

Why human are still vulnerable to the diseases

- Tradeoffs
- Natural selection acts to increase reproductive success of genes, not health
 - Fever - adaptive immune response to infection
 - Higher temperature - help with lower infection /bacteria challenge — immune system work better
 - Symptoms were worse for the one who were treated with medicine reduce fever.
- Mismatch with current environment
 - Myopia - different environment cause the allele to fully expressed - environment influences
 - Show plasticity (plastic traits) - different environment expressed different phenotype. — show variation
 - The current environment cause more myopia as now we are more expose to artificial light/UV
- Pathogens are evolving

Defense

Morning sickness, nausea

- During pregnancy, rapid tissue differentiation of the foetus - more exposed to the toxins
- Body develop this defence to restrict intake of strong tasting or harmful potential.
- Protect fetus from exposure to toxins.
- More nausea - less likely to miscarriage.
- No morning sickness or nausea - mother will eat wider range of food.

Anxiety

- Defence in dangerous situations by promoting escape and avoidance
- Get away from predator
- Selection for genes promoting anxious behaviour implies that there should be people who got too much anxiety and also have hypo phonic who have insufficient anxiety.
- They take drug? Should decrease?

Diarrhoea

- Cause by infection
- People who take antidiarrheal drug stay sick longer.
- The morning sickness - anti nausea drug - found for birth defect by interfering with the mother's defensive nausea
- It may come from something that cause the stomach to not feeling well - therefore, vomitting when no toxin present -

Heart attack

- Becomes widespread and remains high rare
- Prevent this; limit fat intake, eat lots go veggies and exercise.
- Different environment — we still make unhealthy choice - unhealthy food, no exercise
- Modern human have different lifestyle - shaped by different environment.
- Easy access to many kind of drugs - alcohol - responsible for disease, health care cost and premature death.

Drug resistance

- Genetic variation in parasite - variation that already exist
- Less sensitive/more sensitive - have two fitness advantage
 - Survive better
 - Their competitors is remove - can easily access to resources (no competition)
- High replication rate - horizontal gene transfer - fast
- Short generation time
- Massive population size.

Antibiotic resistance

- Bacteria evolved the gene that allow them to grow in the presence of an antibiotic - reproduce faster than other

- gene can spread. - transmit from one bacteria to the different species of bacteria.
- Bred for resistance
- Pathogen become benign with the host after long association - show low virulent - because if they are very virulent they would eventually kill the host and never get to the new host.
- From high virulent → low virulent - become more steady, mild.
- So natural selection favour lower virulence.

How to control virus/pathogen then??

Because pathogen has high replication rate - they increase over time - like exponential rate

- its like a bottle next

- Bigger dose of drug
 - Every pathogen eventually died - it make the barrier bigger - block more pathogen from reproducing - but there is some challenging - increase toxicity of the patient / overdose
- Earlier treatment
 - It stop the reproduction of virus/pathogen
- Combination of drug
 - Make the barrier more complicated as using multiple kind of drug can stop multiple mutations - the mutation rate is high — new resistant mutants arise quickly — it is the most effective way.

Mode of diseases Transmission

1. **Direct transmission** - host to host transmission (human-human)
 - Hosts are mobile and need to be healthy enough to transmit infection
 - **low virulence as there is low replication rate**
 - allow the host to remain active and incontact with others.
2. **Vector transmission**
 - through organism e.g. mosquito
 - host doesn't need to be mobile.
 - **high replication rate = higher virulence**
 - high elected advantage

Example : Cholera

- The water for drinking and bathing becomes contaminated by immobilised patients. The selection increase virulence to enhance the spread of the organism

Optimal virulence

- Increase replication rate is correlated with increase transmission but it comes with cost as it is potentially kill the host.
 - Benefit - transmission
 - Cost - virulence
- Benefit minus cost - the biggest different = the optimal virulence which natural selection may favoured increasing replication rate
- Increase replication = increase transmission = Marginal gain
- Cost = marginal cost
- **Gain = cost** — optimal virulence = natural favour this. — **Intermediate**

If low replication rate = there is low transmission, when we draw the graph the marginal gain is higher than marginal cost which the natural selection will favour increasing replication rate and eventually cause increasing in virulence.

If high replication rate = will have high transmission, the marginal cost outweigh (more than) marginal gain which natural selection will favour in reducing replication rate as it is already high in replication.

Do multiple infection influence virulence evolution?

- Have multiple strains - variation -t they will outcompeting with other strains

- If one strain increase its replication rate - the genotype are more likely to get pass on which only themselves gain the benefit.
- However, cost are shared among other strains as one increasing the replication rate, it will eventually increase level of virulence to be higher which can kill/harm the host therefore, host can't live that long.
- Tragedy of the common - they compete for the same resources

****Multiple infection select for increasing virulence. Natural selection will favour the more virulent strains as they have higher chance for transmit more and will get increase in frequency in the population.

**** Pathogen - tradeoffs - transmitting (high replication rate) to new hosts comes with the cost go harming the host.****

Influenza

- **Zoonotic flu** = influenza viruses in wild animal
 - No human immunity and no vaccine
 - They are not good at transmitting between human-human.
 - However, they can evolve the ability to transmit between people.
- **Pandemic flu** = is the novel human flue virus
 - Human have little immunity,
 - It can transmit between humans
 - Thought to be evolve from zoonotic flu.
- **Seasonal flu** = virus that circulating in human population but comes seasonally.
 - Might evolve from the pandemic flu that stay in human - become less severe.

Mode of evolution of influenza

- Seasonal flu comes from the accumulation of many small mutation - the slow stepwise mutation.
- The RNA segment of virus get transferred from one to another.

The pandemic flu replaced the seasonal flue that circulating in human****

- the seasonal flue strains go extinct - the new one that cause by mutation are descended from a common ancestor.

Natural selection

1. Variation in a traits
2. Variation in fitness
3. Genesis basic

Behaviour Evolution

1. Variation
2. Show different fitness
3. Genesis basic

- Environment influence/effect on genotype - show plasticity
- Phenotypic plasticity = expression of different phenotype in different environment when the genotype is the same. - reaction norm is specific to genotype.
- Can affect behaviour

Daphnia

- Genotype is same but put into different environment- resulting in showing different phenotype

Ultimate - WHY

Proximate - HOW/WHAT

Sexual dimorphism

1. Conspicuous ornament
 - Tail feather - show diversity in male only
 - Variation — diversity
2. Conspicuous behaviour
 - Behaviour that attract other sexes for mating
 - The one that do best get more mating
3. Ornament
 - Competition

Peacock

- Shows sexual dimorphism
- Feather that attract female for mating
- Wiggling the tail to make noise
- Competition between male to get access to female.

***** BUT there is **tradeoffs of the tail feather**

- **Cost = risk for predation**
- **Benefit = mating success**

The natural selection would balance the trade off

Natural selection

1. Survivorship
2. Reproductive success

Sexual selection

1. Number and quality of mates - variance in mating success.

All contributed to FITNESS

- **Intrasexual selection - competition**
 - **Pre copulation - number of copulations**
 - Fighting behaviour
 - Territoriality
 - Social status
 - **Post-copulation - success of copulations**
 - Sperm competition
 - Mate guarding - block the female from mating with others.
- **Intersexual selection - choosiness**

The Operation sex ratio

- Altered by the receptivity of one sex to mating or relating which can drive sexual selection.
- More male — biased male

Potential reproductive rates (PRR)

- Alter the receptivity of mating
- **Anisogamy = investment in the gamete (unequal sized gametes)**
- Female invest more in gamete than male which their fitness are limited by accessing to resources so female tend to be choosing among males for mates. However male fitness were limited by access to fertilisable gamete as there is a competition for accessing the egg.

Negative Frequency-dependent selection

- pay off matrix
 - The success of each strategy depends on the frequency of these strategies in the population where the rare strategy in the population would have the highest fitness.
 - Rare strategy increase frequency over time.
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- Tail manipulation does not effect the intersexual selection (competition) - affect the choosiness
 - Eyespot on peacock -
 - Female choices - choose more complicated call - mate more but there is a cost as predator also prefer complex call.

Direct Benefits

- Produce more offspring
- Parental investment
- Nuptial gift - female preference for males that provision resources.
- Territory quality
- Defense
- Parental care
- Lack of parasite.

Indirect benefits

- Higher genetic quality
- Good genes
- Ability of offspring to survive