

Tissues, Organs, and Organ Systems

Learning outcomes

- ✓ understand how things are organised from atom → organism
- ✓ understand how multicellular organisms have emergent properties with examples
- ✓ understand the function of the 11 organ systems and name/identify their major structures*

1) Digestive
2) Cardiovascular
3) Respiratory
4) Lymphatic

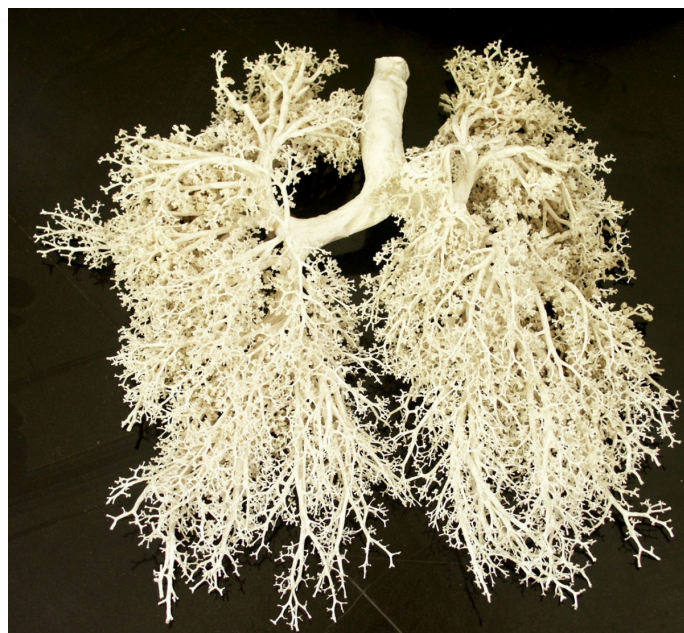
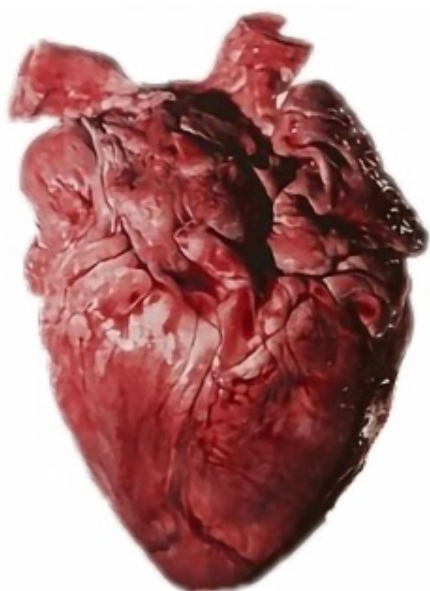
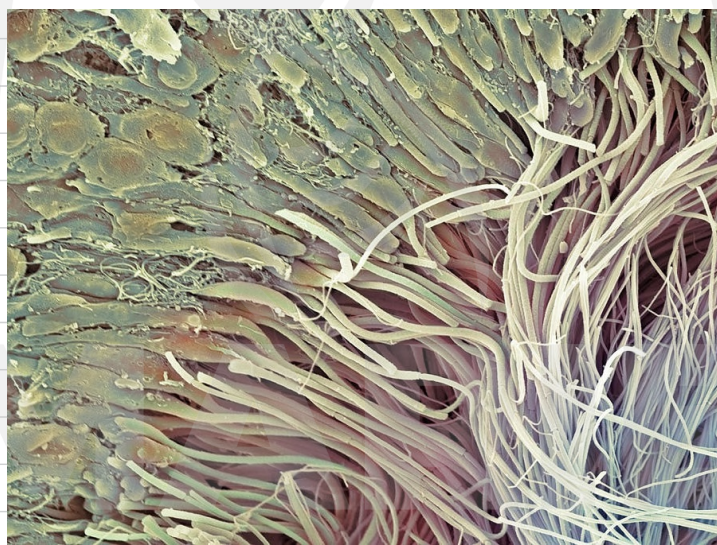
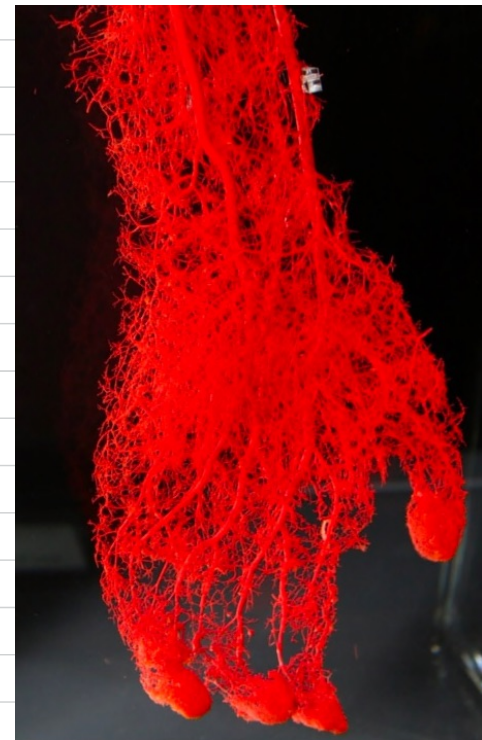
5) Excretory
6) Endocrine
7) Reproductive
8) Nervous

9) Integumentary
10) Skeletal
11) Muscular

* don't need to know functions of each structure

Key terms

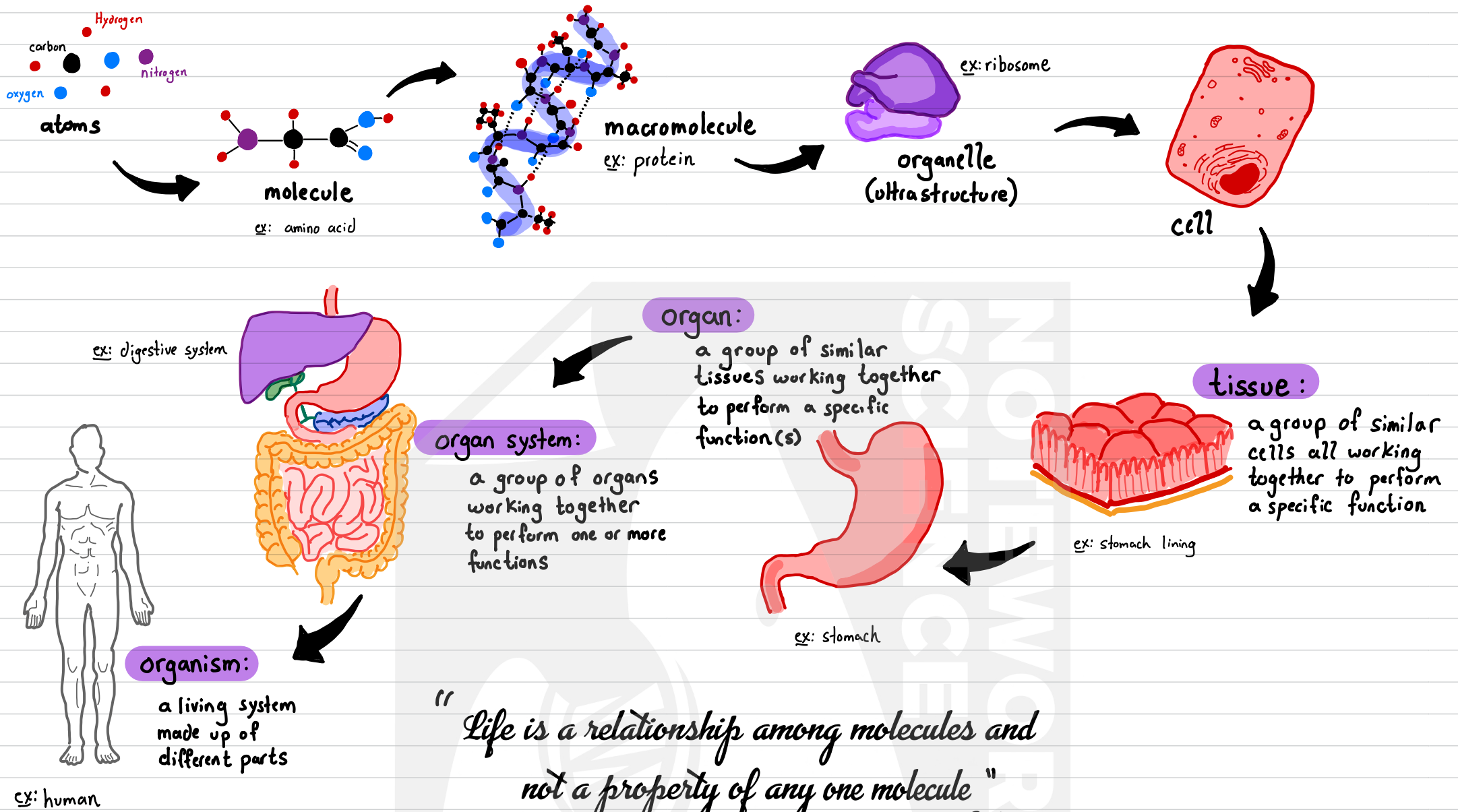
- anatomy
- tissue
- organ
- organ system
- organism
- emergent property
- physiology
- hormone



Biological Organization

Anatomy: the study of how organisms are structured and organized

Biology can be studied by examining how things are organized in a hierarchy

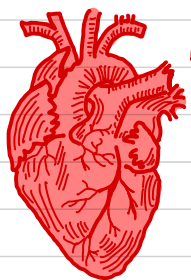


"Life is a relationship among molecules and not a property of any one molecule"
- Pauling & Zuckerkandl

life is defined in terms of **interactions, relationships, and collective properties** of many systems and their parts

Emergent property: a property which a collection or system has, but which individual members do not have

examples:



heart is made up of heart cells. The heart can pump blood but individual heart cells cannot



human emotions (joy, anger) or memories are formed and stored in the brain. No individual neuron can form these

salt (NaCl) has the property of 'saltiness' and edible but Na and Cl are dangerous and not salty



► at every higher level of complexity, new emergent properties appear

i.e. tissues have properties that cells do not, organs have properties that tissues do not ... etc.

Physiology: the study of functions and mechanisms in a living body

< Anatomy looks at how something is structured, >
Physiology looks at how those structures work

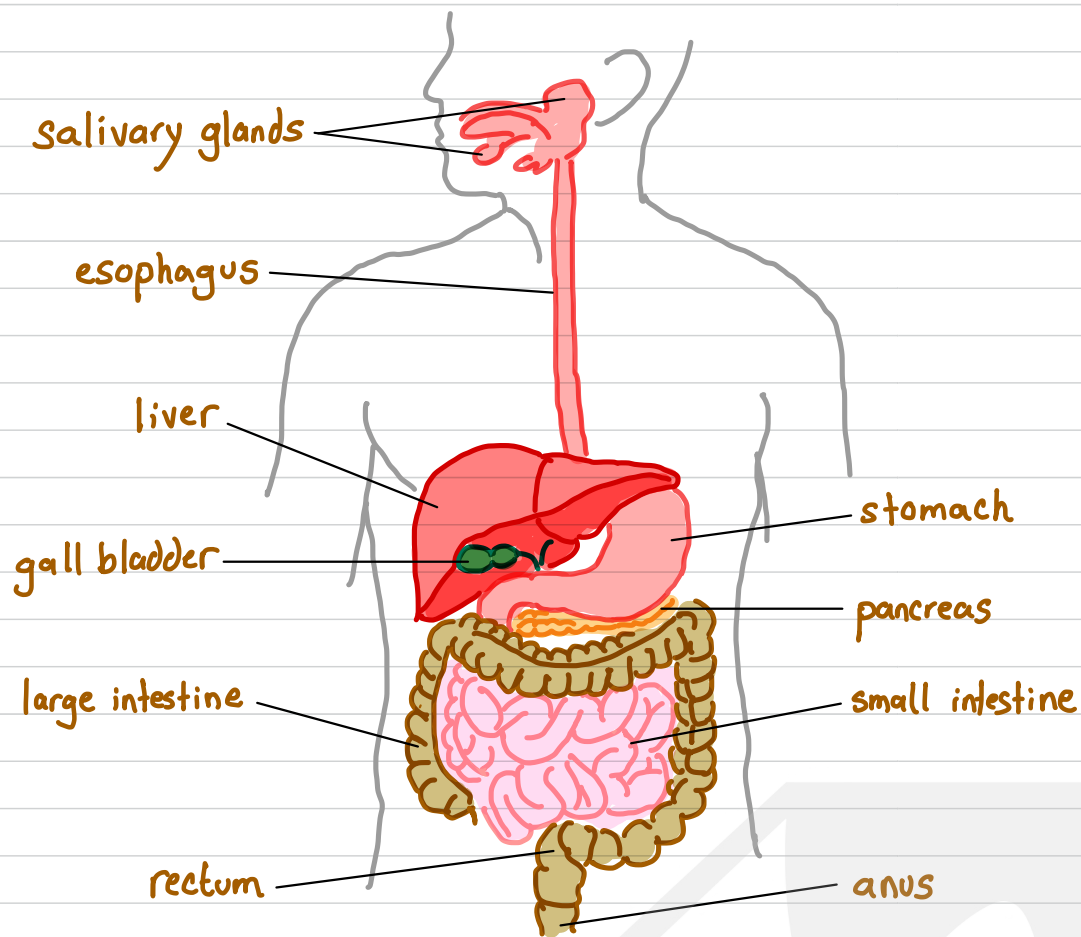
Human Organ Systems

Digestive system

- functions:
- breakdown of food (digestion)
 - absorption of food into bloodstream
 - removal of waste (non-digestible food)

interesting information:

- a person produces 1-1.5 L of saliva per day
- food moves through system by muscles
- ~100 000 000 000 000 bacteria live in the gut
- the digestive system is >9 meters long!
- the surface area of small intestine is ~32 m²
- the acid in your stomach is HCl_(aq) with a pH of 1-2
- the entire process of digestion takes ~2-5 days

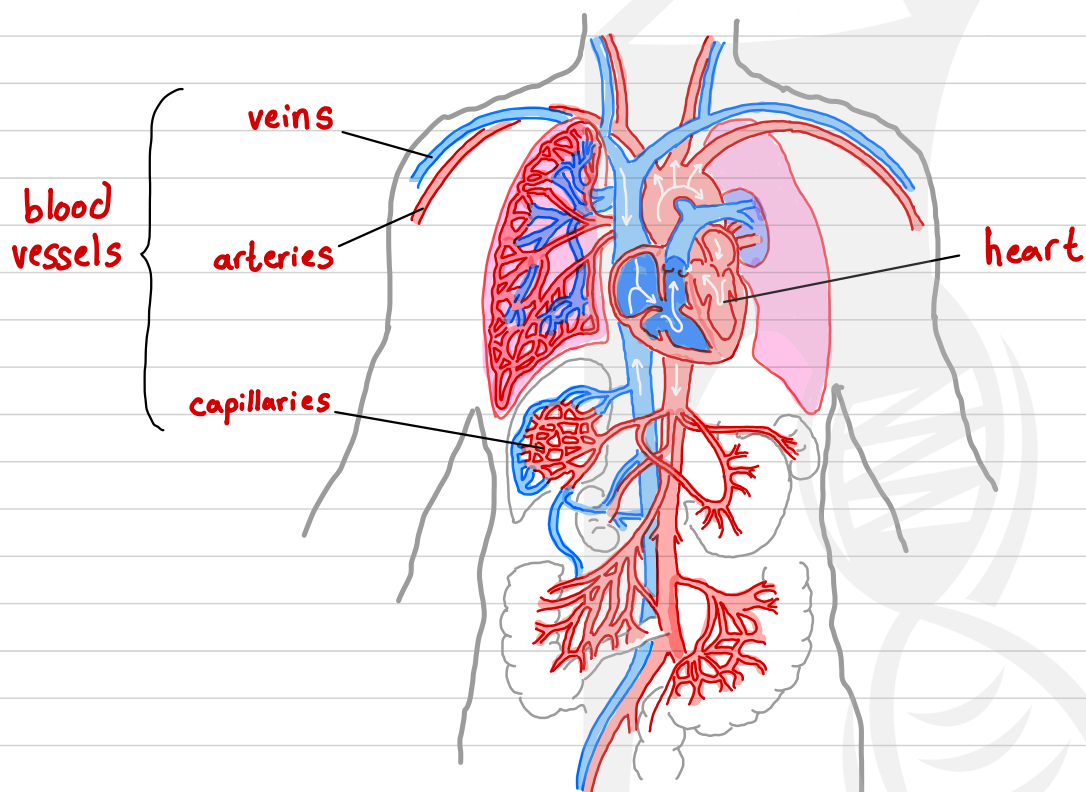


Cardiovascular system

- functions:
- transports oxygen to tissues
 - transports nutrients to tissues
 - transports wastes from metabolism (CO₂, urea) from tissues to excretory system
 - transports hormones and blood cells

interesting information:

- the body has ~5 L of blood
- all blood vessels lined end to end = 100,000 km
- your heart beats ~100,000 / day
- the heart beats without input from the brain
- all blood is red, veins appear blue due to skin
- it takes <1 minute for blood to circulate the body

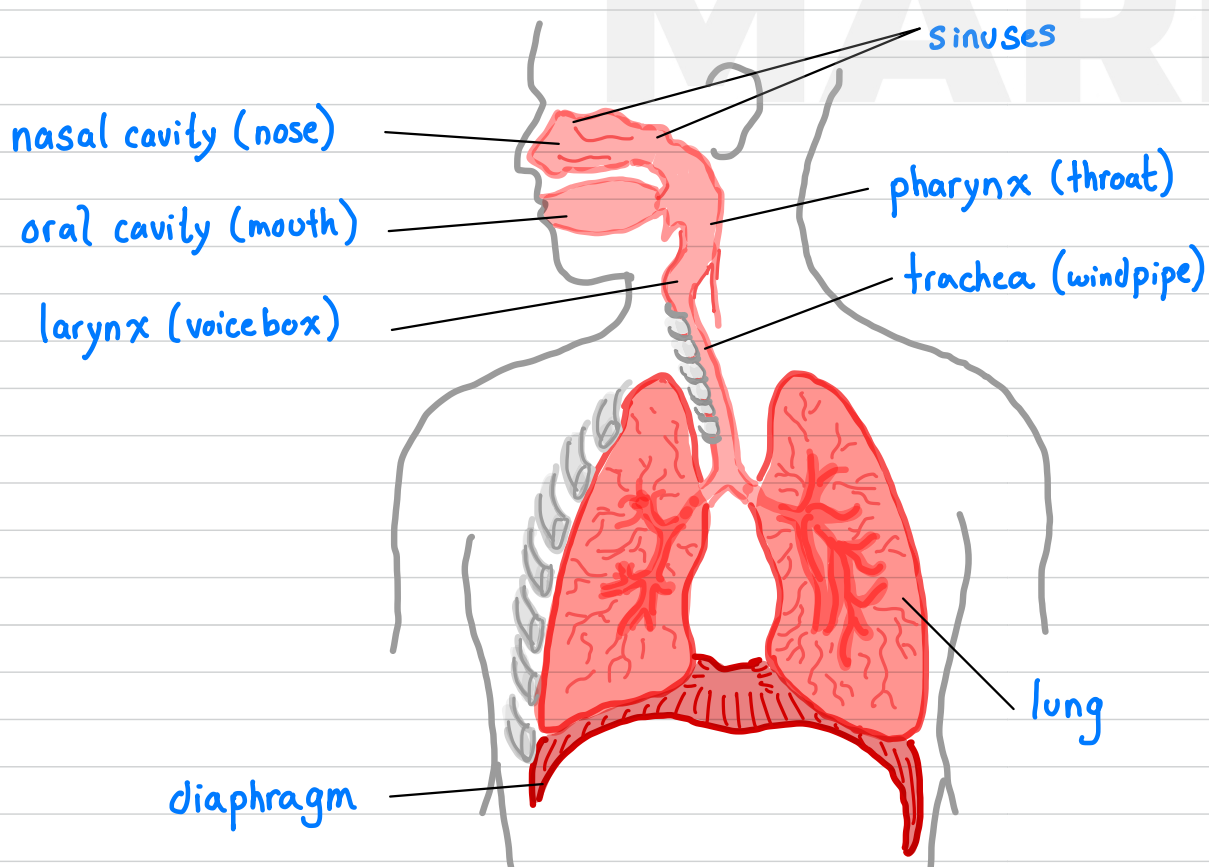


Respiratory system

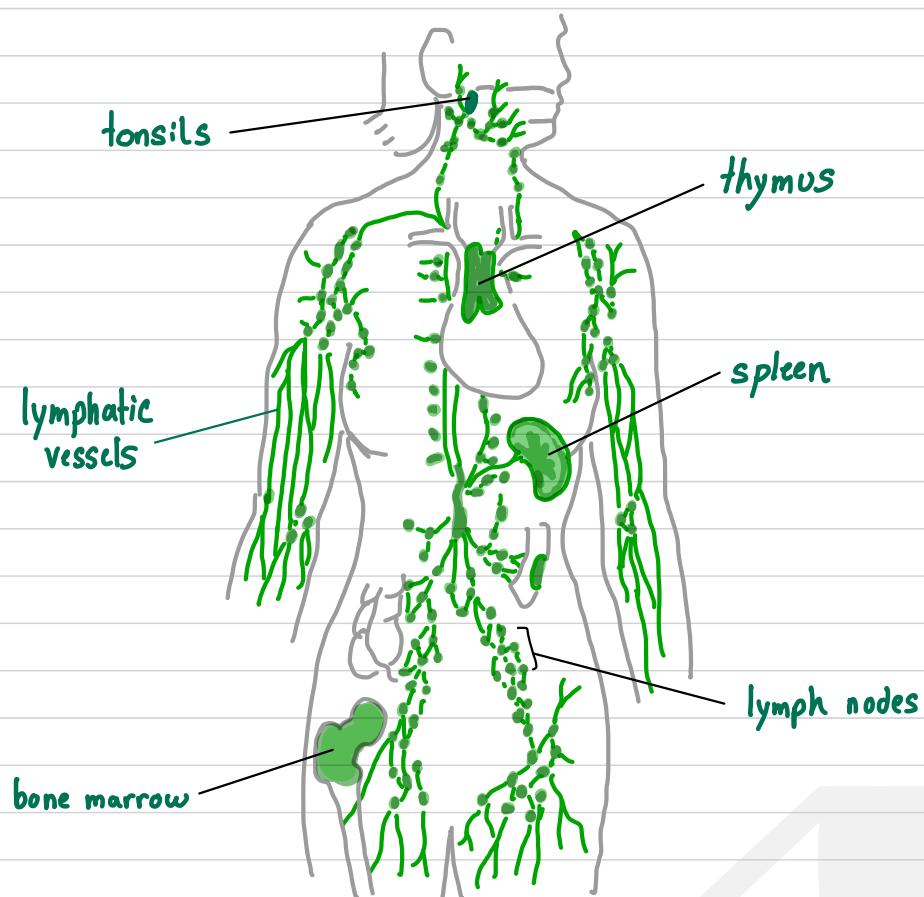
- functions:
- inhales O₂ (air → blood)
 - exhales CO₂ (blood → air)
 - produces sound
 - prevents harmful substances from entering

interesting information:

- left lung is smaller than the right to accommodate heart
- there are ~480 000 000 air sacs in the lungs
- the surface area of the lungs is ~50-75 m²
- lungs are the only organs that float on water
- a person produces 1-2 L of mucus per day
- your voice is produced by vibrating your vocal folds



Human Organ Systems

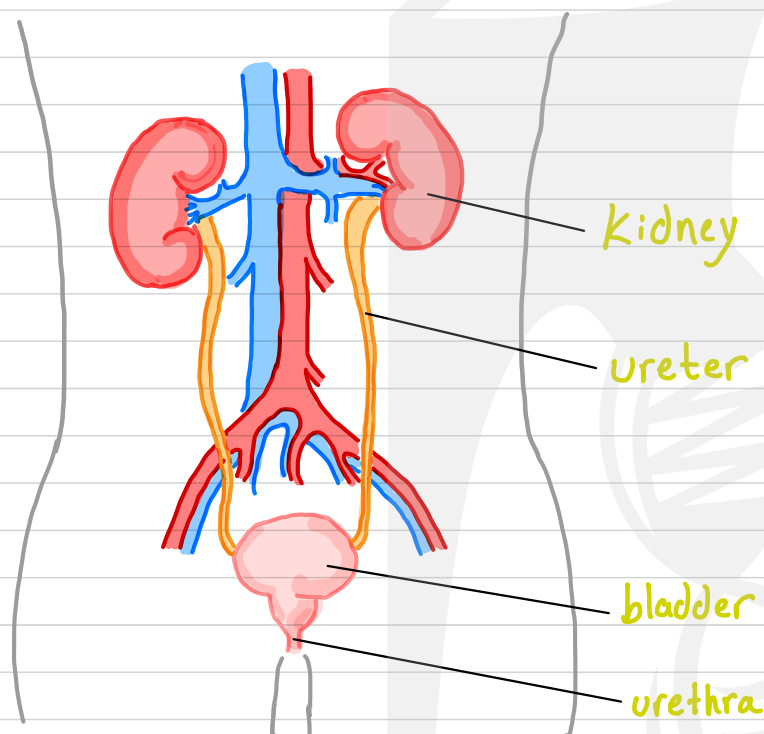


Lymphatic system

- functions:
- removal of excess fluids from tissues
 - absorption + transport of fats around body
 - production of immune cells - fight invaders

interesting information:

- there are 500-600 lymph nodes in the body
- lymph flows in one direction, towards the neck and moves via muscles and gravity
- you can live without the spleen, but are more prone to infection
- swollen lymph nodes means your body is fighting an infection

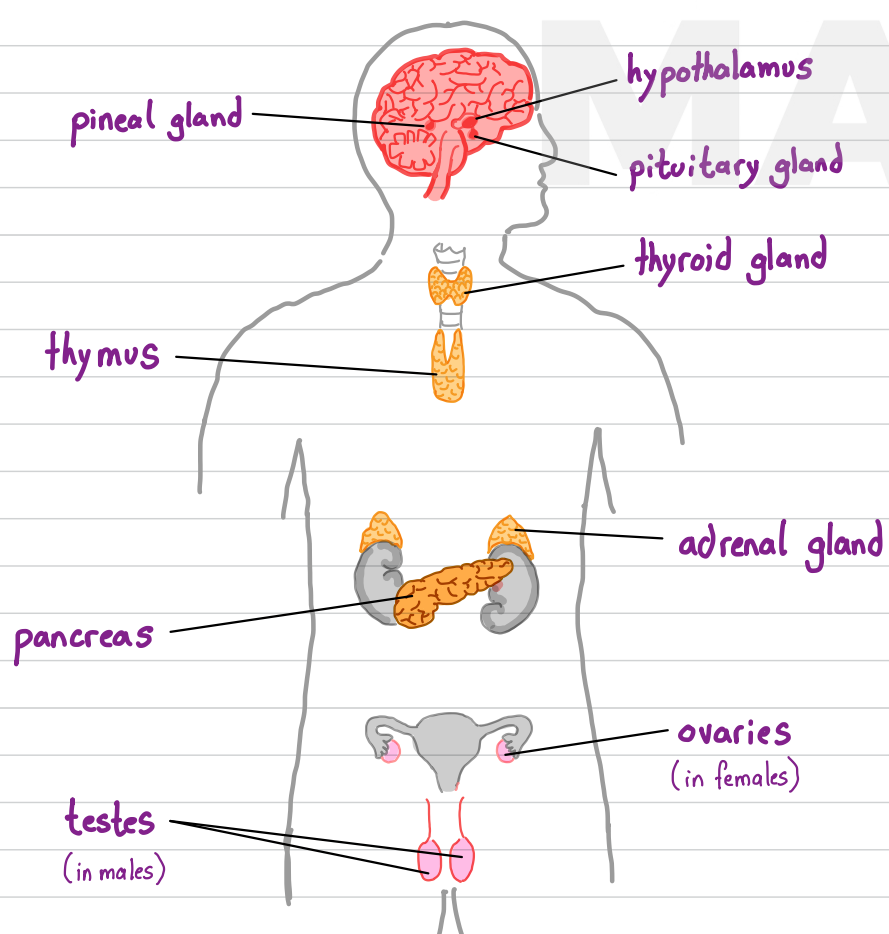


Excretory system

- functions:
- filters wastes from the blood
 - removal of metabolic wastes (urine)
 - regulates fluid levels

interesting information:

- the kidneys filter ~ 200L of blood per day
- the bladder can hold ~ 500-600 mL of urine
- kidneys produce 30-50 mL of urine / hour
- the right kidney is smaller and lower to make room for liver
- you can survive with one kidney



Endocrine system

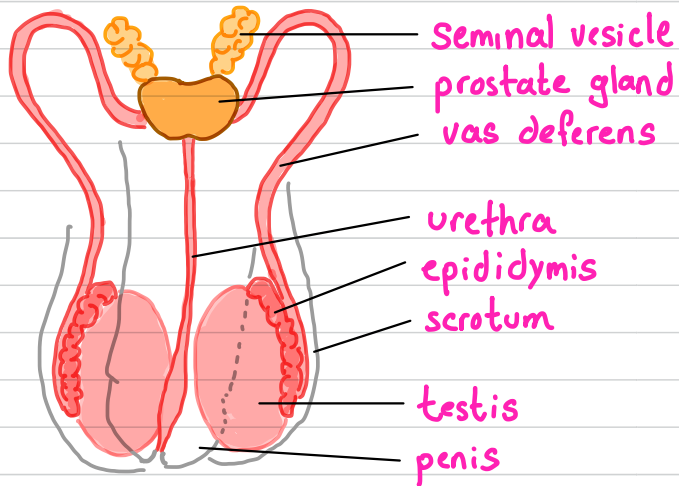
- functions:
- produce **hormones** which regulate bodily functions
 - ↳ chemical messengers (travel through the blood)

interesting information:

- there are >50 different hormones in humans
- hormones are released directly into + travel through the blood
- hormones control your mood, growth, metabolism, reproduction, organs, and more

Human Organ Systems

male:

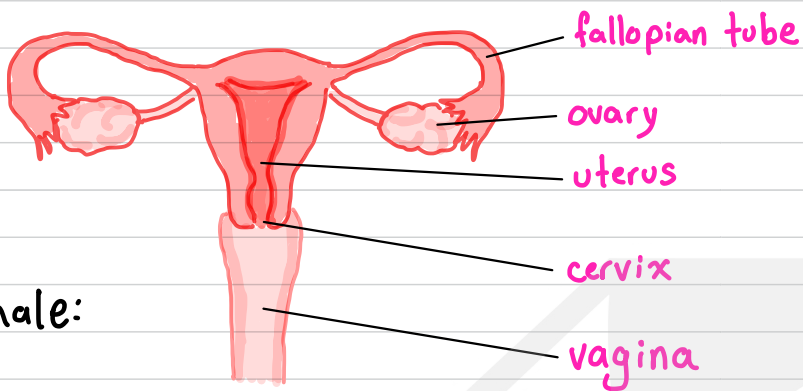


seminal vesicle
prostate gland
vas deferens

urethra
epididymis
scrotum

testis
penis

female:



fallopian tube

ovary

uterus

cervix

vagina

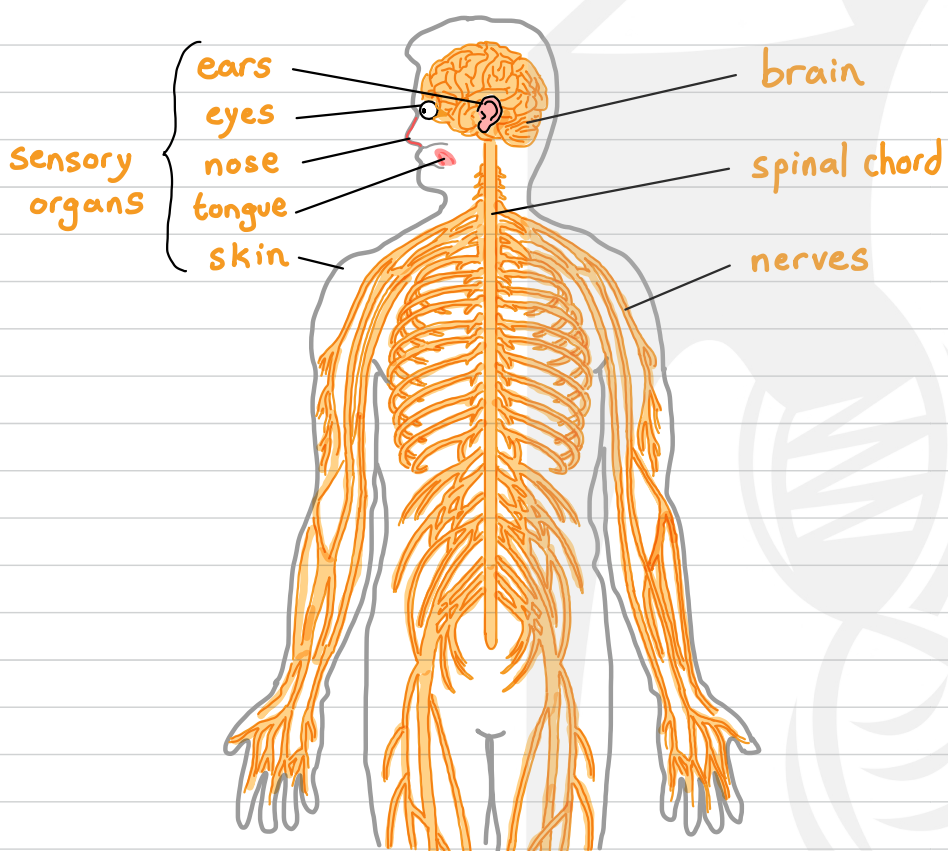
Reproductive system

functions:

- production of gametes (sperm + ova)
- protect and nourish developing fetus (female)

interesting information:

- sperm is the smallest cell and ova are the largest (0.03mm) (0.1mm)
- testes produce 1500 sperm / second
- sperm can survive in female reproductive system for 5 days
- female reproductive system has many microorganisms which keep it clean & protect against pathogens
- more than 40ml of blood are lost during a period
- the uterus stretches >500x its size during pregnancy



sensory organs
ears
eyes
nose
tongue
skin

brain

spinal cord

nerves

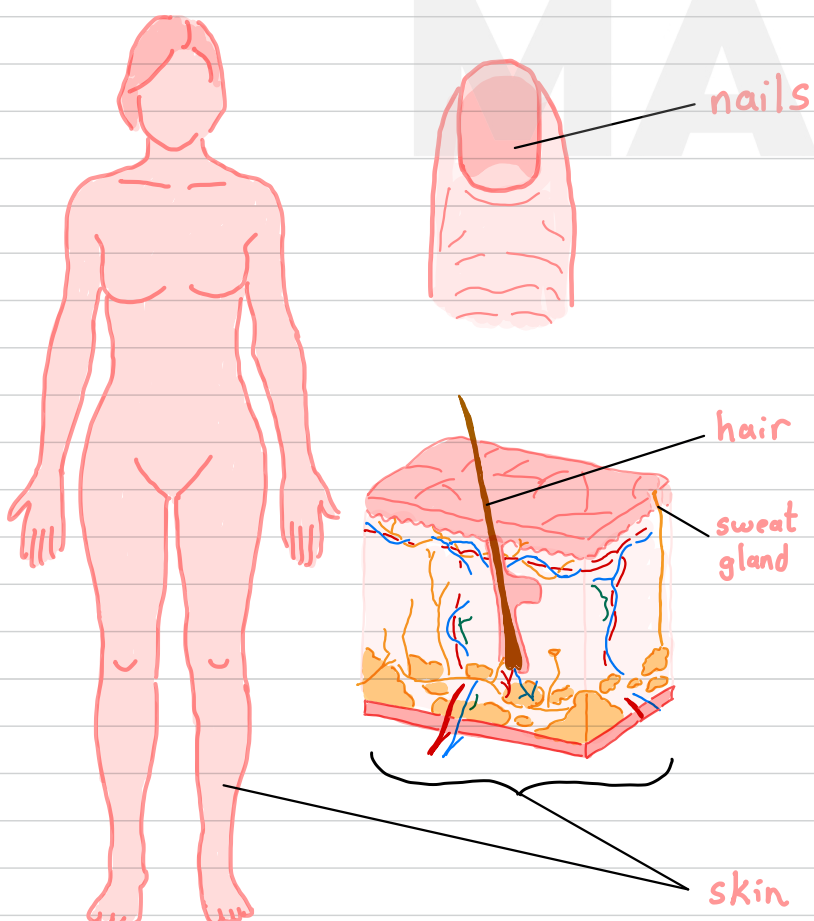
Nervous system

functions:

- detects stimuli (sensory nervous system)
- generate responses (both voluntary + involuntary)

interesting information:

- nerves carry signals at speeds >100 m/s
- the brain uses >20% of the body's energy
- neurons can't divide or repair from damage
- neurons are the longest cell in the body
- involuntary reflexes are not controlled by your brain
- brain structure changes as we learn
- the skin contains ~200 pain receptors/cm²



nails

hair

sweat gland

skin

Integumentary system

functions:

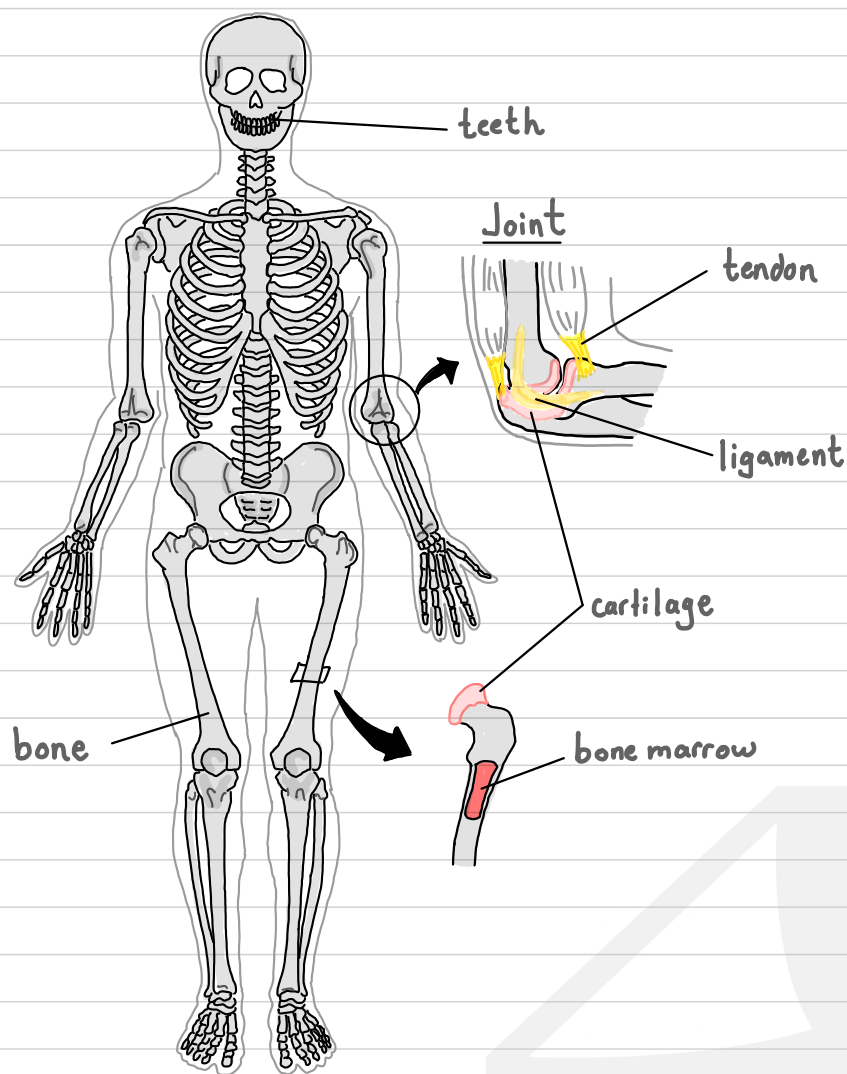
- protect body from invaders and damage
- regulates temperature
- regulates fluids

interesting information:

- the skin is the largest organ
- we shed 30000 - 40000 skin cells / min
- nails grow ~3.5mm/month
- body has 5000000 hair follicles but only ~100000 on head
- body can produce a max of 4L of sweat/hour
- the outer layer of skin contains >25 layers of dead cells

Human Organ Systems

Skeletal system

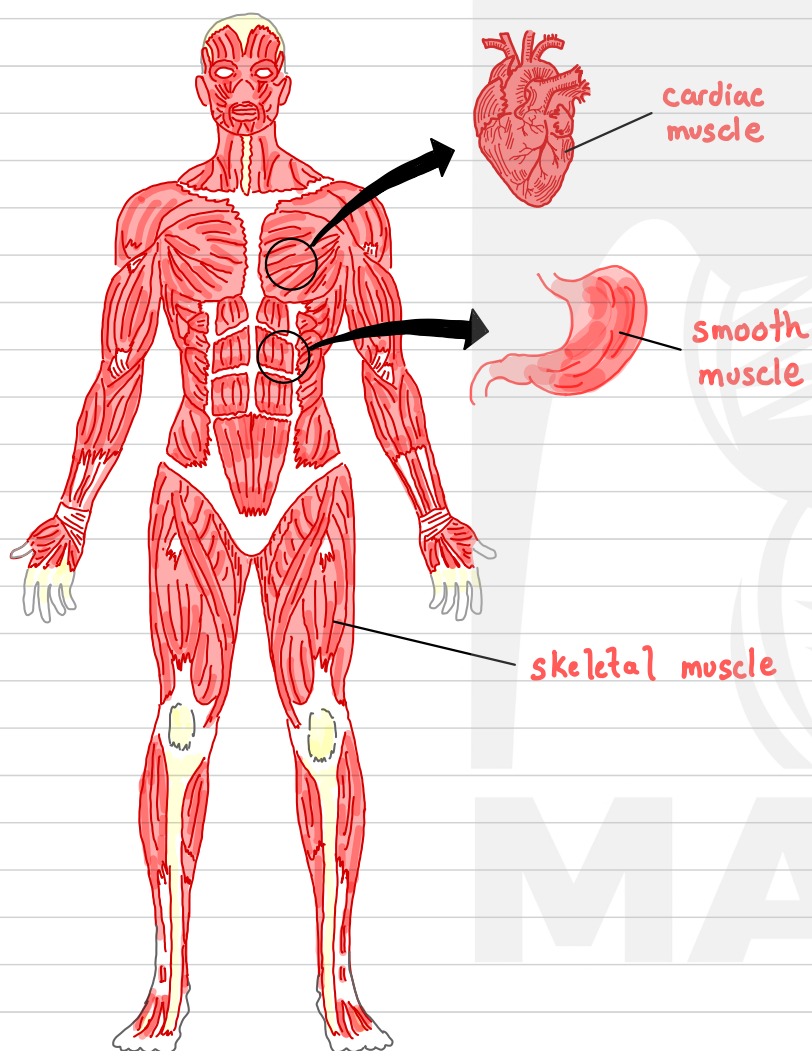


- functions:
- provides framework, supports body structures
 - protects vital organs
 - aids in movement (attached to muscles)
 - bone marrow is site of blood cell production
 - store minerals

interesting information:

- a baby has 300 bones but an adult has 206
- the femur is the longest (48cm) and strongest bone
- the smallest bone is the stapes in the ear (3.2mm)
- the skull is made up of 14 bones which are fused together
- >50% of bones are in hands (27 each) and feet (26 each)
- adults have 32 teeth
- tooth enamel is stronger than bone
- the hyoid bone in the neck is only bone not connected to another
- there are ~900 ligaments and >4000 tendons

Muscular system



- functions:
- responsible for all movement, both: voluntary and involuntary

interesting information:

- there are ~650 skeletal muscles
- the largest muscle is the gluteus maximus (buttocks)
- the strongest muscle is the masseter (jaw muscle)
- muscles produce >85% of your body heat
- the busiest muscles are the eye muscles - move >100000 x/day
- muscles can't push, they can only pull
- muscles grow by first tearing and then being repaired
- you use 43 muscles to frown