BIO 103: Digitized Notes

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Guide 1A: Cells & Discovery

Four Course Topics

Over this course we will focus on four main fields related to the Human body and biology in general. These four topics are:

1. 🧱 **Anatomy**: The *structure* of biology-related things like organs, cells, people, etc.

2. 💪 **Physiology**: The *function* of biological mechanisms like veins moving blood or our lungs breathing in oxygen.

3. 💀 **Disease**: An *altercation in the function* of our bodily mechanisms.

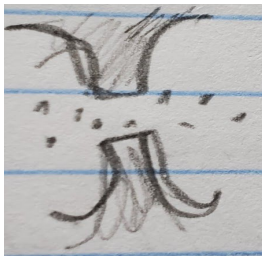
4. ❤ **Health**: How we *prevent disease and maintain* regular bodily functioning.

Contexts: How biology influences our decisions

When it comes to modern day society many micro and macro level decisions get made with consideration to our biological wellbeing. This can be categorized into three distinct levels or contexts.

1. 💲 **Consumer**: How biology factors into our everyday personal choices like whether or not to go out exercising or what foods to buy/eat.
2. **Cultural**: How biological concerns modify our collective action in community settings (like people social distancing in light of the nCOVID-19 pandemic.
3. ⚖ **Citizenry**: How we make choices at a governmental level regarding biological concerns like Healthcare or mandating quarantines.

Metacognition→ Learning:



How do we “learn”? Well at a granular level we can consider learning to be the process of making memories via neurons (cells in the brain) making a connection called a “synapse”.

We can better facilitate these connections via some good advice and a couple basic wellness related habits.

1. Getting Enough Sleep 💤
2. Eating a balanced diet 🍴🍞
3. Generalized Learning Advice: 🏫
    a. Goal Insight:
        i. Goal setting: Determining an End-goal
        ii. Identifying Barriers & Motivation
        iii. Producing a Plan to achieve goal & overcome barriers
    b. Trial & Error:
        i. Being open to the possibility of failure and continuing to try after failing. Reflecting on current tactics and changing learning strategies accordingly.
    c. Repetition:
        i. Doing something multiple times in order to gain an instinctive understanding.
        ii. Examples: Notecards, memorization practice, practicing skills.
    d. Reduce Interferences
        i. Removing distractions in the form of media devices or other things that may impair your attention-span.

Science Discovery:

3 Aspects of Science Discovery:

- 🔎 **Exploration**: Investigating a personally new natural phenomena (thing or occurrence) like a new location or another method of seeing things.

- 📝 **Description**: Recording details and information about the new thing via some medium such as written text or maybe even a picture of the phenomena.

- ❓ **Explanation**: Providing a rationale for why the phenomena occurs in way it does, this can vary in complexity from a basic cause/effect relationship to a more complex systems theory. This final step oftentimes involves inference making where based on the evidence acquired in the previous steps we then make a conclusion. We should be

careful though about the conclusions we make as we can easily make conclusions that are incorrect either through a logical error or from faulty evidence. Either way, we should be careful to not end up concluding on a misconception and should be open to alternative explanations.

Microscopes 🔬:

Microscopes are a useful technology for investigating really tiny things like cells! They date back to the 17th century and since then magnification technology has become a lot better in recent years. Ancient microscopes could only obtain about a magnification 10x finer than the human eye whereas more modern light-based microscopes can obtain 1500x magnification and high-tech electron microscopes from the 20th century can reach over 200,000x greater magnification!

There's a few important notes about microscopes:

- The **overall magnification of a microscope is measured by multiplying the eye-piece's magnification by the objective lense** (so a 10x eye-piece and 40x objective lense would result in 400x magnification!)

- **Slides used for microscopes are stained with dye so as to see cells** which otherwise would not be visible under the light of a microscope. So that is where the color comes from for most microscope images.

- Most slides using microscopy are **cross-sections of 3 dimensional objects** which won't always give us the full picture. This is why using multiple samples from different locations can help prevent faulty conclusions from a limited selection of samples.

- There's often a range in given objective lenses in order to better pin-point locations to observe with a finer microscope. A person might start off with a 40x lense to find a particular location on a cell to observe before switching to a higher magnification lense to obtain more detailed images.

Cells & Tissues:

A **tissue** is a group of connected cells. Most complex organisms are made up of many cells, and consequently a lot of tissue! There's a few types of tissue we should know.

1. **Epithelial Tissues:** Often seen as linings for the outsides (and occasionally insides) of organs and serve a protective function.

2. **Connective Tissues:** These tissues make up most organs and provide an essential role in maintaining the shape of an Organ.

3. **Muscle Tissue:** These tissues often gear themselves towards allowing movement like contracting and relaxing muscles.

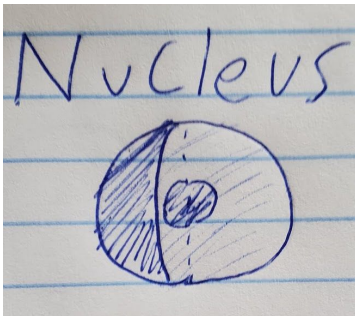
4. **Nervous Tissues:** These tissues are responsible for communication throughout the body (like your finger nerves telling your brain that the stove you're touching is hot).

Cell Structures:

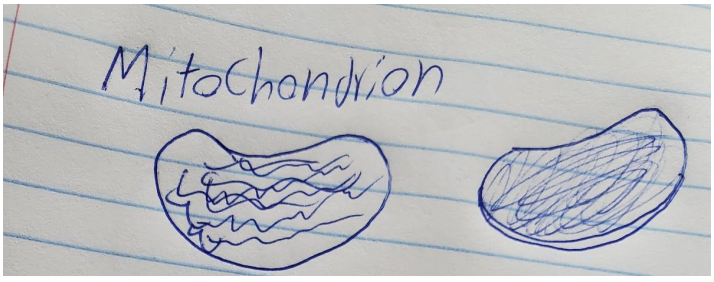
Organisms are made up of cells which in turn are made up of modular cell-like-things called organelles. The two most common cell types discussed in biology classes are plant and animal cells which while sharing similarities, (both have plasma membrane and nuclei) also have a lot of differences (plant cells have chloroplasts, thicker membranes and generally a more angular shape).

Here are some common animal cell organelles along with their shapes:

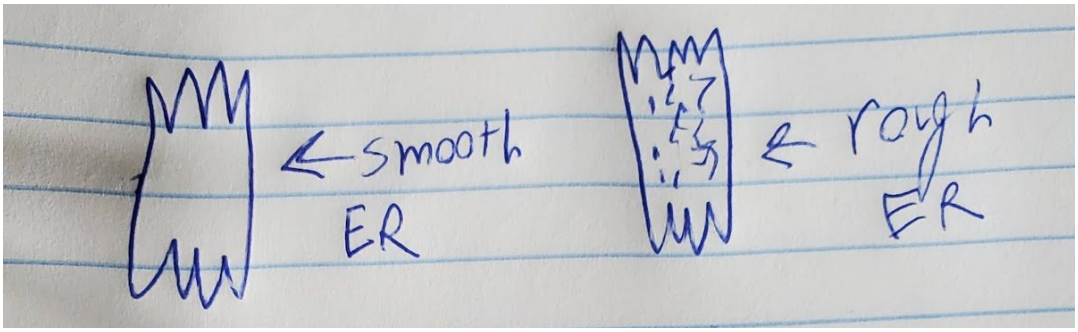
- **Nucleus:** The nucleus normally occupies the center of a cell and holds the genetic information of a cell for later cell replication. They generally are depicted as being circular spheroids.



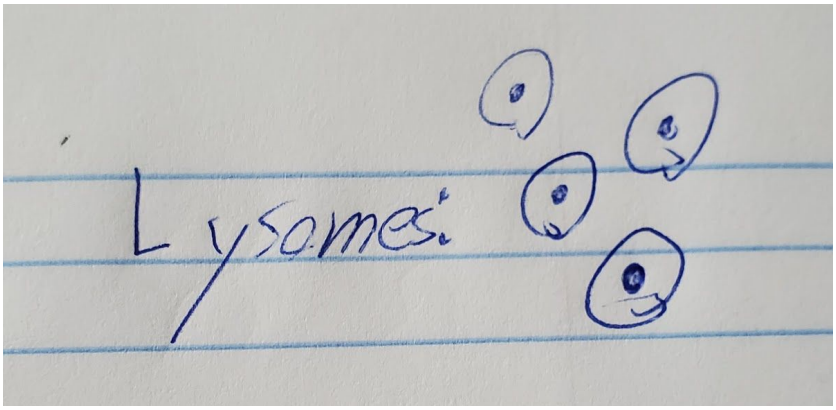
- **Mitochondrion:** The mitochondrion are the “powerhouse” of the cell because they produce “energy rich” ATP molecules used for important cell processes like *active-transport* in the plasma membrane. The mitochondrion generally come in a peanut-shape and look kinda like beans when shown in 3D.



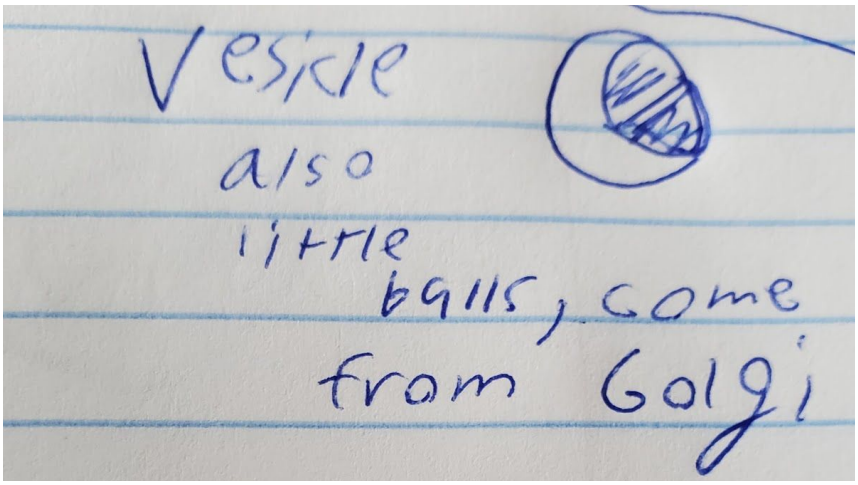
- **Smooth & Rough Endoplasmic Reticulum (ER):** The endoplasmic reticulum produces important resources for the cell varying based on its type. The rough ER produces proteins whereas the smooth ER produces lipids. Both ERs look like weird 3D flaps with the main difference being that the rough ER has more texture to it with dots and stuff whereas the smooth ER is, well, smooth.



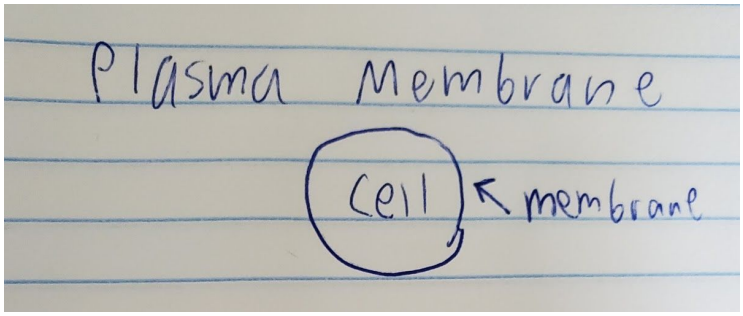
- **Lysosome:** Has enzymes which decompose bacteria, old organelles and other miscellaneous unneeded cellular materials. This has a pretty simple circular spheroid shape but can sometimes stand out due to somewhat visible membranes.



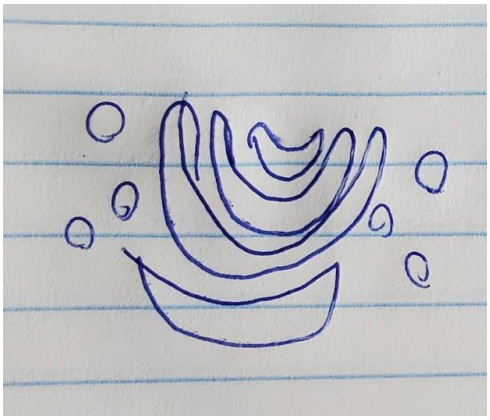
- **Vesicle:** Transporters for the cell which carry cell produced stuff like hormones and secretes them towards the membrane. Look geometrically similar to lysosomes but can oftentimes be differentiated as vesicles can be found closer to the plasma membrane (as that's where they head to after-all)



- **Plasma Membrane:** Outside coating of the cell allowing for the transportation of substances in and outside the cell.



- **Golgi Complex:** The Golgi Complex is a weird pokey oval thing with a cross-section that looks like a butterfly. It acts as an effective factory for the cell producing cool things like Lysosome, Vesicles and processing acid-chains from the Rough ER into proteins!



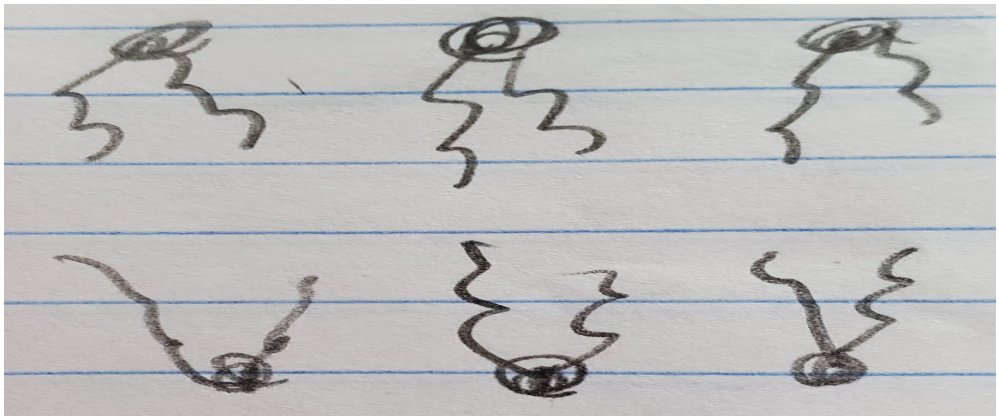
Diffusion and the Plasma Membrane:

Diffusion, simply put, is the process of a substance moving from an area with a high concentration to an area with a lower concentration. This process is commonly used in transporting substances in or out of a cell through the plasma membrane.

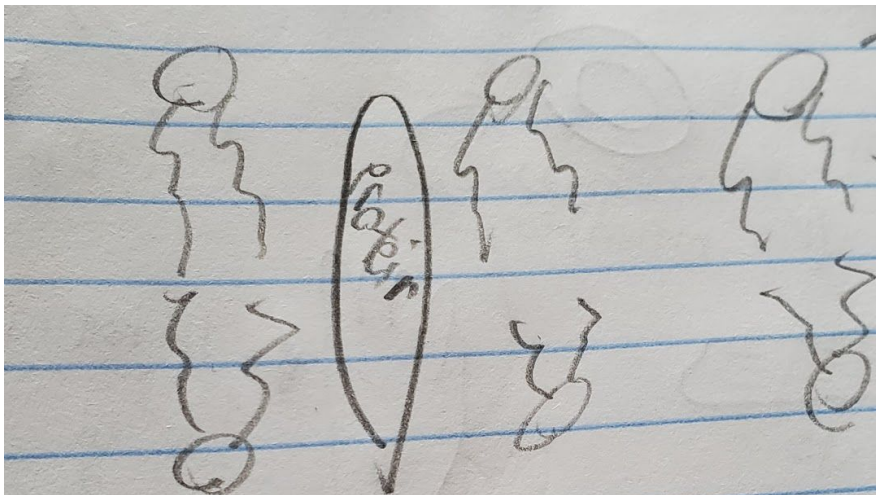
We normally defined **simple diffusion** just as the general process of a substance going from a high to low concentration. However we get more specific when we get to the plasma-membrane.

Anatomy of Plasma Membrane:
The plasma membrane is made up of two layers of “phospholipids” which have little water-soluble heads and long water-insoluble legs.

These phospholipids don't allow substances to travel through them which is why specialized proteins will embed themselves in-between the phospholipids to act a "bridge" permitting substances to travel along them in two specific cases.



Facilitated Diffusion: This process is when a protein allows a substance to travel through the plasma-membrane without expending energy through diffusion.

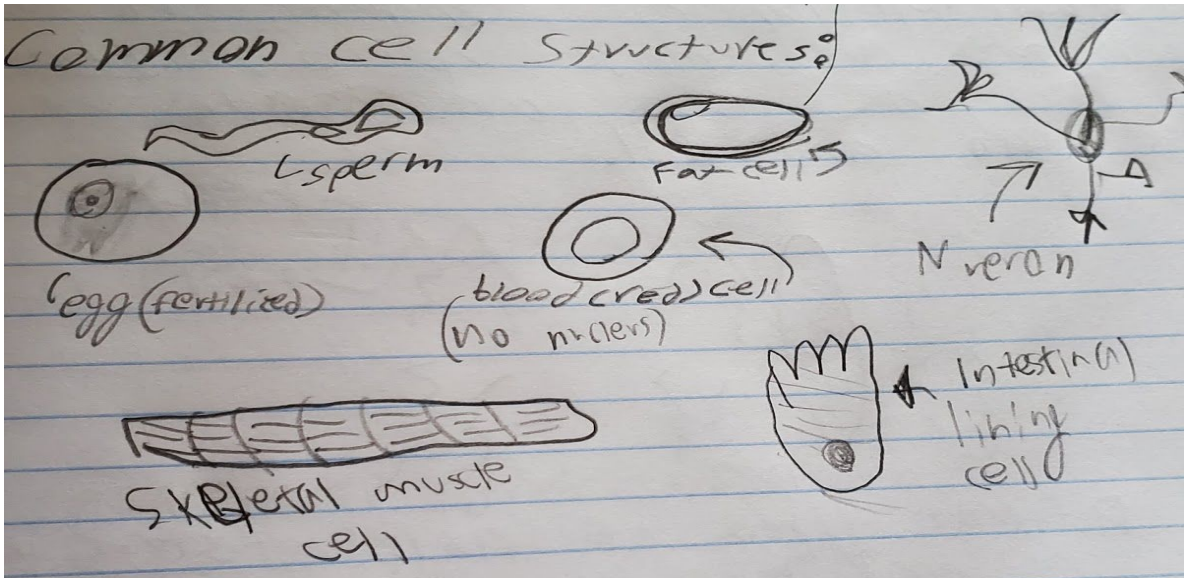


Active Transport: This process is the reverse of diffusion as it is when a substance moves from a high-concentration low-concentration area and needs help actually traveling through the plasma membrane. In this scenario proteins with energy-rich ATF molecules help the substance complete its journey through the membrane.

Cell-lives:

While we often see abstract archetypal models of cells as circular and of some uniform geometry, the reality is actual cells vary significantly in relation to their function. A fat cell for-instance will have organelles to the side to make room for the energy it stores in its membrane whereas neurons will often contain branches used for making connections with other

neurons and intestinal lining-cells will often have a hard coding to protect itself from harsh stomach acid. Understanding the different cell anatomy plays in its physiology is important in biology for gaining an appreciation for the body's diverse range of functions.



Four Stages of Cell-Life: 🎉

1. ***Mitosis***: Cell divides into two 'daughter' cells.

2. ***Hypertrophy:*** Can happen after mitosis, cell grows larger

3. ***Differentiation***: Also can happen after mitosis, where Cell changes its structure and functioning

4. ***Apoptosis***: Phase where the cell is programmed to die. 😢

Guide 1B: Integumentary System

The integumentary system basically functions as the “crust” of large complex organisms like Humans and other mammals. Focusing on humans the Integumentary system basically is the skin and all the stuff which grows on top of our skin like hair, nails and oily acne bumps.

Skin Structure (Anatomy): 3 Layers

Our skin has three distinctive layers whose depth varies across the body:

1. Epidermis:
    a. **Description**: The epidermis is the top layer of our skin which is where all our hair and other stuff is that we can touch. Two notable cells at this level are the *keratinocytes* and *melanocytes*. *Keratinocytes* produce keratin which is what all our hair and nails are made out of. Whereas *melanocytes* produce melanin which absorbs UV radiation from the Sun in order to protect our internal cells from mutating. This sort of backfires when our cells in the epidermis mutate though (skin cancer).
    b. **Tissue Type:** Epithelial
    c. **Important Cells**: Keratinocytes, Melanocytes
    d. **Burn depth🔥: 1°** (First degree)
2. Dermis:
    a. **Description**: The “meat” of skin, contains important stuff like sweat glands and hair follicles. This also contains Fibroblasts which produce collagen proteins which allow our skin to actually be flexible instead of a brittle substance that just breaks when we bend it.
    b. **Tissue Type**: Connective
    c. **Important Cells**: Fibroblasts
    d. **Burn depth🔥: 2°** (Second degree)
3. Hypodermis:
    a. **Description:** This is the bottom layer of skin which contains stuff like blood veins. This is why
    b. **Tissue Type**: Connective
    c. **Burn depth 🔥: 3°** (Third degree)

Integumentary Functions (Physiology):

The integumentary system provides some pretty essential functions for our bodies.

- ➢ **Protection**:
  - ➥ Stops pathogens and elements from entering our body thanks to skin.
- ➢ **Gripping:**
  - ➥ Our fingers have texture allowing us to hold onto things more easily
- ➢ **Vitamin D Synthesis:**
  - ➥ The dermis can absorb sunlight and process it into Vitamin D so we don't necessarily need to get Vitamin D from our diet.
- ➢ **Oil Production:**
  - ➥ Our **sebaceous oil gland secretes lipid-rich sebum** which can keep our skin from potentially drying out and cracking. Oil production increases during puberty (we don't exactly know why) and tends to decrease in advanced age)
- ➢ **Thermoregulation (Temperature Regulation):**
  - ➥ Our integumentary system tries to maintain our body temperature at a particular range. As such our integumentary system will react differently in extreme temperatures.
    - ➘ TOO COLD ❄❄❄:
      - ➡ When it's too cold our blood veins contract to release less heat (as such our skin also becomes more pale), our sweat glands do not secrete sweat, our hair stands up at our muscles which hold our hairs contract.
    - ➘ TOO HOT ♨♨♨:
      - ➡ When it's too hot our blood vessels dilate (expand) to release more internal body heat (making our skin more pink), our muscles holding our hairs relax so our hair rests on our skin, and most obviously our sweat gland releases sweat which evaporates on our skin's surface cooling us off.
- ➢ **Sensation**:
  - ➥ Our integumentary system provides us with an array of senses allowing us to more effectively navigate the world.
    - ➘ **Light Pressure Sensors:** Allow us to feel texture and when something lightly touches us.
    - ➘ **Deep Pressure Sensors:** Allow us to feel heavy pressure like when sitting on a chair is uncomfortable or the like.
    - ➘ **Temperature:** We can sense when its hot/cold
    - ➘ **Pain:** We have a lot of open nerve endings on our skin which alert us of pain as a survival mechanism.

Skin Health:

Basically, wear sunblock to protect our skin from excessive UV radiation and also use soap to wash your hands numb-nuts.

Common Skin Conditions:

- Cellulite:
    - This refers to the collection of fat adipose cells.
        - This is a normal occurrence and can increase in frequency with age.
        - The dimpling effect comes from adipose scaffolding (basically structure of cells) collapsing.
- Acne Vulgaris:
    - When our oil glands produce excessive oil which builds up and hardens resulting in either black/white heads and pimples.
    - Actually doesn't really pose a health risk SO LONG as you don't scratch at them a lot as this can cause scarring.

Wound Healing Process:

When our integumentary system experiences damage through cuts or the like our body has a process to effectively return our integumentary system in that area to normal functioning.

1. **CLOTTING**: Fibrous proteins plug the wound preventing external entities from entering the body.
2. **SWELLING**: Blood seeps into the damaged area resulting in a "puffing up" effect which is essential for killing any pathogens or other harmful things which leak into our body.
3. **CELL REPLACEMENT**: Through cell mitosis and differentiation our lost cells get replaced over time to return our body to normal functioning.

However, sometimes our body experiences interference with the healing process which can result in scarring due to continuous wound opening eventually resulting in collagen having to plug the wound. Scarring is bad and really should avoid it.

Skin Disorders:

Our integumentary system experiences a lot of hardship which can oftentimes result in some bad stuff.

- Dermatitis:
    - "Titis" refers to excessive sweeling and occurs when our dermis experiences excessive swelling.
- Poison oak/ivy/other plants:
    - Many plants in the northwest secrete oil which can cause dermatitis in our skin.

    - Interestingly enough ~20% of people show no response to this oil. They are the superhumans and will one day conquer all of earth.
- Burns:
    - BAD (look under skin layers for difference between different degree burn depths).
    - In severe cases patients need skin grafting.
- MRSA: Methicillin-Resistant Staphylococcus (Staph Infections)
    - Not a particularly common but very nasty infection to get.
    - Antibiotic resistant bacteria who can erode skin.

Skin Cancer:

Cancer effectively refers to the phenomena when cells mutate resulting in either bypassing apoptosis and/or undergoing excessive mitosis. This can cause a problem if it matesizes (spreads) throughout the body as it can interfere with our body's normal functioning. I.E. plug an artery or other vital organ resulting in death. **Tumors** refer to a collection of cancer cells.

Skin cancer is pretty common as people either forgo sunscreen or partake in nasty habits like sun-tanning (don't do this its stupid).

An additional note is that the type of cell which mutates has an influence on the type and severity of the cancer which materializes.

Types of Skin Cancer:

All below skin cancer types refer to cell mutation occuring in the epidermis.

1. Basal Cell Carcinoma:
    a. Refers to mutated *keratinocytes* at the bottom of the epidermis, directly above the dermis. This is the most common type of skin cancer but thankfully the least fatal as it can be removed prior to metastasizing if detected early on.
2. Squamous Cell Carcinoma:
    a. Refers to mutated *keratinocytes* at a higher level in the epidermis which mutate. Less common but a more likely variant to metastasize than Basal Cell Carcinoma.
3. Malignant Melanoma:
    a. Refers to mutated melanocytes in the epidermis. This is the least common but most fatal variant of skin cancer.

How do you detect skin cancer?
You get a diagnosis from a health care professional. However, there are a few heuristics you can try to ballpark if you might have skin cancer. The most obvious indicator is that you have a visible cut or scar thing which expands and does not heal over time.

There's also the ABCDE test:
Asymmetry (not uniform), **B**order (has thicker edges), **C**olor (looks weird), **D**iameter (thick), **E**volution (gets worse over time)

Unfortunately since tumors grow under the skin it can be hard to tell how serious a potential skin tumor growth is as they can operate like an iceberg (the tip can easily be just a tiny fraction of its overall size). As such if you **suspect you have skin cancer go see a healthcare professional.**