Week 1 reading:

- Individuality and variation we observe in each organism is generated through a complex interaction between organisms complete genetic endowment and its environment from conception onward
- Armadillos are ideal animals to use in such research because they are born in quadruplets derived from a single fertilized egg
- Williams and Storrs observed that some phenotypes had variation up to 140-fold among the monozygotic quadruplets
- The norm of reaction is the theoretical concepts that specific phenotype may have a range of manifestations
- A different normal reaction exists for every combination of genotypes, phenotypic traits, and environmental variables studied.
- The position of the armadillo fetus in the uterus may play a role, causing one fetus to be exposed to a different amount of light or a slightly different temperature than it siblings. the blood supply from the mother may also vary between armadillo siblings.
- Herbert Hauser and Ron Gandelman found that female mice that had been situated between two female fetuses in utero showed behavioural responses that were dramatically different than those and females that had developed between two male fetuses
- Possibility is that the four individual armadillo embryos shirt identical genetic sequences but not the same intracellular environment. The cytoplasm and intracellular proteins, mitochondria, and ribosomes are unequally distributed, which may cause variation.
- Nearly every aspect of our development and behaviour is affected by both the personal experiences we gain through our environment and our genetic make-up.
- Environmental factors can affect an alter gene expression while are genes can define how we respond to different environments.

Week 2 reading:

- The major advantage of sexual reproduction comes from genetic recombination. Genetic recombination allows an organism's offspring to be genetically diverse. Sexual reproduction increases the chances of acquiring favourable mutation and is unlikely to propagate deleterious one's. Genetic diversity within a group of offspring as advantages as the local environment changes
- Genetic diversity may also lead to evolve defences against parasites and diseases
- Females typically produce significantly fewer gametes than males and invest heavily in each one. males produced many gametes and invest little into each one
- Bateman's principle helps to make predictions about meeting success and number of mates. Bateman's principal postulates that variance among females in mating success is low, whereas variance among males and meeting success is high
- Nearly all females in a population mate and have offspring but relatively few males mate successfully
- This leads to the prediction that sexual selection should act more strongly on males leading to greater elaboration of behaviour structures using attracting meats and males than females

- The female cichild fish *Pseudotropheus spiliopterus* mates with any male they meet because they have a high risk of getting predated and a small population
- Meeting with any male that is seen ensures that these cichiles have a chance of producing offspring
- The female Malawi blue cichild has a high population but still participate in multiple matings in this case multiple matings occur to avoid inbreeding and increase genetic diversity among the offspring additionally multiple matings by females may increase the likelihood that they will find a compatible mate one that is not sterile or even help prevent infanticide.
- Species females are 201 picking a mate than males a significant reason for this is the heavier investments females make in each gamete than males
- Females may prefer males for good genes meaning that the male has attributes which predict better survivorship of the offspring good potential parenting by the male or possession of resources by the male that will support the offspring during their growth and development
- Additionally in most species females are more likely to provide parental care. females that carefully select their mates are at a lower risk of losing their reproductive investment
- Selection favours females that choose males that enhance the likelihood of their offspring's success
- Male mate choice occurs most often when males are substantially involved in caring for their offspring or when there is a great variation in quality of the females as mates within the population
- if males are choosey about their mates then overtime females may evolve ornamentation or colouration that is subject to sexual selection
- Social monogamy is a behavioural pairing of a single male with a single female it is the most common in birds and where in other animals theoretically individuals in monogamous pairs will both contribute to the defence and parental care of offspring
- Because the cost of poor made choice and monogamous species can be so high in some instances organisms engage in strategies of either serial monogamy or extra pair copulation
- Extra pair copulations are very common in birds
- Monogamy reduces the potential for genetic variation among a female offspring my mating with more than one male over the course of her lifetime a female gains hire genetic variation among her offspring the benefits of monogamy which is shared parental care and territorial resources are maintained by having only one mate at a time or by concealing extra pair Monogamy
- Polygyny is the association of one male with multiple females this meeting system is found in a few birds and insects but is most common in mammals polygyny is a strategy used by males increase their reproductive fitness
- Resource defence polygyny: in resource defence poygyny groups of females are attracted to a resource, males then compete for a territorial possession of the resource,

and by extension meeting priority with females at the resource. thus individual males form territories centred on resources needed for a successful mating

- Another common type of polygyny is membership and a harem a defended group of females associated with one male. males compete for control of the groups. harems typically exhibit a dominance hierarchy among the females in the group
- A lek is an aggregation of males that are each seeking to attract a mate within a lek. males typically perform sexual displays. unlike most other meeting systems leks are not associated with the resources attracting more females as a strategy used by males to help increase their reproductive success
- Polyandry is a group with one female and many males. Polyandry is a reproductive strategy that helps a female ensure reproductive success by providing her with multiple meeting options
- Resource defence polyandry: in the spotted Sandpiper, females control resources which in turn controls male mating associations
- Cooperative polyandry in Galapagos hawk exhibit cooperative polyandry in this case all males in the group copulate with the female and all participate in brood provisioning
- In polygynandrous groups multiple females and males mate with each other and males may care for the broods of several females. chimpanzees and bonobos rely on the strategy that allows groups of males and females to live together and spend less time being concerned with mate competition. polygynandry may be advantages from the females perspective because it causes paternity confusion which decreases infanticide and allows her to have multiple males care for her brood
- In promiscuity there are no pair bonds and males and females although sometimes choosey often seem to meet randomly. as it is typically more advantageous for one or both sexes to pick their mate, promiscuity may current species for which the environment is unpredictable
- The sperm competition is not a type of meeting system per se, it is a form of male-male competition that plays an important role in meeting systems.
- In other words once a male has released sperm, it's sperm must be the first to reach an egg.
- And aquatic animals that released are gametes into the water animals that release the largest amount of sperm and sperm that are highly capable of swimming are likely to produce the most offspring
- For example in one species of damselfly males physically remove any sperm present from the females before it meets sperm competition at the difficulty of obtaining a successful reproductive event by males

Week 3 reading:

- Darwin suggested that elaborate and apparently non-adaptive sexual traits might evolve if they are sexually selected that is if they increase the individuals reproductive success, even at the expense of their survival
- Darwin noted that sexual selection depends on the struggle between males to access females. He recognized two mechanisms of sexual selection which include intra-sexual selection, or competition between members of the same sex, usually males, for access

to mates, and intersexual selection, were members of one sex, usually females, choose members of the opposite sex.

- Bateman's principle: female reproduction is primarily limited by their access to resources to nourish and produce these large gametes, where is male where production is mainly limited by access to females. Therefore males typically compete among themselves to access females, as females tend to be choosey and mate only with preferred males
- If a male gains a disproportionate share of reproduction, he will take away reproductive opportunities from other males, leading to a high reproductive variance among males. A successful female on the other hand, will not take away we productive opportunities from other females, leading to a smaller variance and reproductive success.
- The higher the reproductive variance, the stronger the effects of sexual selection. Sexual selection typically results in sexually dimorphic traits that are exaggerated, or more elaborate, in the sex with the highest reproductive variance.
- The degree and direction of sexual dimorphism can be explained by the relative selection gradients of each sex.
- In species were biparental care is required to successfully raise offspring, variance in the male reproductive success is generally lower, since males are engaged in providing parental care will not be able to invest as much energy in pursuing additional mating opportunities. This situation often results in the emergence of sexually monomorphic species, in which the male and female look and behave in similar ways.
- Sexual selection can operate both intra-and inter-sexually either sequentially or simultaneously.
- Intrasexual selection is typically responsible for the evolution of male armament such as deer antlers, beetle horns, and large body size, that provide individuals with an advantage one fighting of potential competitors.
- By contrast, intersexual selection results from interactions between the sexes, typically involving mate choice. The evolution of elaborate behaviour and displays of morphological traits can often be explained as a result of intersexual selection.
- An extreme example of intersexual selection can be found in species were males form leks were multiple males gather to display to females
- Females can directly increase their reproductive success by meeting with certain, select males and acquiring direct benefits.
- Female can also gain indirect benefits of the other offspring. These indirect benefits are usually genetic rather than resource-based. By choosing certain males, their offspring were likely inherited genes that tend to increase their fitness.
- Two major mechanisms that account for female mate choice has been proposed: good genes, and Fisherian and arbitrary processes.
- Good genes:
    - Under the good genes scenario differences among males provide females with information about the genetic qualities of the different males they can be inherited by the offspring.

    - There is correspondence between the putative role of natural versus sexual selection, since preferring certain males can result in a female gaining higher viability, fecundity, and reproductive success, for her offspring.
- Fisherian aribitrary choice
    - This model suggests that female preference can evolve for arbitrary traits that do not provide information about the males quality, and that therefore do not reinforce the effects of natural selection.
    - The fitness advantage of the arbitrary trade exist only as a result of its covariance with the preference. By choosing a male with a particular traits value, the females gain the indirect benefit of producing offspring that will be more sexually attractive to females that carry their preference.
    - This type of process can result in a runaway positive feedback loop, whereby the traits becomes more exaggerated as selection on the preference increases
- Sexual selection can affect reproductive success at multiple reproductive stages. First, it acts during all the processes that lead to acquiring meeting opportunities which Darwin referred exclusively to pre-copulatory sexual selection in his discussions.
- Post copulatory selection refers to the events that occur during and after meeting. Post copulatory male-male competition is known as sperm competition.
- Post copulatory female choice refers to the ability of females to affect the likelihood that sperm of a particular male fertilizes the egg, and their decision to invest in offspring based on the identity of the male with whom they mate.
- Females exert this choice via morphological, chemical and behavioural adaptations. This type of selection is called cryptic choice because it occurs inside the female reproductive tract and cannot be detected from behavioural studies alone.
- Sexual conflict can often results in an revolutionary arms race, whereby the evolution of a traits that imposes harm and one sex will result in evolution of a counter trait to migrate the home of the affected sex, with subsequent escalation in both.
- Examples of sexual conflict include traumatic insemination and bedbugs, copulatory grasping and anti-grasping structures in water striders, and general coagulation in water fowl.

LECTURE 4 READING:

- Many social behaviours of animals are adopted, meaning that being social ultimately increases an animal fitness, it's lifetime reproductive success. One example of how social behaviour is adaptive is aggregation against predators.
- In the circumstance of an attack by a predator, the odds of one individual being targeted are 100% for solitary individuals, 1% in a group of 100, 0.1% and a group of 1000.
- Wild beasts do suffer social costs from aggregation in groups, grazing sites may not provide adequate food for every individual in the group, for example. However, it is not difficult to imagine that the costs of social aggregation are much smaller than the benefits of the defence against predation.
- Living in groups involves a balance of conflict and cooperation, which is mediated by the costs and benefits associated with living socially. When the benefits of living socially

exceed the costs and risk of social life, scientists predict that social cooperation will be favored.

- ALTRUISM
    - An altruistic act as one that increases the welfare of another individual at an actual or potential cost to the individual who performs the act.
    - The benefit of an altruistic behaviour is ultimately measured and it's a fact on an animal's lifetime reproductive success.
    - Natural selection operates against individuals who reduce their own fitness. Altruism by definition decreases the fitness of the individual.
- RECIPROCITY
    - Vampire bats in Costa Rica often share blood with other bats sharing their roots. He found however that but did not share their meals with all other pets equally.
    - Bats were more likely to interact with certain individuals more than others. Bats were more likely to share food/blood with bats they were more likely to encounter in the future. In other words, when there was a greater opportunity for reciprocation, the bats were more likely to share their meals.
    - So prosody enable to existence of altruism because in the long term the benefits of altruism cannot waive the costs of altruism.
    - Fats that are more closely related
- KIN SELECTION
    - Bats that are more closely related are more likely to share resources
    - Natural selection reflects how an individual passes and copies of their own genes through survival and reproduction but can selection reflects how copies of an individual's genes are passed down through the survival and reproduction of their relatives.
    - And individuals direct fitness is measured by copies of her own genes passed onto children, grandchildren, and so on, whereas indirect fitness is the measure of copies of her genes passed on through her non-descendent relative such as cousins, nieces, nephews, and siblings.
    - When individuals are more closely related, they have a great relatedness (r) and all tourism is more likely to occur.
- EUSOCIALITY
    - eusocial species live in colonies. Only a relatively small fraction of the animals in the colony reproduce; the non-reproductive colony members provide resources, defense, and collective care of the young.
    - Individuals in colonies are usually related to one another, and relatedness can't even be greater than 0.5 as a consequence of the unique genetics of some groups of insect or inbreeding. Hamilton's rule and Ken selection provide at least a partial explanation for the evolution of eusociality
    - Colonies often produce a very large number of offspring, such that even when relatedness is low the indirect fitness of the non-reproductive workers may be greater than if they had the capacity to reproduce independently.

LECTURE 5 READING

- When nestlings late leave the nest too early, they fly poorly, or not at all, because their wings are small and underdeveloped. Fledging too early is usually a fatal decision, it is a nestlings best interest to remain and its nest for as long as possible to allow its wings the time necessary to develop more fully.
- But remaining in the nest for too long is tremendously dangerous for many bird species because predators are always searching their territories for something to eat.
- Predictably, Predation plays an important role in driving the evolution of optimal fledging times for birds.
- As expected, Dr. Martin and his collaborators found that song bird species with higher nest production rates produced fledgelings that left their nests earlier, and they had smaller, more under developed wings, and poorer fight abilities.
- They found that all young John Kos had nearly identical masses regardless of experimental treatment, but the wing links of the delayed fledgeling John calls were substantially longer. the scientist found that mortality decreased for individual Junko fledgelings as their wing length increased.
- They found that daily mortality is higher for Junko fledgelings than for junco nestlings. Whilst it is true that one nestling Junko sleeve later the risk of Ness production increases, but delay leaving allows greater wing development and thoughts. Reduces overall individual fledgeling mortality.

LECTURE 6 READING

- The miserable odds for individual parasites can potentially drive the evolution of something remarkable, the ability of parasites to manipulate their house. By controlling their hosts, the parasites can raise their odds of surviving and reproducing.
- *Toxoplasma gondii* forms cysts in peoples brains. Unless their host has a weak immune system, versus cause no apparent harm.
- Perhaps 1 billion or more people carry *Toxoplasma* cysts in their brain.
- It's in casts that the *Toxoplasma* lifecycle gets its start. The parasites made in the intestines of cats and then produce act like offspring, which are passed out with cat droppings. The durable eggs can stay viable for months as they wait for their next host, which can be any species of mammals or birds.
- Only if they can get back into a cats got it will they be able to take the next step in the *Toxoplasma* lifecycle.
- And the number of experiments, infection with *Toxoplasma* appears to make the rodents less frightened by the smell of cat urine. Some studies even hint at an attraction to the scent of their killer.
- They observed that the parasites produce a range of affects on the behaviour of their hosts.
- In one study, scientist found that *Toxoplasma* impaired a host ability to learn, and in another, it didn't. The same split and results turns up and tests on memory, a preference for exploring new things, time spent meerkat urine, and anxiety.
- Just because a parasite does something that appears to make it easier pray does not mean that natural selection produced that change to improve its odds of completing its

lifecycle. *Toxoplasma* could be altering its posts as a side effect of infection, not as an involved adoption.

- Another single celled parasite called *Eimeria* also robs mice of their fear of cats, despite the fact that it's lifecycle takes it from mouse to mouse, not mouse to cat.
- In case of *Toxoplasma*, rodents may lose their fear of cat urine but might still avoid other scents from their predators such as the smell of cat fur.
- *Toxoplasma* has to get into cats in order to sexually reproduce but it can also clone itself and other species. The parasite can even spread from mothers to their offspring.
- Joanne Webster thinks that the evidence for *Toxoplasma* is strong, and the criticism against its power to manipulate are weak.

LECTURE 7 READING

- First, some of this comforting conditions, such as pain, fever, cough , vomiting and anxiety, or actually neither diseases nor designed effects but rather are involved defenses.
- Second, conflict with other organisms like crocodiles for instants, or a fact of life.
- Third, some circumstances, such as the ready availability of dietary fats, or so recent and natural selection has not yet had a chance to deal with them.
- Fourth, the body may fall victim to trade-offs between a traits benefit and its cost; a textbook example is the sickle cell gene, which also protects against malaria.
- Finally, the process of natural selection is constrained in ways that leave us with sub optimal design features, as in the case of the mammalian eye.

LECTURE 8 READING

- Ageing or senescence as it sometimes called, is an inevitable progressive deterioration of physiological function with increasing age, demographically characterized by an age dependent increase in mortality and decline in fecundity.
- Instead, they argued, ageing of bulbs because natural selection becomes an efficient and maintaining function and fitness at old age.
- The force of natural selection, a measure of how effectively selection acts on survival rate or fecundity as a function of age, declines with progressive age.
- First, for most organisms, the natural world is dangerous since it abounds with competitors, predators, pathogens, accidents, and other hazards.
- In natural populations most individuals die or get killed before they can grow old and suffer the symptoms of aging, thus, individuals have a very small overall probability of being alive and reproductive at an advanced age.
- Second, the strength of natural selection declines with increasing age, such that selection ignores the performance of individuals late in life. As a consequence, selection is unable to favourite beneficial effects, or to counteract deleterious effects, when these effects are expressed at advanced ages.
- THE MUTATION ACCUMULATION HYPOTHESIS
    - If the effects of a deleterious mutation were restricted to late ages, when reproduction has largely start and future survival is unlikely, careers of the negative mutation would have already passed it onto the next generation before the negative late life affect would become apparent

    - Natural selection would be weak and in efficient at illuminating such a mutation, and over evolutionarily times such affectively neutral mutations would accumulate in the population by genetic drift, which in turn would lead to the evolution of aging.
    - The effects of such a mutation accumulation process would only become manifest at the organismal level after the environment changes such as the individuals experience less extrinsic mortality and thus live to an age where they actually expressed a symptom of aging.
- THE ANTAGONISTIC PLEIOTROPY HYPOTHESIS
    - It is true that selection cannot counteract deleterious effects at old age, he argued, the mutations or alleles might exist that have opposite, pleiotropic affect a different ages; genetic variants that on the one hand exhibit beneficial effect on fitness early in life, once election is strong, but that on the other hand have deleterious effects late in life, once election is already week.
    - That early fitness components such as reproduction to genetically trade-off with late fitness components such as survival at old age, so that, for example, genotypes with high early fecundity should be shorter life than those with low reproduction.
    - Idea here is that the evolution of a higher investment is unlikely to pay off since the return from such an investment may never be realized due to extrinsic mortality.
    - Weather is such trade-offs are physiologically caused by competitive energy or resource allocation, as would be expected under the DS hypothesis, remain somewhat controversial but the trade-offs themselves are well-established.
- A longer lifespan normally in place increased reproductive success, and factors such as low adult mortality, high juvenile mortality, and high variation in juvenile mortality from one bouts of reproduction to the next therefore all tend to lengthen reproductive lifespan.
- Consequently, if extrinsic, environmentally imposed adult mortality is high, selection becomes a week, other by allowing the evolution of higher levels of intrinsic mortality for example aging.
- Moreover, even though selection my favour increase reproductive success, and that's a longer reproductive lifespan, the length of life might be limited by intrinsic trade-offs between reproduction and survival caused by AP.
- In symmetrically dividing unit cells, for example, individuals should not age because parents and offspring are phenotypically indistinguishable, it is impossible to determine old from Yonge, and Yonge is that invisible to selection. By the same logic, ageing should exist in asymmetrically were producing organisms were ageing parents are phenotypically distinct from offspring.

LECTURE 9 READING

- HORIZONTAL GENE TRANSFER. WHAT THAT MEANS IS GENES MOVING SIDEWAYS ACROSS BOUNDARIES, BETWEEN INDIVIDUALS, BETWEEN SPECIES, EVEN BETWEEN KINGDOMS OF CREATURES.

- Further research showed that the pocket could cross boundaries between other species, even from genus to genus, amongst almost every group of enteric bacteria, a large family of bugs that live within human intestines.
- Scientist now neck hurt recognize plasmids as a major mechanism for transferal of antibiotic resistance genes, sometimes whole packets of genes for multiple resistance, from one species of a bacterium to another.

LECTURE 10 READING

- Myxoma virus, highly lethal, specific to rabbits, and spread by mosquito bites, was exactly what the Australian government was looking for.
- Government scientist finally released infected rabbits into the Marie Valley of south eastern Australia
- The myxoma virus quickly evolved. The strain that had initially been used was almost inexplicably lethal, killing virtually every rabbit it infected. But within a few years, the strain had been replaced with milder ones, which killed less rapidly and frequently.
- After it's released in 1950, it went from killing more than 99% of rabbits to killing around 75% of them, or under 50% in some cases. In response, the rabbits evolved resistance, shrugging off strains that would want to finish them off. And then we launch the arms race between myxoma and rabbits, promoting the virus to evolve it on counter measures, which is still deployed today.
- The team showed that by the 1990s, the virus had gained a new ability, it could completely shut down a rabbit immune system.
- These rabbits never develop the skin tumours or any of the classic symptoms of the virus. Instead, they die from massive and sudden infections. Their lungs filled with fluid and they start bleeding uncontrollably.
- These immune supporting strains might have in emerge as early as the 1970s, and they're circulating broadly now.
- The wild rabbit started to resist the virus, the virus started to kill them in anyway, and neither side gained any ground.
- Laboratory experiments using bacteria and viruses have shown that when hosts involve resistance against infections, viruses can rapidly overcome host immunity.
- The broad lesson is that there is a variety of revolutionary trajectory is the pathogens can take.

LECTURE 11 READING

- Neither bacteria or viruses evolve resistance to vaccines as easily as they due to drugs.
- The two key differences are that that vaccines generally act earlier than drugs, and that the natural immune response they promote is usually more varied, with more lines of attack. A drug may be nearly targeted, sometimes attacking one metabolic pathway or bio chemical process.