

## Topic 5: Cancer

- Cancer: a part of your body that has lost the ability to control its growth and it grows uncontrollably and interferes with function
  - Beginning: things like cysts or wart
    - Will grow
    - Tend to stay in the same location and confined shape
    - In Canada they are non life threatening, however in third world country can get out of control
  - Malignant tumor
    - Uncontrolled
    - And can spread from one part of the body to another
    - Takes over your body and steal nutrients
    - Moves organs
    - Opens you up to infection
- The highest cause of death in Canada
  - The older you are the higher your risk of dying of cancer
    - Really low risk until you hit about 55 then it spikes
  - The death rate of cancer has not changed in the last 50 years
  - Men die of cancer at a much higher rate than women do
    - One reason is because more men smoke than women and lung cancer is a self inflicted disease by smoking
- Cancer is a lifestyle disease
- Occurs in children but is rare
- Treatments are very unpleasant:
  - Side effects can be similar to the effects of the disease
  - To be treated you have to be healthy enough to survive treatment
  - a lot of people will die from treatment instead of the actual disease
- Lung cancer has increased considerably due to smoking
- Stomach cancer has decreased but we do not understand why
- One of the cells in your body goes out of control
  - A small alteration in a single cell in your body and begins to grow uncontrollably
  - It is a separate organism within your body
    - Either uses up all your nutrients
    - Or interferes with your body functioning normally
  - Cells in our body do not divide all the time they do so in an extremely controlled manner
    - Only happen if a modification has to occur
      - To repair an injury for example
    - Some cells divide a lot some not very much
    - After a cell divides 50 times it can't divide anymore
    - They have a protective mechanism that it must be touching other cells
    - Must receive specific chemical signals
  - Cancer Cells:
    - Cells divide continuously
    - More than 50 cell divisions (immortal)

- Cells are mobile (metastasis)
- Cancer requires 8-10 mutations within the same cell (DNA letters, just a one letter change is considered a mutation)
  - A tumor typically takes 20 years to occur
  - Children with cancer have bad luck and developed a tumor very quickly
- There will never be a cure all for all types of cancers
  - Every cancer is different
  - Every cell in your body can develop cancer
- Biological signals are cascading chemical reactions
  - These are complicated systems and are easy to interfere with that can lead to the development of cancer
- Cell division is regulated in 2 ways
  - Stimulation (accelerator)
  - Repression (slows down/stop)
- Cancer mutations involve loss of function
  - Impossible to repair the function with small molecules
    - Easier to break something than to fix it
  - Cannot repair the damage with today's technology
    - Genetic repair expensive, difficult and unreliable

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- Programmed cell growth in wound healing
- Programmed cell death protects the body from viruses and cancer
  - We can detect cancerous cells and kill them off
  - P53 controls this
- Normal cells count cell division
  - The telamer counts this
    - Keeps our chromosomes from unwinding
    - Eventually once the cell has divided too many time the telamar disappears and the cell is unreadable (DNA comes unwound)
    - Cancer cells can rebuild the telamer
- Once we build a protein it can fold into a 3D
- Genetic Susceptibility:
  - Some individuals are more susceptible to cancer
    - Ex: someone with lighter skin have less protective material in their skin to protect them from skin cancer
- Tobacco
  - Nicotine is not the cancerous ingredient but it is the addictive one
  - Carcinogens:
    - Polonium 210
      - Found in the ocean water
      - Birds poop out this stuff after eating fish which created Concentrated in phosphate deposits
      - Alpha radiation which is safe (weak, our outer layer of skin protects us, if you are standing more than 10 cm away you are completely okay)

- When you burn something without enough oxygen to get a bunch of stuff that not good for you (found in the smoke of cigarette)
    - The chemicals in the smoke will interact with the DNA and cell division
- Tobacco smoke:
  - These things are in all types of smokes but when smoking a cigarette we ingest them directly whereas when beside a campfire you do not directing ingest the smoke
- Benzopyrene Carcinogenicity
  - Changes the DNA coding
- Cooking our food
  - When we cook our food we produce carcinogens
  - But we have to cook to our food to be able to eat it
  - The bacteria involved in meat rotting will also do damage to us because we are also made of meat
    - So we have to make sure they are not spoiled
  - Cooking meat produces smoke
  - The darker the cooked meat the more damaging materials present in the food
- Fruits and vegetables protect us from this
  - Eating theses produces new pathways for the meat to be processes/digested
  - Also gives us fibre
    - Stimulates the digestive system to move food through the digestive system and helps remove toxic material
- Much more of the population is obese
  - Obesity increases your risk for everything
    - Ribcage protects organs that keep our body working
    - The extra weight gets put on top of the skeleton, which does not change shape
    - The organs then are too small to maintain the new body size
  - The cause for the increase of obesity is our increased ingestion of prepared foods which have more fats and sugar
    - Fats make food taste better which helps when producing food on a large scale
  - Portion sizes have also increased
    - This is because people want more for their money
- High risk Viruses
  - Cause cancer
  - They target p53
    - Important part of how the body protects itself from viruses
  - There are now vaccines against cancers
    - Ex: gardasil for cervical, anal and penile cancer
      - HPV causes these so the vaccine protects you from HPV
- While consuming alcohol you produce your own carcinogens
- Correlation between physical activity and the risk of cancer
  - Not sure why but probably because if you are in good shape your organs work really well

- UV light causes skin cancer
  - Most common in Canada
  - Usually not fatal because it is easier to catch it early
- Environmental exposure
  - Pesticides and stuff we make and put on grass have low risks, and this usually is only a problem if you are exposed to a lot of it
  - The planet is radioactive
  - There are things naturally occurring in the environment that are extremely carcinogenic
    - Mold that grows on peanuts
    - Phorbol
      - So potent that we use it to cause cancer in the lab
- Medical procedures (benefit outweighs the risk)
  - X-rays
- Chance of survival depends on your age
  - If you are young you are stronger and are more likely to survive the treatment
  - Most people who get cancer are old and close to dying soon anyways and that skews the stats on survival rates
- Treatment
  - Cancers are caused by abnormal proteins in our body
    - Cause non functional enzymes & proteins
    - We do not have the drugs to restore function
    - The only treatment option we have is to kill the tumor
  - Cancer cells are still human cells
    - Drugs can't tell the difference
    - So they target cell division
      - Cancer cells divide all the time
      - The drugs target the mechanisms involved in cell division
  - Chemotherapy
    - Extreme side effects
      - Death
      - Cancer
      - Etc
    - We accept these because cancer will 100% kill us but the drugs are less likely to kill us
  - Types of chemotherapy
    - Nitrogen mustards
      - Used in world war I to injured soldiers
        - This then made 5 more soldiers busy trying to save the injured soldier
      - Outlawed as a chemical weapon after WWI
        - Wasn't used in WWII however they were produced just in case another country decided to use it
      - How it was discovered:

- In WWII a ship containing mustard gas was sunk and the sailors that ended up in the water were covered in it
- Doctors noticed survivors of this exposure had a lower white blood cell count
- They then discovered the gas reacts chemically with DNA and selectively kills white blood cells
- By reengineering the chemical structure they came up with a less reactive chemical compound to use for chemotherapy treatment
- Does Not do as much damage but still damages DNA
- It damages a small amount and a normal cell can correct this damage
- However cancer cells can not correct it and this small damage kills the cancer cell
- Side Effects:
  - Sometimes the normal cells can not correct for the damage this then causes another type of cancer in the body
- Most drugs today are still based on this structure
- Peyrone's Salt
  - Were growing bacteria in the lab and were running electric currents through the bacteria
  - They found that a by product was created that stopped bacteria growth (it shut down the cell division)
- Cisplatin
  - Unactivated in normal cells
  - In cancer cells it is converted to a toxic substance
    - This toxic material also gets trapped in the cell and can not escape
- Taxol
  - Cytotoxic means it kills cancer cells
  - Found in Yew Bark
  - Was effective in 30% of breast cancer cases
  - Can only be found in a natural source
    - Need 13000 kg of bark to get 1 kg of Taxol
    - The tree is really rare
    - Would need 360000 trees per years
    - There are only enough trees in north america to supply us for 5 years
    - Can harvest the leaves instead, but they had to modify them a bit to get taxol
      - Performed a semi synthesis
    - It is now manufactured using a cell culture
      - Plant cells suspended in growth medium
      - Genetically modified to maximize production
- Summary:

- Kill the cancer faster than you kill the patient
- Side effects are common – 100 %
- Side effects are severe
  - Death
  - Cancer
  - Extreme nausea
  - Hair loss, immune suppression
- Cancer is a lifestyle disease