on genes
- Respiratory: moving O_2 in, CO_2 out
- Skeletal: supporting framework



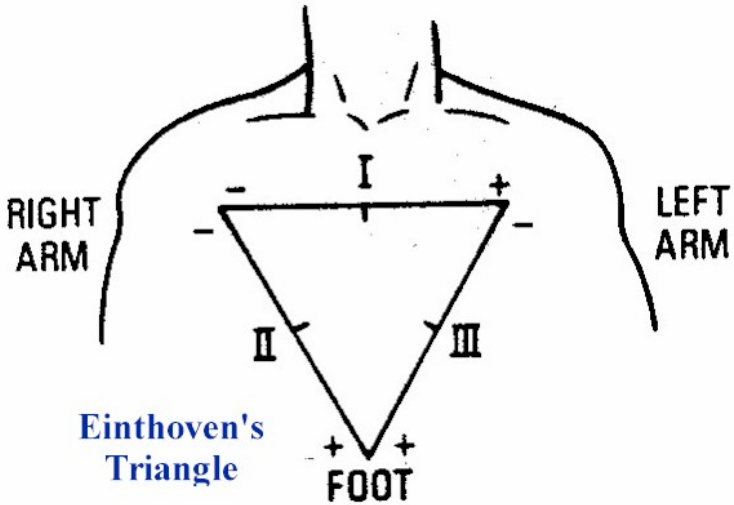
Circulatory system:

Heart: double pump (lungs, body)
Muscle contracts @ 1 Hz for ~80 yr

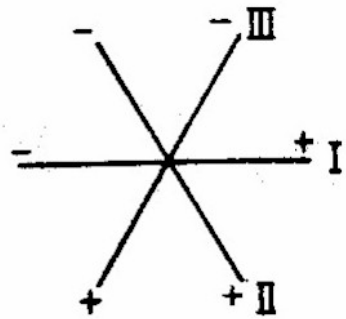
Arteries: High-pressure tubes to tissues
Veins: Low-pressure return to heart

Automatic controls to maintain pressure & need-dependent distribution (to gut after meal, to muscles before exercise)

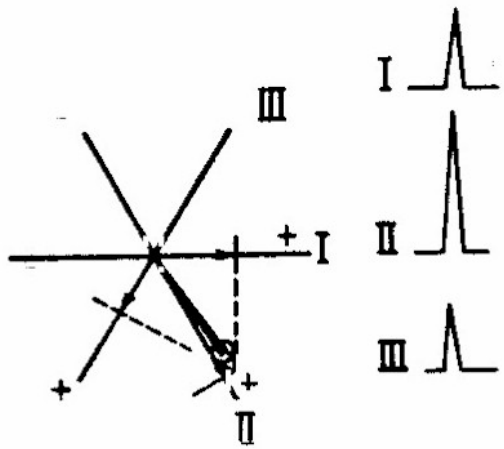
The Triaxial Reference System



Einthoven's Triangle



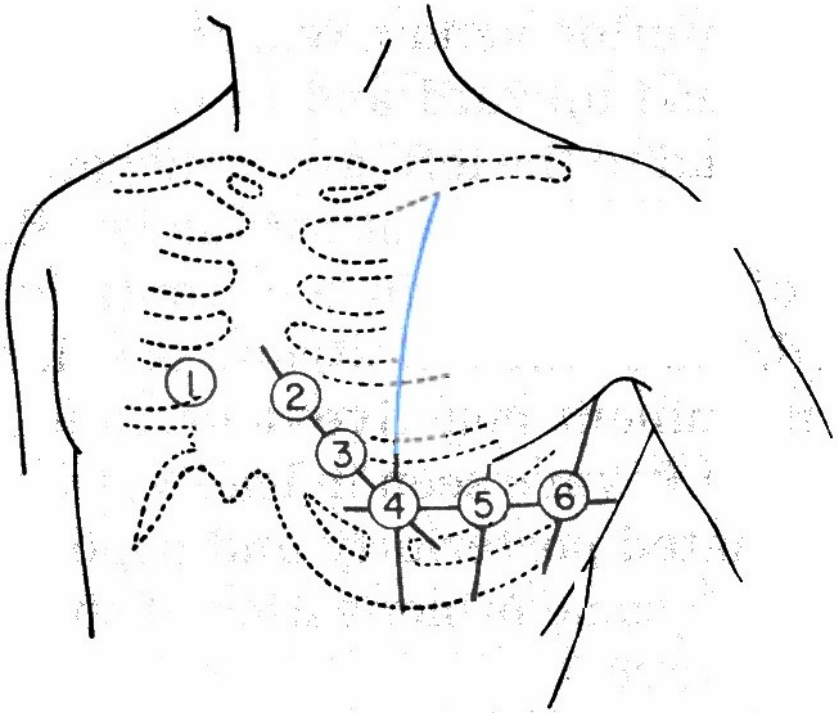
3 lead axes rearranged to cross at centre



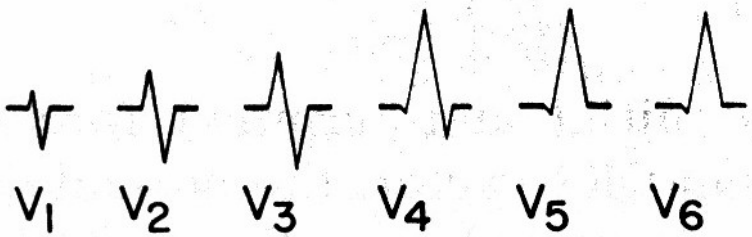
QRS vector drawn with its projections on standard limb leads I, II & III

From:
Best & Taylor's Physiological Basis of Medical Practice, 12th Edn.

Precordial Leads

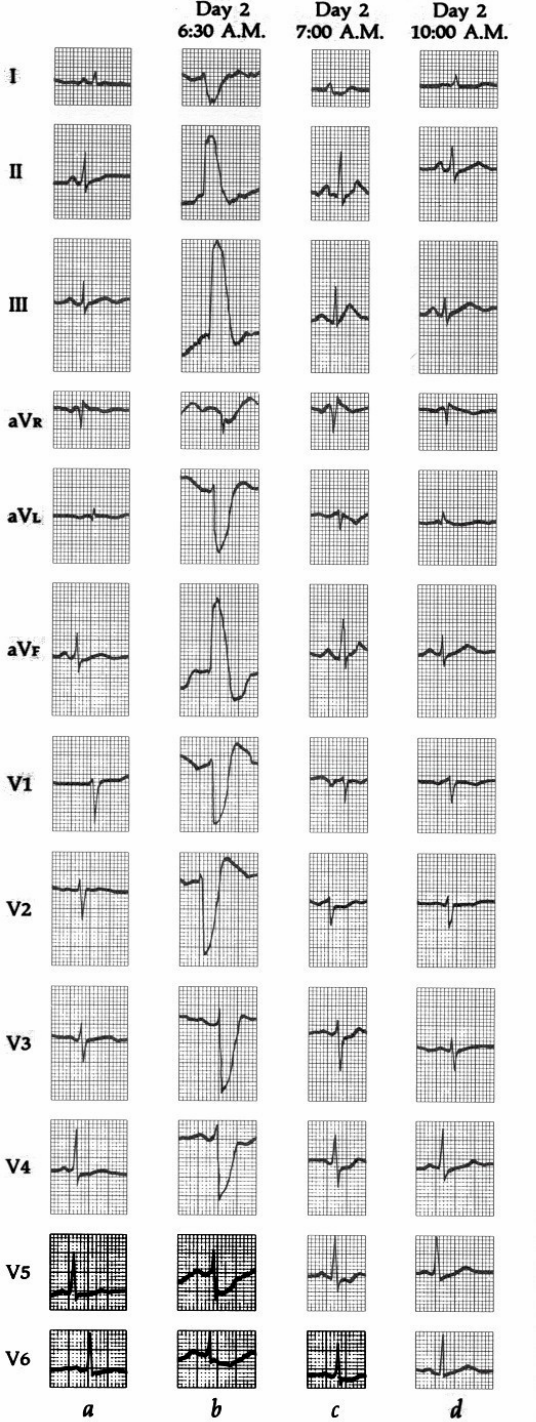


V1: 4th intercostal space right of sternum
V2: 4th intercostal space left of sternum
V3: midway between V2 & V4
V4: 5th interspace & midclavicular line
V5: anterior axillary line
V6: midaxillary line,
same level as V4 & V5



Normal QRS in precordial leads

From:
Best & Taylor's Physiological Basis of Medical Practice.
12th Edn



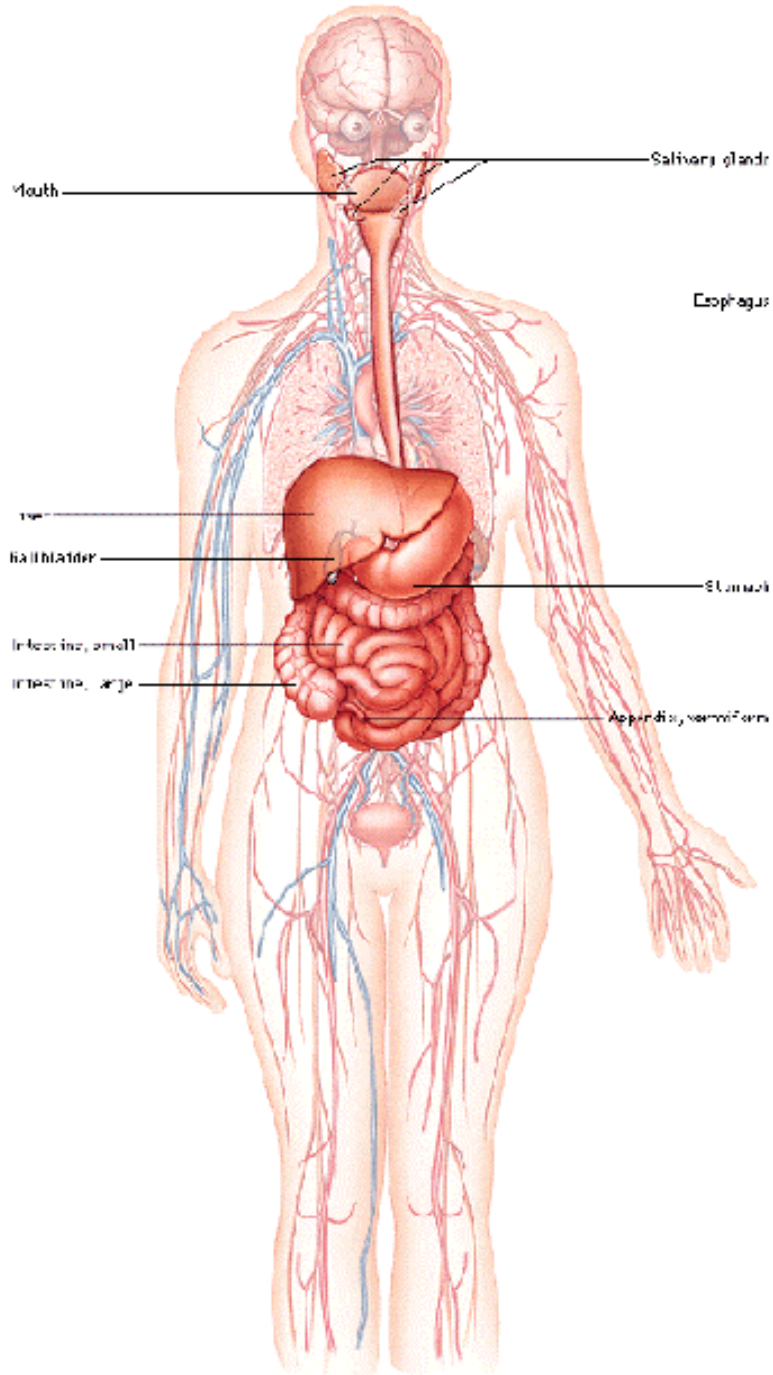
a: baseline ECG before pain onset

b: ECG during angina pain indicates the ischemia is epicardial

c: ECG 30 min after pain relief

d: 3.5 hr later, baseline ECG pattern is again evident

From:
Hutter AM (1995) Ischemic heart disease: Angina pectoris. Scientific American Medicine, Scientific American Inc, New York.



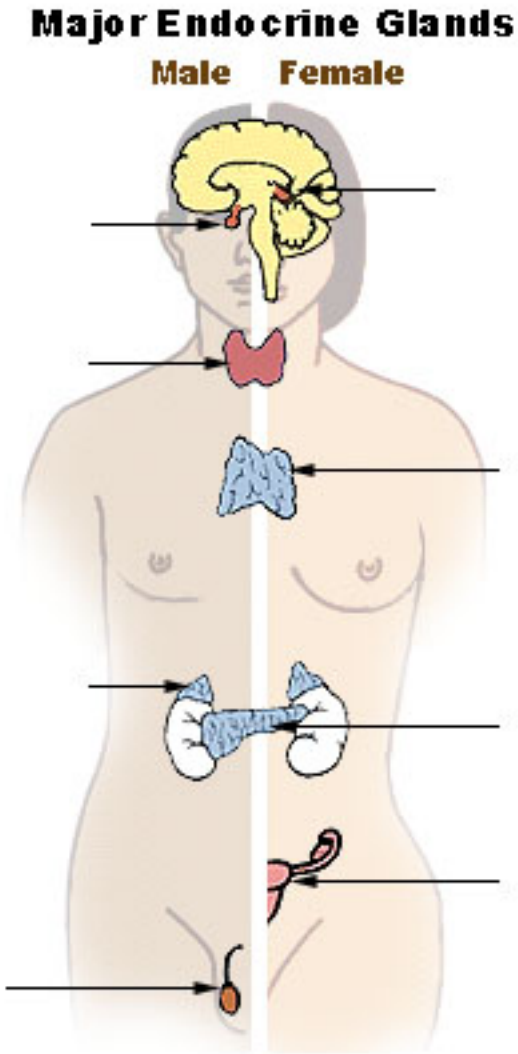
Digestive system: tube from outside (mouth) to outside (anus).

Breakdown of food (acid, alkali, enzymes) into absorbable forms.

Transport via blood to liver; further breakdown into forms useful for energy-production & repair

Unabsorbed materials expelled

Slow, rhythmic contractions can be recorded via a swallowed balloon or electrodes



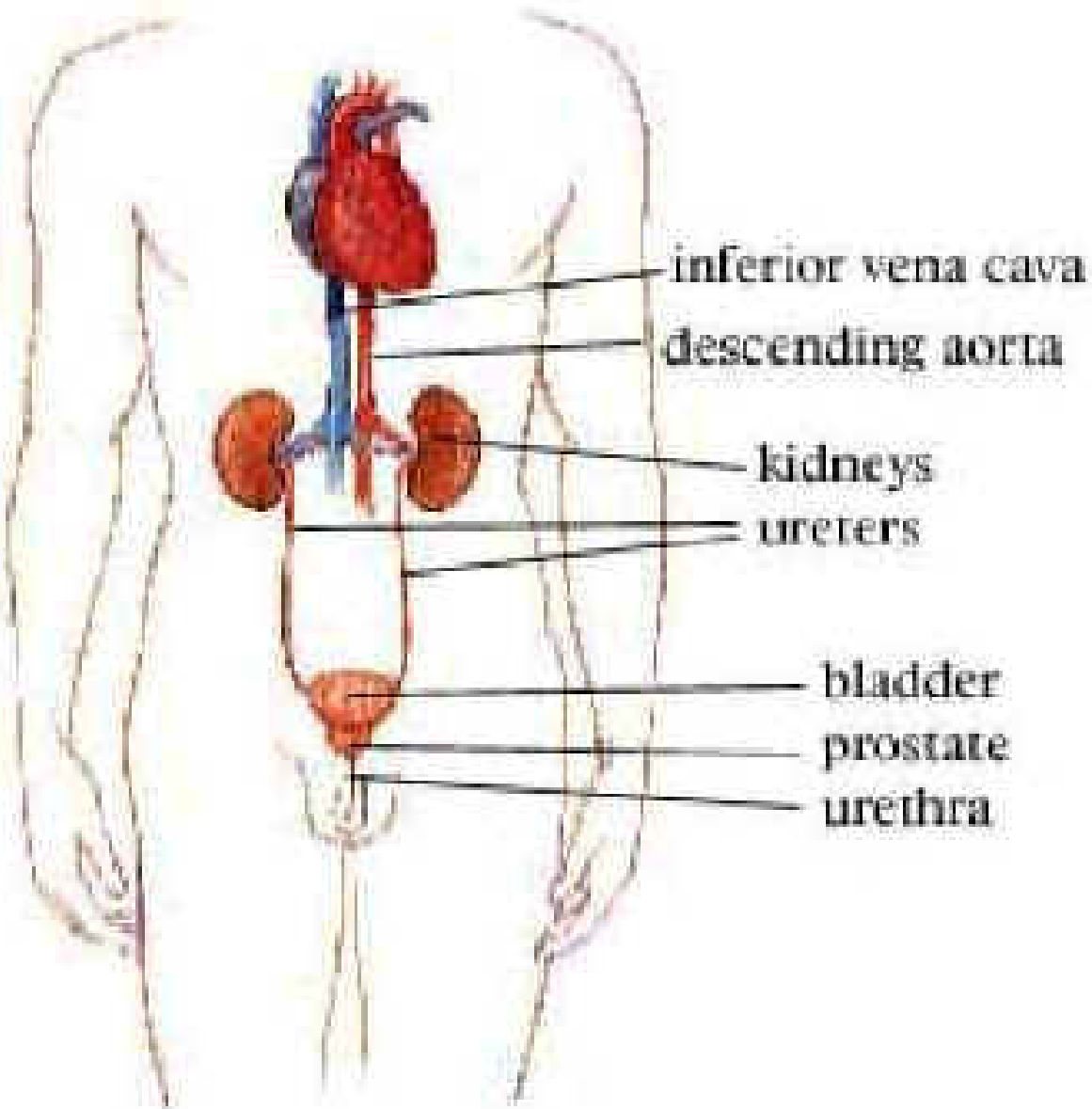
Endocrine system: slow maintenance & feedback control via chemicals secreted into blood.

Control of metabolic rate (chemical activity), growth, reproductive status.

Example:

Food $\rightarrow$ $\uparrow$glucose $\rightarrow$ $\uparrow$insulin $\rightarrow$ $\downarrow$ glucose

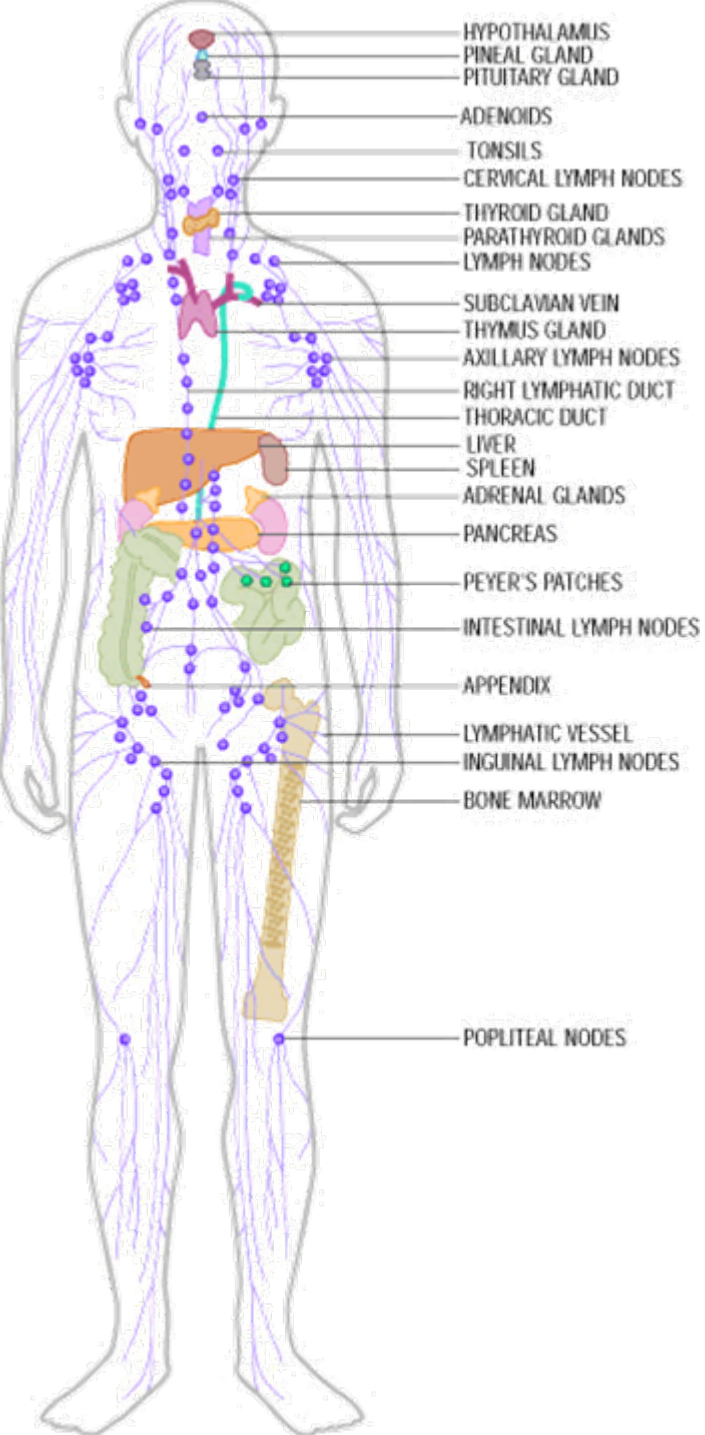
Monitoring requires chemical sensors



Excretory system: blood filter

Kidney: selectively filters out waste or excess materials

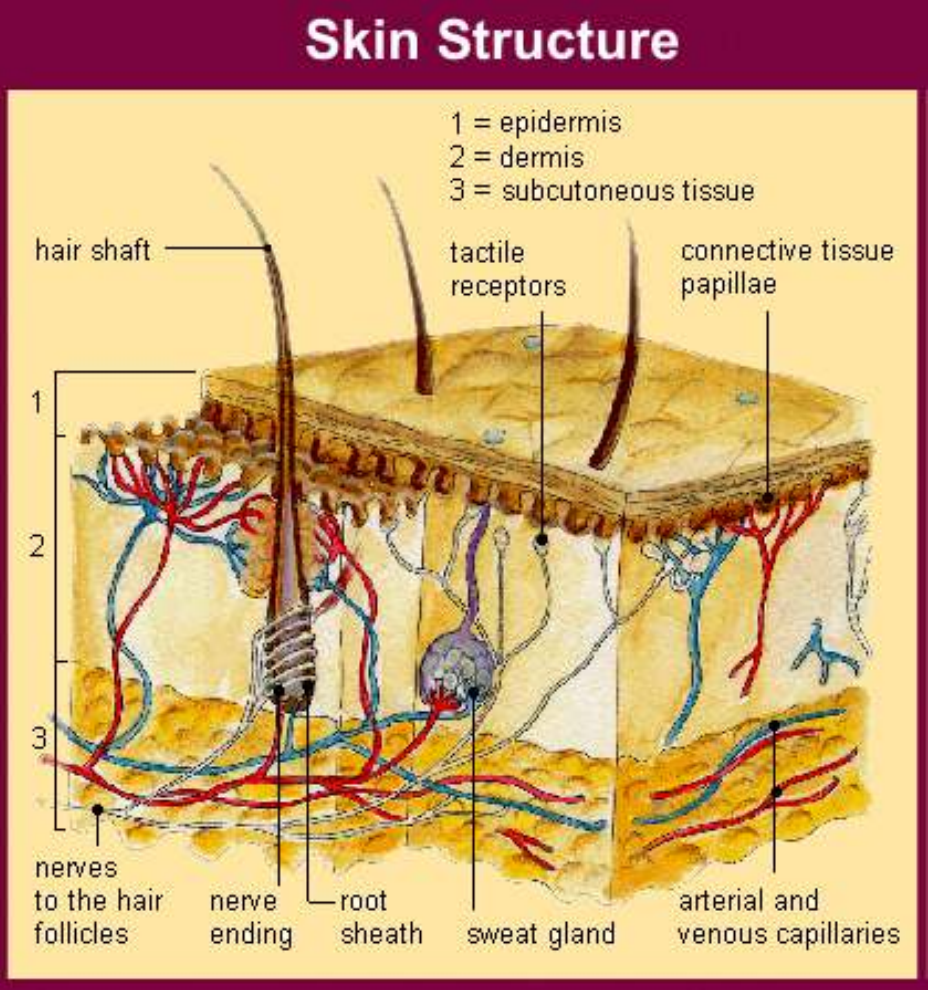
Bladder: temporary storage of filtrate, automatic emptying



Immune system: Defence against invasion

Sensors: Detect non-self chemicals

Effectors: Combine with and break down alien organisms or products



Integumentary system: barrier to loss of fluids, entry of alien materials.

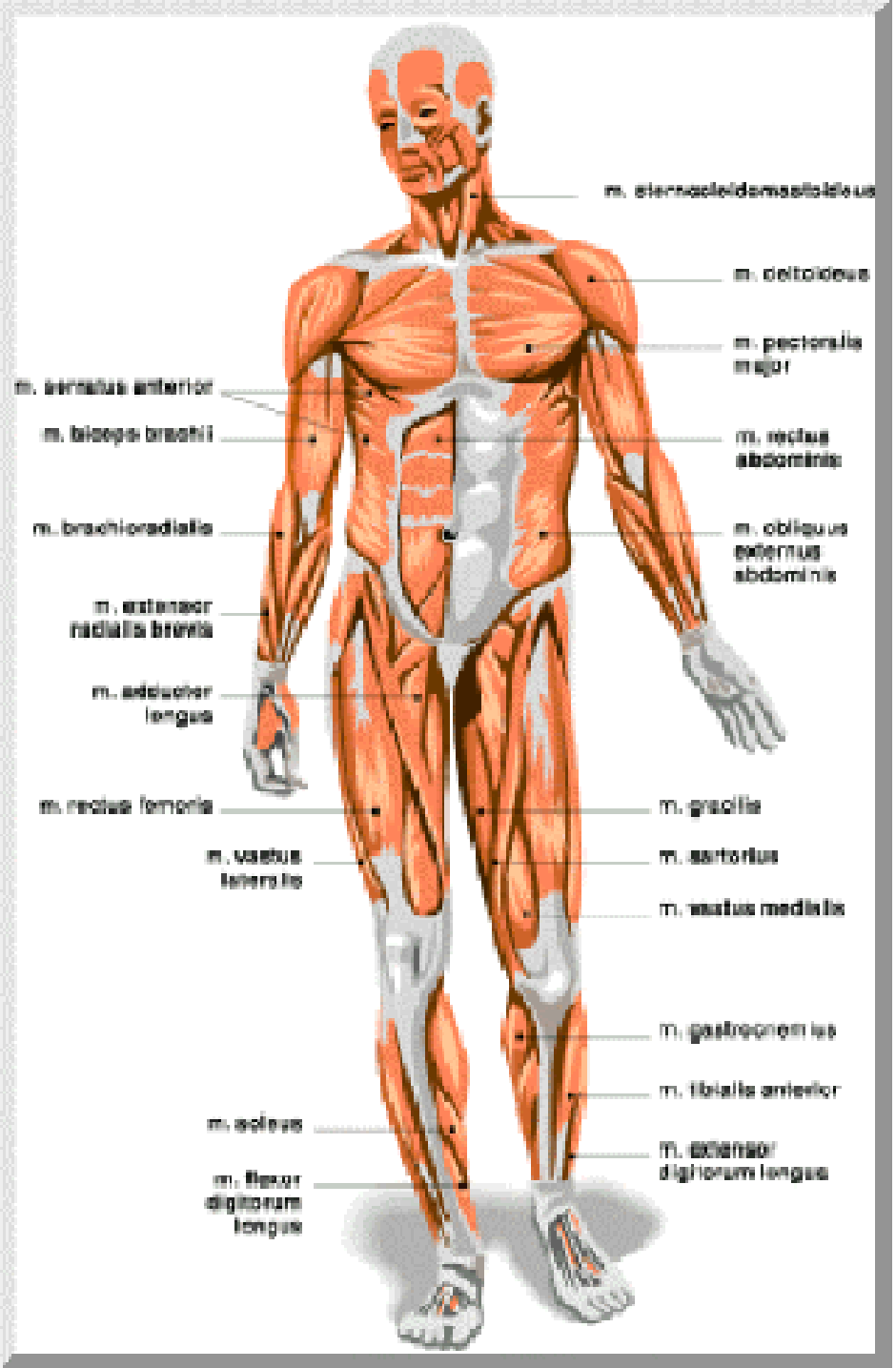
Sensitive to mechanical forces

Surface area for evaporative cooling

Protection against radiation

Barrier to surface recordings

Skin resistance $\propto$ sweating/blood flow

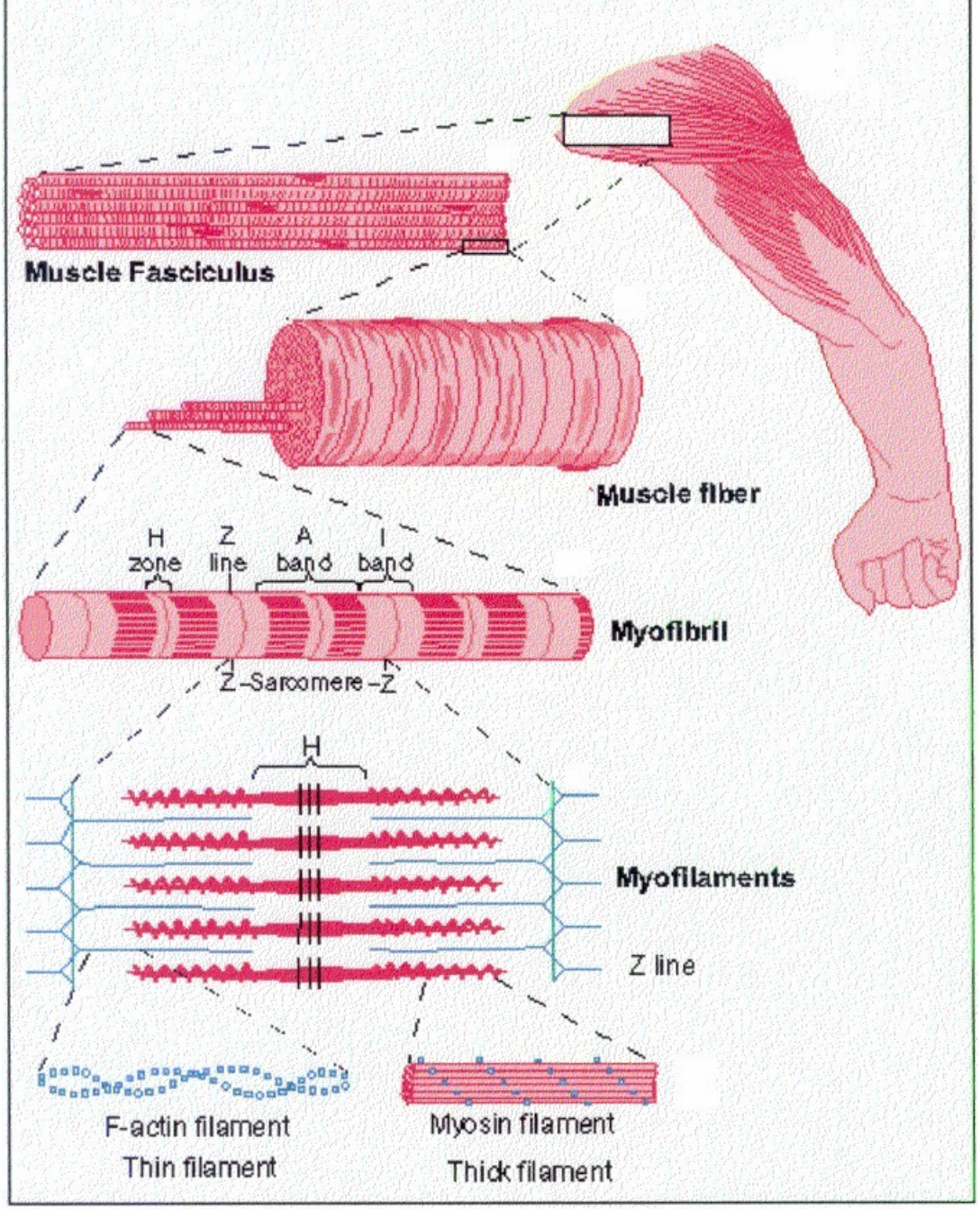


Muscular system: generate forces against levers (bones/joints) resulting in movements.

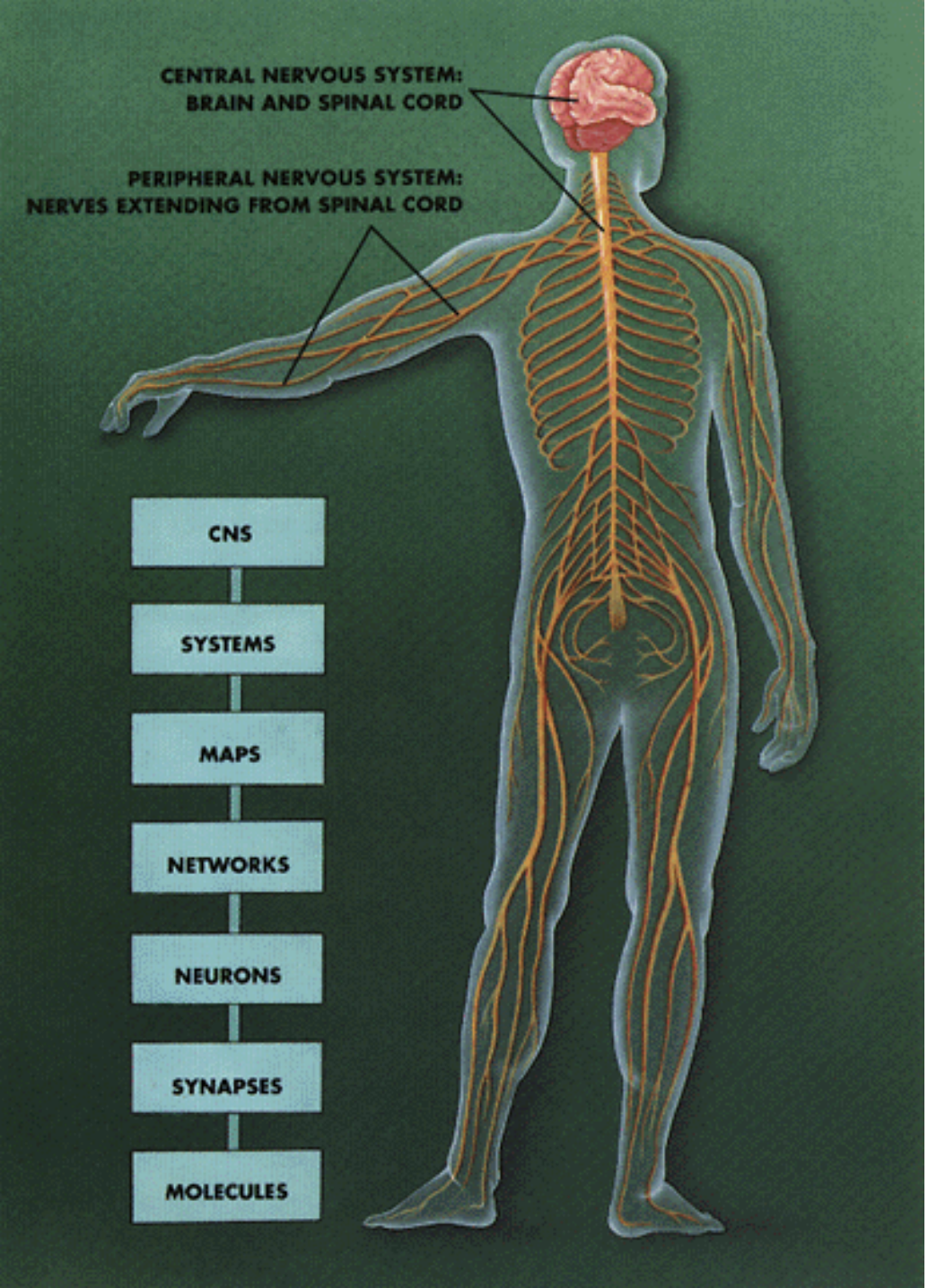
Speech is a special case

Surface recording (EMG)

Needle recording (single muscle fibres)



From:
http://www1.oup.co.uk/best.textbooks/medicine/humanphys/illustrations/

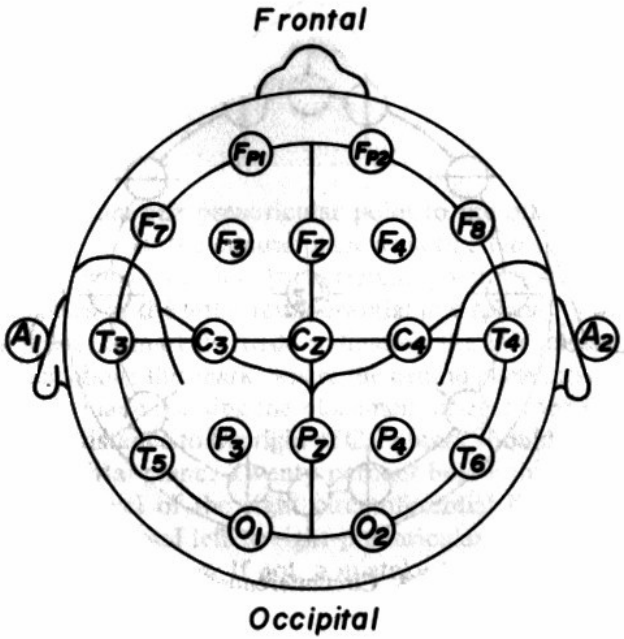


Brain: The most complex piece of matter in the known universe

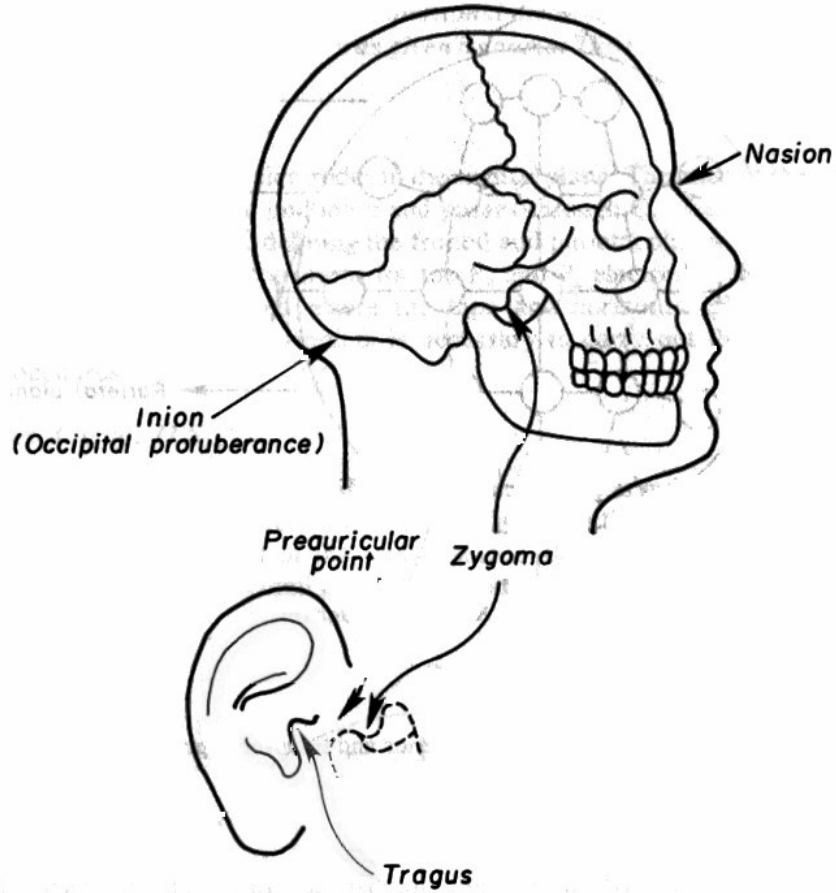
Massively parallel information processor

Capable of independent thought

Controls, directly or indirectly, all other systems



Schema showing locations of electrodes in the ten-twenty system of electrode placement.



Anatomical landmarks used to define primary measuring points in the ten-twenty system

From: Tyner FS, Knott JR, Mayer WB (1983) Fundamentals of EEG Technology, Vol 1. Raven Press.

A SAMPLING OF BRAIN WAVES

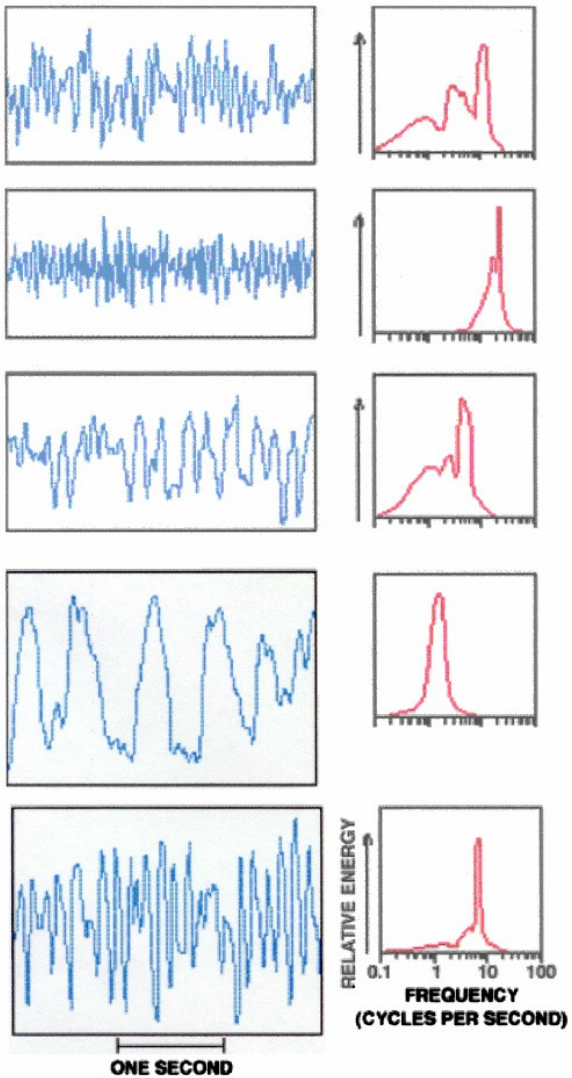
ALPHA WAVES, brought on by unfocusing one's attention, have relatively large amplitude and moderate frequencies.

BETA WAVES, the result of heightened mental activity, typically show rapid oscillations with small amplitudes.

THETA WAVES, which can accompany feelings of emotional stress, are characterized by moderately low frequencies.

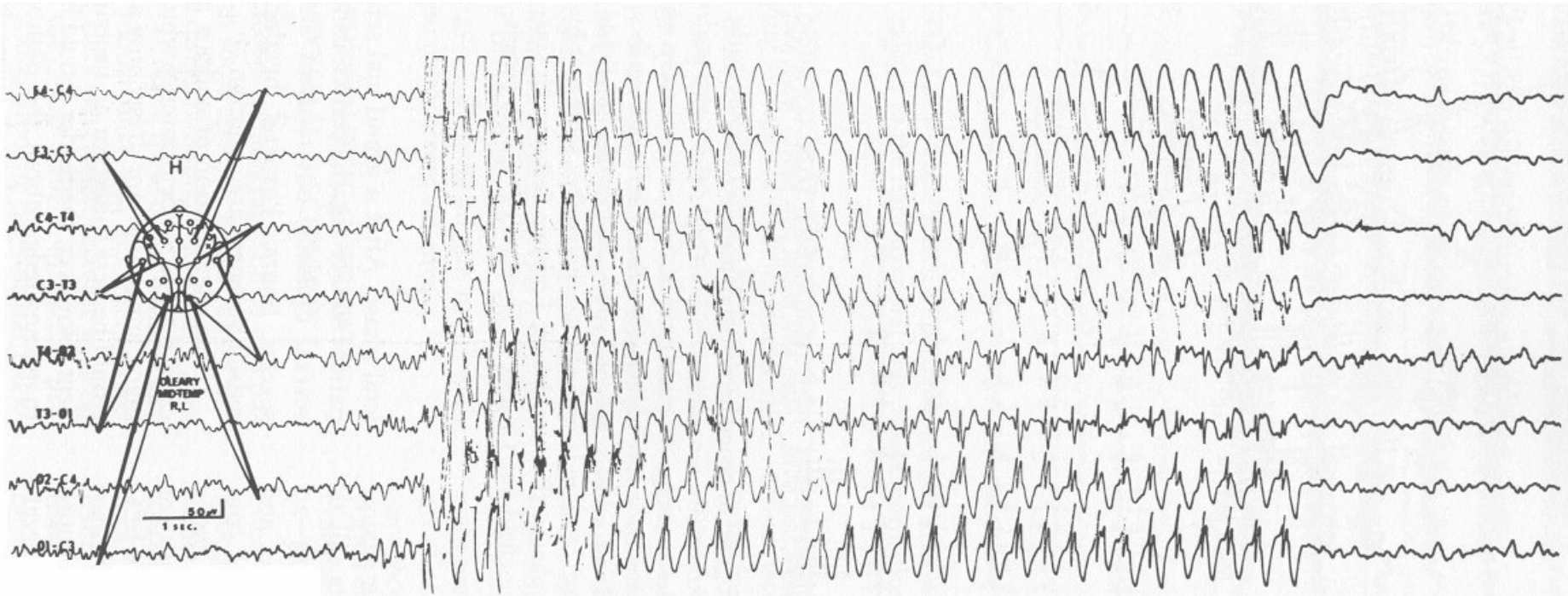
DELTA WAVES result from an extremely low frequency oscillation that occurs during periods of deep sleep.

MU WAVES, which resemble croquet wickets in shape, are associated with physical movements or the intention to move.

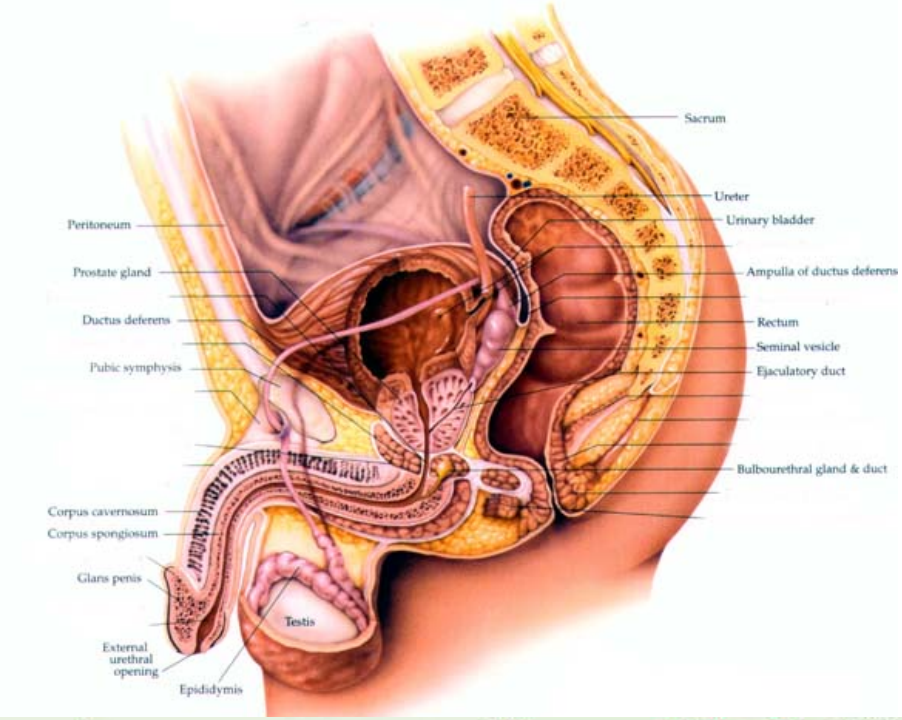


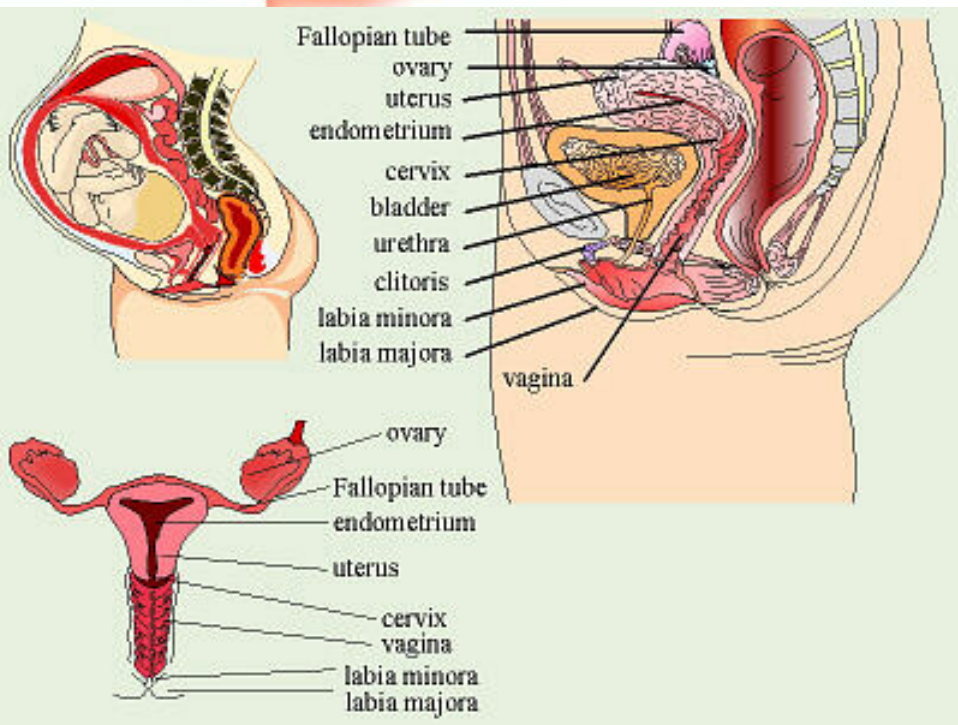
Credit: Johnny Johnson

From: http://www.sciam.com/1096issue/10961ustedbox2.html



Electroencephalogram during a petit mal seizure. Each line tracing denotes the difference in electrical potential between two electrodes on the scalp. These are indicated on the dorsal view of the head (nose anterior) called the EEG montage. Note the sudden eruption and cessation of three per second spike and wave discharge pattern distributed synchronously throughout all leads. The clinical correlate in this 12-year-old boy was staring with occasional eye blinks. During the discharge he was unresponsive to questions. Discontinuity in record denotes removal of 3 seconds of tracing.

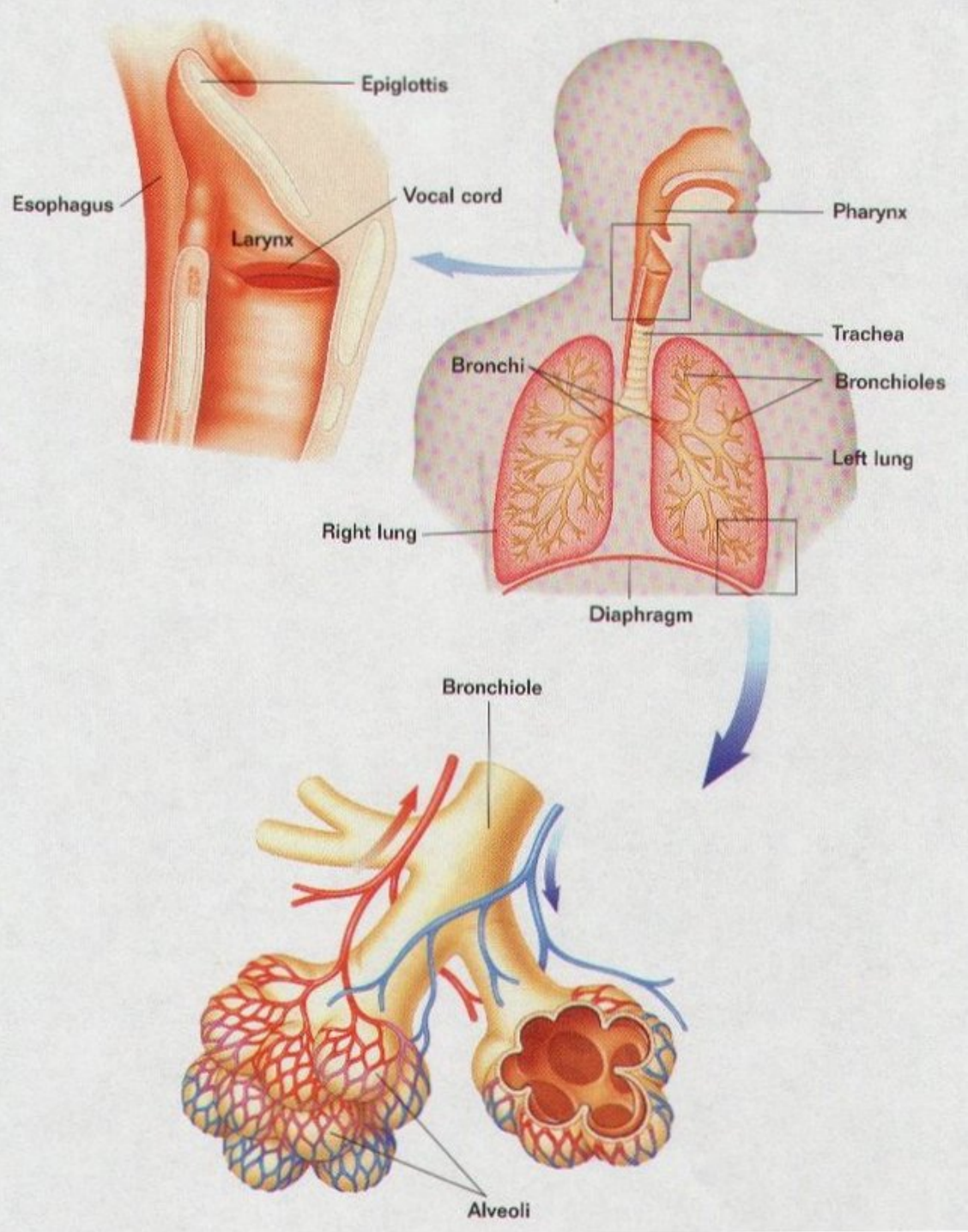




Reproductive system: male & female genes meet

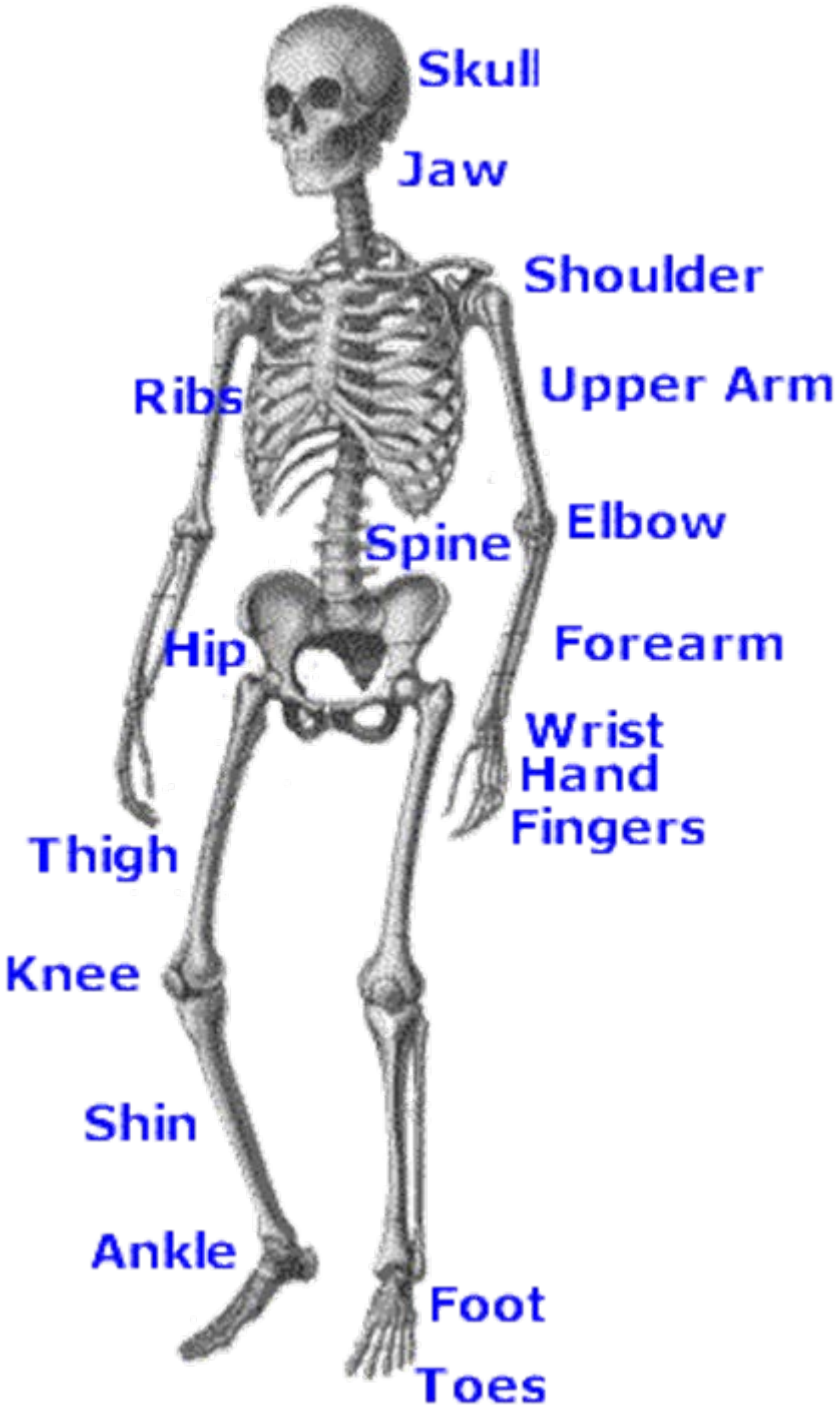
Major changes in female body to accommodate & feed fetus

Main control by endocrine system



Respiratory system: bellows arrangement; Negative pressure by expanding chest, air sucked into lungs.

O_2 and CO_2 diffuse along their concentration gradients (O_2 from air to blood and CO_2 from blood to air)



Skeletal system: joints and levers

Support/protection

Reservoir of calcium