

Topic 11: Heart

- Heart has been recognised as an important organ from ancient times
 - Was seen as the seat of the soul
 - Where the soul is attached to the body
 - Lead to valentines day and such
- The association of love
 - We feel strong emotion in our chest
 - Gives the illusion that our heart is related to the feeling
- The only thing in the body that moves all the time
 - It is alive (doctrine of signatures)
- Throughout our history we didn't know what the heart does or how it works
 - This is due to the fact that autopsies were very taboo in the past
 - In ancient rome in gladiator wounds allowed up to look into someone's body and see how everything works
- 600 years ago we figured it out
 - William Harvey
 - Figured out the heart is a pump and circulated the blood throughout the body
- Pumps 2.6 billion times during your life
- Coronary vessels
 - Often the source of heart problems
 - They nourish the heart
 - Weak point of heart
- Risk of heart attack
 - Tobacco (most dangerous, heart attack is the number one way tobacco kills you)
 - CO from cigarette smoke causes hemoglobin to carry less O₂
 - Obesity
 - Overworks the heart
 - Diet
 - High in fruits and vegetables is beneficial
 - In north america we tend to eat more meat and less plants
 - Variety in the diet is important
 - Quantity is very important, we eat too much food, the average person in north america eats double what they need to survive
 - If you were born after 1990 you have probably never eaten a proper sized meal
 - Salt
 - Saturated Fat
 - Being male
 - Men are 10x more likely
 - Because of this heart attacks in young women are often misdiagnosed
 - Risk for heart attack equalizes after menopause
 - Not completely sure why this is the case
 - Stress
 - Dramatically increases your risk
 - Most stressful jobs are the ones that have the most controlling

- Lack of exercise
 - Exercise strengthens your coronary arteries
- Genetics
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- Infection (least dangerous)
 - Certain species of bacteria that are linked to heart disease
 - Herpes virus
 - Cytomegalovirus
 - Chlamydia pneumoniae
 - Porphyromonas gingivalis
 - Associated with gum disease
 - Our inflammation response to infection sends chemicals into our bloodstream, these can then cause a heart attack
- Problems you can have with your heart
 - Improper functioning of the valves
 - The only way it can be repaired is by surgery
 - They replace the valve with either a mechanical or a ‘natural’ one from a big
 - The ‘natural’ ones have to be replaced every 10 years
 - Our immune system wears them down
 - Mechanical are occasionally replaced
 - They sometimes cause a clicking sound
 - Impaired neural activity
 - Sympathetic
 - The structure of the neurotransmitters used
 - Drugs that stimulate the sympathetic increase the heart rate
 - Parasympathetic
 - Drugs that stimulate this decrease the heart rate
 - Adrenalin antagonists are usually used
 - Block signal by filling the receptor
 - Pacemaker to stimulate heart rate
 - Don't use a drug because there is less control over the rate
 - High blood pressure
 - ‘Silent killer’
 - No way of knowing if your blood pressure is high unless you actually check it
 - Normal value is about 120/80
 - First number is the systolic pressure
 - Pressure when heart squeezes
 - About 40 – 50 mm higher than diastolic
 - They worry about this getting too high as you get older because your vessels are weaker and could burst
 - Second number is the diastolic pressure
 - Pressure when heart rests
 - When you are young this is the one they worry of getting too high

- Means the muscles never gets to relax
- Effects 20% of adults
 - Some people debate this
- Two components to maintain blood pressure
 - Essential blood pressure
 - Susceptible to high sodium levels
 - Once it goes up due to high sodium there is no reversing it you will be on drugs the rest of your life
 - Associated with hypertension
 - However is it a essential ingredient in our diet
 - Need a gram a day to survive
 - Too little is not good
 - Too much is not good
 - Roman soldiers were paid in salt this is where we get the world Salary
 - Processed and fast foods are full of salt
 - Cooking food in large quantities removes flavor
 - So salt is often added to make it more flavorful
 - Most of us eat double the salt we need
 - Nothing you can do once this goes up
 - Secondary blood pressure
 - Controlled situationally
 - Allow for increases and decreases depending on situation
 - Regulated by enzyme system
 - This system gets treated with drugs
 - Vasodilation
 - Snake venom
 - Vasodilator
 - However other effects
 - Has to be injected
 - Not drug-like
 - Blocks the formation of Angiotensin II
 - Vasoconstrictor
 - Raises blood pressure
 - Captopril
 - Was inspired by the snake venom
 - Took the functional parts of the venom and got rid of the rest
 - First ACE inhibitor
 - Had side effects
 - Cough
 - Coppery taste

- Enalapril
 - 100x more potent than captopril
 - Small dose requires
 - No coppery taste
- Ang II antagonists for hypertension
 - Block receptor of Ang II
- Congestive heart Failure (dropsie)
 - Liquid pools in lower areas of the body
 - Blood vessels are leaky
 - When the heart is pumping blood fast enough the leakage in cancels out with the liquid being sucked back into the vessel
 - However if it is not being pumped properly this liquid will pool in areas of the body
 - Foxglove plant stimulates heart
 - In small amount
 - In high amounts it is poisonous
 - Digitalis/Digoxin
 - Can not artificially reproduce the chemicals because the compound is too complicated to make an artificial version
 - Narrow therapeutic window
 - The difference between the effective and dangerous dose
 - Has been used by a number of serial killers over the years
 - At the hospital for sick children in toronto there was a case of poisoning in the intensive care for babies, they had been poisoned with digoxin
 - The woman who was accused did not answer any of the polices questions and asked for a lawyer, the police took this as an admission of guilt
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 - Charles cullen, would get a job at a hospital and kill a few people then change hospitals
 - Coenzyme Q10 supplements
 - No real evidence that this gives any value
- Angina
 - Causes extreme pain in chest
 - Caused by impaired blood flow to heart
 - Blood vessel that nourishes the heart contracts
 - Causing the heart to be malnourished
 - Nitroglycerin

- Can be taken as pill, as nasal spray, patch
- Discovered in dynamite workers
 - had to be made by hand, noticed the worker were alleviated of their angina symptoms
- Secretes chemical substance that dilates blood vessels
 - Works the same way viagra does
 - People will put their patch on their dick to increase blood flow
- Arginine (dietary supplement)
 - No benefit is proven
 - Is used to make the signaling chemical that nitroglycerin stimulates
- Cholesterol
 - Is found in all animal cells
 - Egg yolk 300 mg
 - Egg substitutes are available so you get the egg produce that is low in cholesterol
 - Farmer used omega-3 fats to help market the eggs when sales decrease
 - Shrimp 181 mg
 - Crab 113 mg
 - Lobster 94 mg
 - Chicken 91 mg
 - Fish 74 mg
 - High cholesterol is associated with heart attack
 - High cholesterol does not mean you will absolutely have a heart attack
 - It affects some people but not others
 - Our bodies do not absorb cholesterol through diet
 - Cholesterol is produced in the liver
 - Saturated fats are associated with the production of cholesterol
- Failure to pump enough blood
- Reduced flow through coronary arteries
- Omega 3 Fatty Acid
 - Found that people in Greenland a lower percent of the population have irregular heart beat
 - They eat a lot of fish, which is high in Omega 3
 - Less than 1% of the population actually suffers from irregular heart beat
- Feeding chicken fish increases the content of Omega 3 fatty acids in their eggs
 - However the eggs smelt like fish
- Feeding chicken flax seeds increases the content of Omega 3 fatty acids
 - However theses Omega 3 fatty acids are different form the ones in fish
 - There is no evidence to suggest that the flax seed Omega 3 has the same benefits or any benefits

- Omega 3 that give benefits
 - Eicosapentaenoic acid
 - Docosahexaenoic acid
 - You want at least 500 mg
- Best source is from a fish
- Cholesterol is made in the liver from saturated fat
 - Stores excess in the walls of arteries
 - This creates blockages
 - The cholesterol gets oxidized and then that is when the problems arise
- Antioxidant supplements are taken to prevent cholesterol from being oxidized
 - No proof that there is any benefit to these
 - Will prolong the life of certain microorganisms in a lab but does not work in people
 - Found in fruits
- Cholesterol builds up on the inside of the arterial lining
 - The diameter of the inner arteries does not change but the artery will bulge out
 - Occasionally the diameter will get smaller if the outer bulge hits a bone or something and has nowhere to go
- Oxidized cholesterol attracts macrophages
 - The white blood cells will suck up so much of the cholesterol that they morph and turn into 'foam cells'
 - They will get so full that they secrete substances
 - These substances then weaken the inside lining of the arteries
 - Causing it to be easily torn
 - Inflammation then causes plaques to burst
 - To repair a tear the blood begins to clot, and the clot will then block the artery
 - If the artery is a coronary artery it could do serious damage to the heart
- C-reactive Protein
 - Signalling protein the body produces to signal infection
 - This is a sign you have material that can induce a tear in your arteries with a lot of cholesterol build up
- Cholesterol Transport
 - Does not dissolve in water
 - So the body uses lipoprotein to carry cholesterol from one place to another in the body
 - 2 Types
 - Low density lipoprotein (LDL)
 - Referred to as bad cholesterol
 - Transports cholesterol from liver to rest of body
 - As it gets to the cell it wants to deliver the cholesterol it deposits it in cholesterol receptors
 - If there are no receptors LDL will store the cholesterol in walls of arteries
 - High density lipoprotein (HDL)
 - Good cholesterol

- Operates in the reverse direction of LDL
 - Transports excess cholesterol from the body to the liver
 - Need a balance of the two
 - Doctors will measure the ratio of the two
 - <3 is low risk
 - >5 is high risk
- Lipids
 - Fats
 - Come from animals
 - Typically solids
 - Contain specialized fatty acids
 - Saturated fatty acid
 - Usually the fats in animals
 - Mono-unsaturated fatty acid
 - Has a double bond
 - If you occasionally find one in an animal it will often only have one double bond
 - Allowing them to fit together nicely and remain solid
 - People in north America prefer to eat fatty foods, we like the creamy sensation rather than an oily ones
 - Oils
 - Come from plants
 - Most are unsaturated (have multiple double bonds: polyunsaturated)
 - Multiple double bonds causes the molecules to not fit together well and will most often be liquids
 - More double bonds the faster the oil will go bad
 - Hydrogenation of oils convert them from liquid to solid
 - Gets rid of double bonds
 - Will occasionally change the shape of the connection from a cis (bent) connection to a trans connection (straight line)
 - The right ratio of the two create a perfect buttery creamy texture
 - So it was used for a long time as a food additive
 - Simulates animal fats
 - Long carbon chains
 - Energy source
 - Form cell membranes
 - Used to make steroids and hormones
- Trans Fats
 - Alter the ratio of LDL & HDL in the body
- Akira Endo discovers Statins
 - Prevents production of cholesterol in the liver
 - Blocks cholesterol biosynthesis
 - Lovastatin was the first one

- Went onto the market did sell very well at first
 - Doctors were afraid to sell these drugs
 - In 1950s there was another drug that caused a lot of problems
 - So there was a connection with drugs to treat cholesterol and toxicity side effects
 - So they conducted a clinical trial
 - Scandinavian Simvastatin Survival Study
 - Found that it reduced cholesterol and such and sales increased
- Lipitor was first artificial statins
 - Did not work any better than existing drugs
 - So they were concerned if it would make it to market
 - Lipitor was not going to be the first drug to reach the market
 - You want to be one of the first three companies to release a drug on the market
 - The first makes the most money, the second the second most, and the third the third most money
 - Anything after the first three have trouble making profit
 - They discovered the drug was just as effective at half the dose as the statins
 - They then had to convince the FDA to fast track approval;
 - You only get a 20 year patent on your drug
 - And you want to spend as much of that time on the market before other companies start producing the same drug
 - Sold it as an orphan drug
 - Orphan drug act gives you incentives to create drugs for orphan disease
 - Disease not many people have
 - Familial Hypercholesterolemia
 - Body produces so much cholesterol that it gets deposited on the surface of the sin
 - Found the drug was successful in treating the disease
 - Has since sold \$131 Billion
- 1.5 million heart attacks per year
- 25% die immediately
- 25% are unaware of their heart attack
- Some animals have multiple heart
- Most cancer death is avoidable
 - Tobacco
 - Diet and Obesity
 - Viruses
 - Everything else (in order of prevalence)
 - alcohol
 - lack of exercise
 - UV radiation
 - environmental exposure (2 - 4 %)

- genetics
 - medical procedures (X-rays and chemotherapy)
- Many deaths from heart problems are avoidable:
 - Tobacco
 - Obesity
 - Diet
 - Salt saturated fat
 - Being mail
 - Stress
 - Lack of exercise
 - Genetics
 - Infection