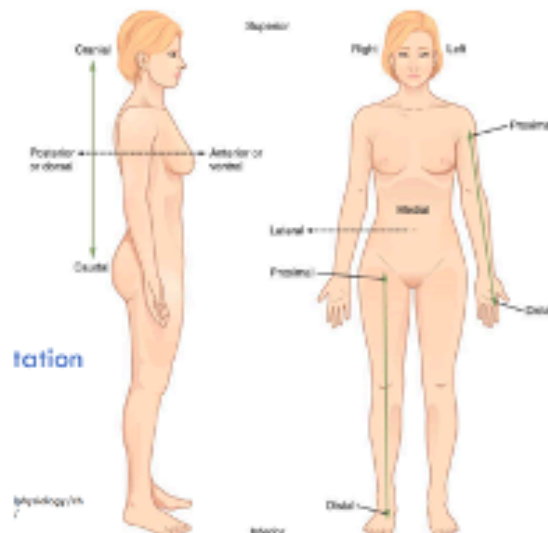
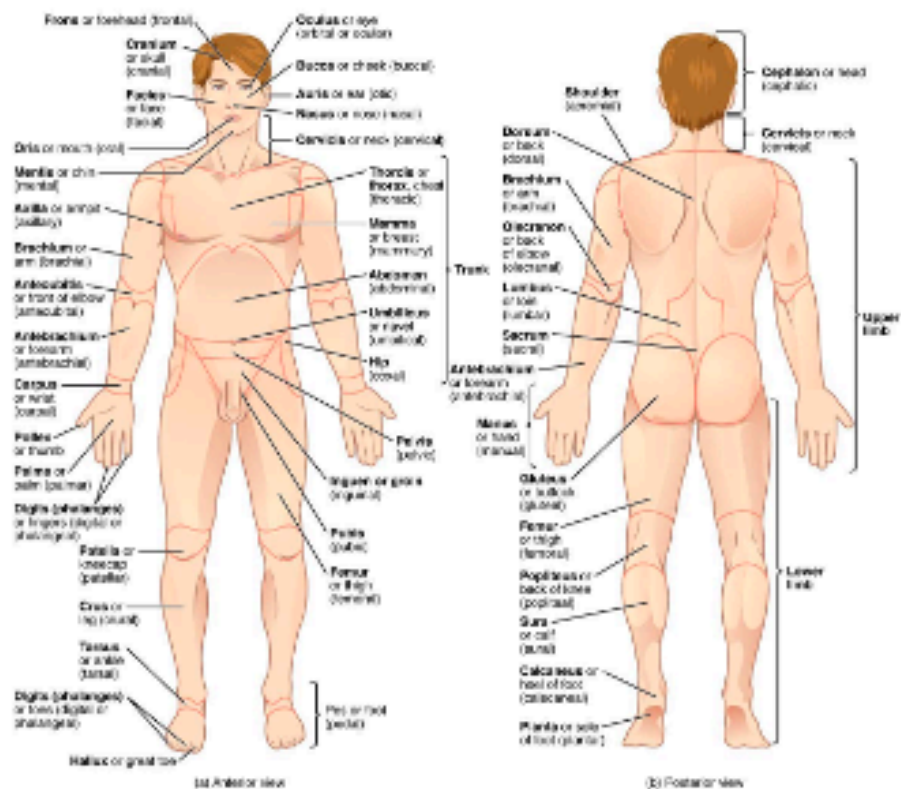


Topic 1: Cell Diversity

- Theory of natural selection: Organisms produce more offspring than are able to survive in their environment. Those that are better physically equipped survive, grow and reproduce
- Cell theory:
 - o All organisms are made of cells
 - o Cells are the basic units of life
 - o Cells come from pre-existing cells that have multiplied
 - o Organisms are made of cells and water + other minerals
 - Different types of cells, e.g. blood cells (red and white), skin cells, muscle cells
- Classes of cells:
 - o Prokaryotes: Cells that lack a nucleus and other organelles
 - o Eukaryotes: Cells that contain a nucleus and organelles
- Apoptosis: Programmed Cell Death
 - o As many as 10^{11} cells can die in one day in a living organism and are replaced by new ones
- Tissues: complex organizational arrangements of cells to fulfill specific functions
 - o Combine to form organs
 - o Organs combine to form an organ system
- Types:
 - o Epithelial – Skin + Lining of hollow organs
 - o Connective – Soft padding tissue (Made of fibroblasts and adipose)
 - o Muscle – Cardiac, Smooth and Skeletal Muscle
 - o Nervous – Brain, Spinal cord and nerves
 - o Adipose – Fat
- Human Genome Project: 1990-2003, mapped the entire DNA of a human
 - o Around 20000 protein-coding genes in the human body
 - o Humans are made of roughly 60-65% fluids and 35-40% solids (more fluid in men than women)

Terminology:





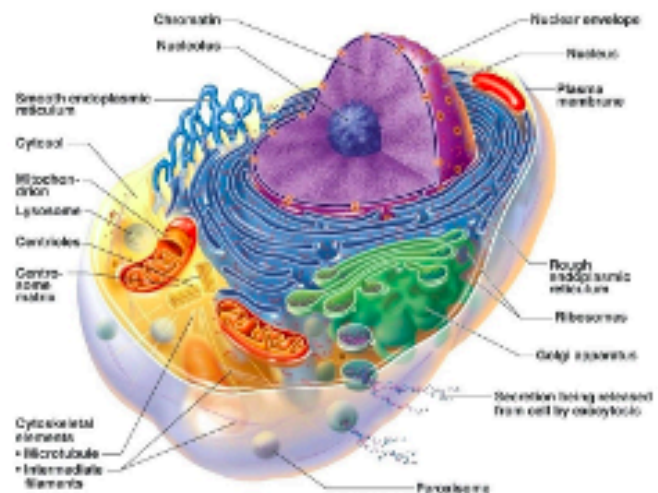
- Systems need balance: E.g. acid-base buffers for CO_2 /Electrolytes
- This is harder to achieve with the complexity of the human body (tightly packed + high surface area to volume ratio)
- Developments have been able to alter human germ lines and genes to produce offspring that becomes less susceptible to diseases
 - o Raised many ethical concerns and controversies
- Other developments (still in development):
 - o Exoskeletons: Battery-powered system that attaches to body and allows for remote controlled movements, allowing people to walk with a natural gait
 - o Bionic ears, eyes and artificial hearts: Implants that mimic the functions of these organs by using electric impulses and transmitters
 - o 3D printed organs (e.g. kidneys)

Topic 2: Cell Structure

- Humans start as one cell (fertilised ovum) that multiplies into an organism (of around 37 trillion cells)
- Cells grow by themselves and perform their functions on their own (e.g. individual heart and neuron cells beat/vibrate and are self-sufficient given the required energy intake)
- All have common structural features, but different functions and structures

Cell Breakdown:

- **Nucleus:** Controls cell functions
- **Nucleolus:** Site of RNA transcription and ribosome biogenesis (ribosomes cause protein synthesis and DNA replication)
- **Rough endoplasmic reticulum:** Involved in protein synthesis and folding
- **Smooth endoplasmic reticulum:** Lipid and steroid hormone production
- **Golgi apparatus:** Sorts proteins from the ER (endoplasmic reticulum)
- **Mitochondria:** Makes ATP (energy) to power cells through respiration, contain their own DNA
- **Lysosomes:** Acidic organelles for waste breakdown and disposal
- **Cytoskeleton:** Made of filaments and tubules, used for structure, support and movement



Movement in Cells:

- The **plasma membrane (phospholipid bilayer)** is the lining of the cell
- The membrane is a thick sheet (non-rigid) with hydrophilic edges and a hydrophobic interior (intercellular space is hydrophobic)
 - o Impermeable to most molecules and ions (without facilitated diffusion):
 - Metal ions
 - Large molecules (e.g. proteins and RNA)
 - Hydrophilic molecules like glucose
 - o Let water + small uncharged molecules through (e.g. oxygen, carbon dioxide)
- Movement of molecules is by **diffusion** (molecules become equally distributed due to their random motion. Facilitated diffusion uses carrier proteins to pass molecules/ions through the membrane)
 - o Water also follows diffusion, and flows to where its concentration is lower, as to reach an equilibrium concentration (where concentration [in M] is the same on both sides)
 - o **Osmosis:** Movement of water through a semi-permeable membrane (e.g. skin, plasma membrane) to a compartment that has a higher concentration of solute
 - o **Facilitated diffusion:** When carrier proteins facilitate the movement of molecules through the cell membrane
 - **Passive transport:** Movement along the concentration gradient (high \rightarrow low concentration by diffusion) without using energy
 - **Active transport:** Movement against the concentration gradient using ATP energy

