

# EVOLUTION, BEHAVIOUR & ECOLOGY

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My initial definition of evolution: The reaction of an organism or species to an environmental stimulus over time.

Natural selection: The behaviour of certain traits over others by the natural environment.

Fit to its environment.

What is confusing, unclear or seems impossible about evolution?

- Naturally some religious competition in my eyes

## Why the topic in the first semester?

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Organisms don't always become better adapted to the environment because the environment changes too.

- Species come extinct when they can't evolve as fast as the environment changes

Most schools do wb and molecular biology in the first semester

-helps you to understand way things else w/o that you must have a lot of facts

- This is the why of biology.

- The modern way is evolutionary history.

- So much medical insight to be gained by knowing we evolved to become hunters and gatherers.

- Don't use humans as your example to try and understand the biological process (Culture and ego)

## NOTES AND STUDYING

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### Feynman technique

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Write what you know about the topic by hand

Explain to a younger person

Notice what you can derive, explain

Follow up and then repeat

### Notes

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- Don't dictate but paraphrase what the professor says. They won't say anything that they think is useless.

- Leave some space in front for additional and leave back empty for later
- Improve yourself with others after class.
- Work together to determine main points, their relation and how they relate to points in previous classes. Shouldn't be laundry list of materials
- Write this down on blank spaces.
- Use reading to learn about the topics you all don't understand.
- Have a new note book( with blank pages at the front), develop
- Do not transfer anything you do not understand.
- Write in complete paragraph, write out explanations in your words
- Add outline of the day in the beginning of the book
- Keep up day by day
- A list of topics and subtopics with any explanation
- To study, look at the outline and see what you can do. Use that to guide your test prep

## CHAPTER 18: EVOLUTION AND THE ORIGIN OF SPECIES

All organisms evolved from a different species and evolution is ongoing.

Evolution is the rationale to all biological processes and drives current curiosity

### 18.1 UNDERSTANDING EVOLUTION - Evolution as a science precedes Darwin.

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Age of the earth is integral in early evolution conversations. Galapagos

Tom: Similar organisms on different islands with some distinct differences.

Alfred Wallace and Charles Darwin independently thought of natural selection simultaneously. Natural selection ( survival for the fittest), the more prolific reproduction of individuals with favourable traits that survive environmental change because of those traits. The how evolution ( adaptive evolution.....other types)

1. Most traits of an organism are inherited
2. Competition for space in every generation (from Mathews)
3. Observable genetic evolution, characteristics that compete better will be passed to progeny- Descent with modification change in population over generations. Non genetic variations do not contribute to evolution because not inheritable

- A. Mutation or change in DNA new adults can have (+), (-) or no effect (neutral mutation) with varying degrees.
- B. Sexual reproduction= Unique mixing of parent DNA, unique combo.  
Adaptation a heritable trait that helps an organism survival and reproduction in the present environment.
- Genetic variations overtime contributes to fitness.
  - Favourability- Environmental conditions (not static), directions can fit.

**Divergent evolution evolution in diverse direction from a common point.**

**Convergent Evolution Similar traits evolve independently in species that do not show common ancestry.**

Same destination, different journeys (group of traits).

**Homologus structures, some overall construction/ synonymous parts in differwnt species.**

**Vestigial structures Unused structures with function appendix.**

**Analogous structures Similarities not done to adore evolutionary relationship for common reaction to the envirnoment.**

- Ex. many arctic aanimals are white because arctic is white not because of common ancsetry.

## **Misconceptions**

- Scintific theory = Common ways theory.
- An individual organism cannot evolve.
- Evolution not about the beginning of life
- Evolution not intentional, fast logical outcome
- The variations must already be present to be selected for evidence:

Fossils

Anatomy and embryology ( homologus and vestigial structures)

Homogeography ( like mainland/ \Island similarities)

Molecular biology: Similarity in Dna, Similarity in anscestry.

## **Artificial selection:**

**Evolution driven by decision of people ( whether intentional or not) people determine which individual will reproduce and/or survive.**

- Generation by generation; the preferable selected/battained generation.
- "Artefact of human activity" De es
- "Different with modificatio" Darwin
- Modern fruits and vegetables are a good example of artificial selection.
- Most of what we eat is a product of intentional artificial selection.

**Natural selection: Natural, ecological processes determine which individuals survive and reproduce.**

- Do not have to be the predator/prey situation
  - Mechanism of evolution.
  - Due to what circumstances natural selection occurs
- I. Competition
  - II. Individual not identical
  - III. Some variations inheritable

## **Three circumstances**

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- I. More BOM than environment can support- Not enough resources for all to survive; don't all survive to reproduce.
- II. Individuals aren't identical Some different genetic, not all different genetic
- III. Some of the variations among individuals is heritable.
  - Rooted in genes (how is this different from the one above)

## **Consequences of those three circumstances**

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1. Individuals best suited to environment (fit) most likely to leave offspring (Natural selection)
2. Because only reproduced genes are passed on, competition of gene foster changes ( evolution)

- There is still room for bad luck in ecology. Fit organisms can still die before reproduction, chance exists overtime, probably is truer.

" Evolution doesn't occur so that anything"

- Evolution not on purpose, it is as a result, not a goal. The consequences of evolution are not "why" for evolution.

Some of the real time evidences:

- Look for evidences for hypothesis being wrong, not for reasons they are right

- Try to reject hypothesis. If you can't its apt to be right  
unintentional artificial selection:

Due to the mean yielding unintentional effect or we do not know we were selecting? Or both?

People have trouble breathing. Modern cops must be babied on a town.

Why would a physician make you keep taking antibiotics even when you are telling the truth?

## 08/30 LECTURE

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- Don't develop the potential to evolve because of exposure to environmental purpose unless on genetic variations that just happen to occur.

- We don't write untides on unknown mutations (a lot)

Observations of evolution in progress

Unntentional artificial selection may produce a super bag.

Ex 1:- Antibiotics are for bacteria

- Not enough antibacterial in your system to kill all tje bacteria; leaving just a few over, they'll reproduce exponentially still.
- Why do some survive and some not?
- Bacteria are not genetically identical (never to me)

- **Q1:** How does bacteria even mutate if they reproduce asexually?

Some more questions on 8/30 reading google due

- Maybe come on Wednesday. Office hours.

- Taking antibiotics gives advantage to the antibiotic resistant bacterium; useless w/o bacteria

- Evolution involves trade offs; genes that contribute to fitness in one way typically distract from fitness somewhere else

- Pretty much an inherent costs to mutated advantages.

- Pre antibiotics, the bacteria compete with each other.
- Antibiotics example nalogues to superweeds example
- Taking all your ntibiotics doesn't ensure all the bacterium are gone (answers to question)
- Resistance doesn't mean 100 % resistance.

## Ex 2

- Why do commercially- hooted become reportedly mature at smaller size than periodically.
- Commercial kept bigger fish and returned smaller fish
- Wet fish memory made of fish; fish left to reproduce and the small enough to fit the net
- Again, relies on the just happening to mature at smaller size
- Unintentional artificial selection

## Ex 3

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Changes in break depths of gala pages finches following drought

- 400 miles off share, not on a migration path, not until from mainland
  - Lots of different examples of evolution w/ the G.I became its initial cause drew a lot more
  - Under lively of punch species
  - "Evidences back and forth" with writhes cycles: Short-hand evolution that frequently changes direction
  - Islands from mainland tend not to have many species b/c difficult for specie to get there.
  - GL volianic ( from volcano) difficult way a lot in holic presence, difficult in age for
  - inches seed rating birds in strong hill to break sudor open
  - How will its will unlet martially determine fitness drought on island.
- Few seeds available one lunge (for whatever leaves) only can bust it open
  - Small hills can't grow
  - Small birds don't survive/long hills survive

Next generation from large filled parents mostly natural selection examples due to natural why/how does it switch back? How do small hills even have an advantage over large hills?

Evolution not a good relationship to conditions of environment

## Ex 4

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- Armor of spined stickleback- ocean us take population
- Take have less and less armour on time
- Revoke to hide in ocean so are not necessary
- Lake pops have places to hide and hanging more while helps them to hide in the lake
- Occurs due to already existing mutation
- Make sure you can explain piece of nutria evidence of revolution by natural selection

## Evidence Of Past Evolution

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Regimented change in fertile will survive

Gradual segmented

Decent from common ancestor

"Legacy of structure multiplied by different environment"

How does this prove common ancestry?

Whales have hip bones with no limbs- decent from ancestry that did have liger

"evolution doesn't make things perfect" not ecologically experience for whales to have hip bones- will he opaquely lost destroyed things don't get lost very fast since neither advantageous or disadvantageous

Amino acid sequences of humans most similar to aeneous similar to humans.

More similarly means more recent common ancestor dissimilar species evolving predictably due to shared mental pressure

Not unlauted species becoming related

Similar selective faces simulation adaptations

Whale (mammal) descends have land mammal best shark have similar not related to overall shape.

Similarly, the same

Can convergent species occur geographically if selective presents one the same?

Humans have common ancestor same point but dissimilar

Look similar but different development

Convergent evolution

How are environmental presentations the same?

Anatomical homologies: bones in the wings

Wings: Convergent evolution (common ancestor had a land leg, not wing) but similar in the way a shark and mammal are similar

Similarly but not same structure from same ancestor

Know differentiation of evolution and natural selection but generally knowing the meaning is enough.

Mix of MCQ and SAQ

Anything discussed in class (renew non bio stuff too?)

Evolution doesn't result in perfect form, it's the form that vented for summarily in the past, could very well be better)

French doesn't fly them from mainland on purpose

One finch species on mainland in Ecuador

-13 finch species in G.I

Gangts/ the island (GI) would be rare too, even that too last and very unlikely that finches how to GL to Hagen

GL habitat variation

Islands difficult from each other's different environmental pressures

Two individual's summaries

Not one species/ on land different directions of evolution

More than one on an island

Any of these species make or less related to the ancestral finch? Does amount of dangerous relate to amount of relatedness amount of dangerous relate to amount of relatedness to ancestors does it even match?

## Essay Examples

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When you write an essay that includes a technical team, plan the class, define the team to demonstrate you know its meaning

When answering a question, one we answering like when explaining it to a professor (you) on to someone with zero language? Who was audience?

Explain your reassuring, finish your thoughts

Complete sentences

Do not use a word to define a word



Examples are often helped in explaining

Define terms of not common knowledge

## 19.1 Population Evolution

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Blending inheritance was the theory before natural selection

Best genes formed to have potential nature, passed

Population genetics discussed in terms of allele frequency

Genetic change, phenotype change

Natural selection affects frequencies

Gene pool sum of all alleles to genetic change with no advantage

Occurs alongside natural selection

Found it won't change one of in an isolated part of the population that typical.

Valuation restoration of phenotypes humility -- the part of phenotype variation from genetic variance (among individuals in a population)

- Phenotypic variation, evolution
- Genetic variance- diversity of alleles and genotypes
- Inbreeding depression- inbreeding leads to loss of genetic diversity (should dilution alleles)
- By chance some alleles have more children
- By chance very different from before
- Founder effect also of small groups assess a lot of individuals have gene flow of alleles and part of a population due to migration of individual of genotype
- Some populations have more than others
- Plants spread pollen
- Can introduce new genetic variation mutation
- "Species evolve because of mutation accumulated overtime"
- Introgressive hybridization and phenotypic variance
- Natural selection selects traits performed by changes in mating.
- More gene flow between, less difference and divergence

## 19.3 Adaptive evolution

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- Natural selection= adaptive evolution
- Not all evolution is adaptive!!

- Acts not idol allules
- Evolutionary fitness
- Adaptative litters only matters abit companies to other age anomously of the same population
- Stabilizing selection preferred average an extreme phenotype
- Directional selection
- Strong selective on males to obtain matter
- Same species six role reviewed so UV sexual demography
- Some traits and sexual traits that distract from handicap principle.
- N.S cannot make a perfect age, cannot select mutable limited by genetic mutations and gene flow. Net effect galleles often reduce certainty of UV.

## MODES OF EVOLUTION

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### MUTATIONS, INBREEDING, DEPRESSION, COMMON PATTERNS OF EVOLUTION, GENE FLOW, & GENETIC DRIFT

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Natural selection is not the only mechanisms of evolution, but it is the most important population: a group of individuals of the same species with opportunities to interbreed (offspring able to reproduce).

- Species: the potential to interbreed (what if they had the opportunity) in nature, members of same species not necessarily same population.
- Some species have only one population, but some species have lots of populations.
- Gene: a unit of heredity made of DNA
- Affects same nature of an organisms allele- a variant of a gene- e.g a length of DNA that codes for a population genetic trait.
- Variant of alleles on same gene- difficult effect
- Natural section concerned with alleles, not gender filters the relative contribution an individual makes to the gene pool of the next generation.
- Highest tends to be what's best
- Filters = strength

# Processes that allele cause evolution

1. Mutation (new allele = new genetic varieties = new possibilities)
2. Evolution by natural or artificial selection (adapts population to amend condition)
3. Gene flow
4. Genetic drift (chance change in allele frequency)

Mutation- a change in the DNA sequence

Mutation occurs randomly (not because it may be beneficial)

Create new genetic variants (only case where new happens)

Any specific variants (only case where new happens)

Not that many mutations are actually beneficial not all mutations matter: random change to functional system may become common of its selected

Male genetic diversity and male capability for evolution/ capacity to adapt to new circumstances

- Don't want to expose yourself to mutagens (carry yourself up when getting mutated)
- 2 copies of most genes (one from the parent) thus alleles same on different
- Genotype individuals compete the alleles
- Phenotype not solely genetically determined
- Natural selection acts on phenotype, not genotype any measurable point of an individual
- Don't necessarily blend
- Dominant male fit

## 09/13

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Dominant mutant- expressed, affects phenotype

Recessive mutant- typically only expressed of homogenous dominant harmful alleles rapidly

Selected against with only one copy

Recessive harmful alleles do not affect heterozygotes

And thus, rooted out (acts on phenotype, not genotype)

So, they accumulate in heterozygous individuals

Only harmful when homozygotes

Have a reason evolution didn't lead to perfect organisms

We all carrying harmful recessive alleles

Inbreeding depression- reduction of fitness due to mating between closely related organisms

How related is always a relative term in biology

Most mutations are harmful and have no consequence

Do mutations happen on the allele scale or gene scale? Allele

Inbreeding increases the chance one, harmful alleles will be passed on homogeneously (cannot have children- harmful phenotype)

Dilute recessive alleles are common but didn't affect fitness in outbred populations

Hapsburg chin

Became fashionable for German shepherd to have short back legs

Why do thus individuals have?

Is this artificial selection or inbreeding or both?

# The importance of mutations to populations

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Not good on the individual level but valuable from the population perspective because... the same that one beneficial

New genetic material only from mutations

Lot of genetic diversity and capability to survive/ respond to mental change. The alternative is extinction "potential to adapt" genetic phenotype variation from mutations

I. Mutations (random, doesn't happen because related for doesn't matter)

II. Natural selection (not random, adaptive)

III. Gene flow (not mutually adaptive)

- Distinction between populations can be hard to determine
- Individuals (their alleles or gametes) move between populations

IV. Genetic drift (not usually adaptive)

V. Artificial selection (not usually adaptive)

- Usually don't have to survive on their own

# Common Patterns of Evolution by Natural selection

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## 1. Directional natural selection

- One extreme phenotype is selected for (does this assume binary traits, either/ or) quantitative phenotype addresses this but what about something more qualitative?
- Look at ape in slides
- Gallons of being a bell-shaped curve means there was a long period of standing selecting the past
- Length of finch beaks varying with seasons in directional selection
- Doesn't necessarily have legs into the same direction for a long period of time. The direction can change and change often

## 2. Stabilizing selection

- Intermediate phenotypes selected for highest fitness in intermediate phenotype

## 3. Developing selection

- Both extra and intermediate
- African lack backed selection

# 09/15

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Scientists seek evidence that an idea is wrong

A hypothesis that explains a lot and has survived many attempts at being moved wrong

Hypothesis must be tested- potentially preferable able to be supported wrong with evidence

Scientific thinking- open minded people active based on evidence

Scientific based on inductive reasoning- extrapolating from specific to general: inherently limiting.

This is why status is so important

Is there terminology for the different diagnosis of certainty? i.e I know there's one pretty solid but are there any evils between hypothesis theories and theory?

Understanding science seeks to find evidence supporting that an idea is wrong and that we use minds like constant and supportive rather than proves what must be understanding?

Are proposed explanations scientific?

We don't talk about the beginnings of life. Can we even talk about them scientifically given lack of empirical evidence?

# MODES OF EVOLUTION

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## 09/18

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Sexual selection- behaviour and morphology

Male chance is an aspect of natural selection must be suited in survival and for reproduction.

sexual selection - behavior and morphology

- mate chance is an aspect of natural selection - must be suited for survival and for reproduction/ mating (when mating is a relevant concept . is it unit for bacteria ) - birds not the only world sexual selection thing African long-tailed woodhoopoe

no survival fitness with long tail bird and being attractive to mates something that survives and doesn't reproduce is not fit - animal phenomena

usually the females are choosier about mates because usually the female invests more energy + time into the reproduction / post consumption; at the very last, gestating - female fitness more at stake because they have less chance for

reproduction (see males can mate a lot a lot a lot but female goes out of commission for a while)

evolutionary selective incentive In: we can't really understand what animals can perceive - female unconsciously choosing - it's instinct - # of offspring among individuals make is super variable

her contribution to the next generation; her offspring over her genetic contribution - there is no fitness of an individual if their offspring don't reproduce, must produce fit offspring exceptions where males choose the young - then makes one choice

A wider sales are as a few males mate

mate chance very contributive to evolution

- probably less directional changes with this one since it's based in instinct? mate chance must have high fitness or otherwise the alleles causing mate choice will be deleted and worked out

gene flow - alleles moving from one population to another populations not totally absolutely 100% separate, some potential for interbreeding

changes frequency of source and destination populations critically important in preventing inbreeding depression in small pops - greater genetic diversity + greater capacity preservation - is genetic diversity undivided? gene flow random, don't happen in purpose

genetic diversity from gene flow don't always persist (new) alleles may be deletions if and be wiped out)

genetic drift- chance change in allele frequency, not adaptive potentially important in small populations

- when a few individuals of a species colonize a new moon (founder effect) and when they've decreased to a small population by a bottleneck (bottleneck) - genetic drift in large populations

(almost all of - only a few survive)

not all times when most of pop dies = founder effect

- has to be random event not related to natural selection won't of sex examples of slider

organisms continually & constantly subject to selection pressure - why don't they decrease genetic diversity = 5 reasons why natural selection doesn't eliminate genetic variation diploidy (necessary alleles hidden in heterozygotes)

3) sometimes heterozygotes better than either homozygote - one sickle cell while protects against malaria (+) but two are very harmful (-) - sometimes hetero has different phenotype than homo com 4) not all genetic variation affects individual fitness 5) mutations

evolution does not create perfect organism NO!

evolutionary trade-offs (can't prioritize both of them are in conflict) natural selection can only act upon existing genetic variation - organisms constrained by this past evolution mutations random, not adaptive

lag between evolution (response) and environment (selection pressure) - extinction b/c they can't with it as fast as were waiting a problem gene regulation problems (epigenetic processes) interpret w/fitness get it - turn on and off

## SPECIATION

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so far we've been talking about steady evolutionary changes in populations of some species undergoing evolution in different selective pressures for long enough (separate environments) may speciate

or one species splits massively and time until it a new species don't get too hung up on definition of species, it's a concept we've made up gene pools have to stay separate for speciation

population w

sometimes same specs don't recognize their ability to mate x opportuni  
City group of individual organisms that have the potential to infutured  
# fond prince fertile forming [ under natural arconstance ] vary dine

- 2 different species contrat produce fertile offspring (ie male)

this definition can't always be stated

seporante species are reproductively 150lastiftare different (also  
relevant to two populations of the same species ) give flow b / pops  
means they're not reproductivity isolated cannot just go by appearance  
to differentiate by species anotherway way Indagato distinguerse  
species. 1) morphology or

2) genetics (unique DNA sequences) - universally the same across  
species and univonly different

& among other species, not necessarily the most obvious, but necessarily  
every difference (look at slide sx)

-sometimes confuso lag- indutid populations and actual separate species  
-does it un matter? ele met volley)

gin of new species

allapatie - two populations one physicaly separated idifferent  
environments means different selective conditions meaning differences In  
evolution

## 18.2 Formation of New Species

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hybrid- infertile euro betaren tuo species

sexually reproducing organismy can only pass on DVA +/- gameter typically  
not interbreeding b/ species in the wild

-hypuedo in nature suggest desert pan common ancestor ( interbreeding  
species) , distribution same avions geography typically narogersous ("")  
gene pool for gagraphically continuar species because of que genefer

allepatric - disperant - afew members ofa species more new geographic  
area

presses

vicariance - natural situation physicaly to organismes - the further  
the distance , the more likely speciation

- probably more difference wong latitude than longitude (I think)



adaptive radiation - many adaptations for single part of organism (central vertebrates) different ages of one population / found a niche in a new area abundantly - ever occurring at + [n+ / or 24-1 chambers)  
-diploid(m)

fewer species

- polypheny (4), futureland/org w/ (m, can self pollinate)  
allelopathy gametes from two different species contain Species 1-) nemal  
gamete first mate in self pollinate

-) julyproud -, sicard making

species 2 -1 polyphard gamete high mite of ridyplenty in porto temporal  
solution difference in breeding time Websarany solution garnele barrier

## 18.3 Reconnection and speciation rates

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runfront firmen stability

gradual speciation - like a ramp punctuation equilibrium (donot exclude  
gradualism) - like a starreise Quanto changes an environment lefrenine  
speciation inte

Reflection

1) Jynman technique, but I didn't actually explain it to a separate  
person, just myself.

2) Pretty much , yuh . I imagined I would need to do some specific  
revision or targeted new , but I was satisfied in my ability to explain  
waything

3) answer in second sentence of (2)

4) I was confident yo?

5) I was not at all international about blocking out time specifically  
to study ,

6) more intentionality in scheduling and listing objectives but I was  
pretty comfortable with my readiness and mountain that having taken the  
quiz even without receiving or grade got . A bad grade would definitely  
undermine my confidence through. very lite method in my studying for this  
test

## SPECIATION

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Factors that increase the likelihood of allopathic speciation: 1) different  
selective pressures in different locations (Will evolve differently)  
-virtually no gene flow between populations I give small amount of gene  
flow can make two "populations indistinguishable 2) many different  
populations, not just two - this is not have

- species have certain specific habitat requirements

- just easier to study with island biotas

3) in that ability frequency differences b/ populations -ex. deer larger at higher latitudes and smaller closer to equator the two different pops have different frequencies for size (part #1 100) for under effect can cause this factor (e) I was right about temp kg :P inbreeding depression can apply to individual, not only population; not only relevant at population level, really referring to individual fitness

- I don't know that my quiz answer may only reflected that, but this specific jubilee is kind of new to me

Harrison archipelago

- Each island has very different environments

1) stands far away from each other for birds to interbreed most likely

archipelagos often sites of adaptive radiation (= from one species to many as a result of different adaptation to different selective pressures, lots of allopatric speciation, many species resulting) +/- adaptations to new environment)

IR one Aran bird 754 Hawaiian honeycreeper

okay to me how the different Galapagos Islands have such different environments - is understanding how the magnitude of these differences is necessary?

to him define a qualifier at all for adaptive radiation? Is it just kind of relative what we call adaptive radiation since all life is a product of evolution from a common ancestor!

- 300 cichlid species in Lake Victoria example

- when with level competition @ low, became created populations - adaptive radiation how all in one lake

sympatric speciation harder to study and provisos, probably not very important"

- not a physical barrier but don't interact

- harder to tell if they didn't specialize somewhere else and then end up here (Gryllus species) non-directional function of chromosomes during meiosis don't need to know the gritty details of meiosis

## 20.1 Organizing Life on earth

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phylogeny = evolutionary history, provide info on show ancestry

1) can change at time

phylogenetic tree, hypotheses of genetic part - nodes do show a common ancestor

branch point where a single lineage evolved into a distinct - basal form  
: lineage that evolved early from the root (like ancestor) but remains unbranched - sister taxa : two lineages stemming from the same place

- polytomy branch w/ 2 lineages not a rotation at such points does not change the information used for phylogenetic systematics - the field organizing + classifying - going back on evolutionary relationships not a matter of time

but

they show of relationship than physical similarity branch length not related to time under standard three domains : Bacteria, Archaea, Eukarya

then kingdom? phylum? class? family? genus? species

- each level specific name for an organismal classification

## 20.5 Perspective on the phylogenetic tree

free limitations to classic model : genes transferring by horizontal spread  
horizontal gene transfer (HGT)

- occurs in prokaryotes, also some in Eukaryotes

gene transfer other than parent to offspring (vertical gene transfer)  
genetransfer among common bacterial mechanisms:

1) transformation

2) transduction : a virus transfers the genes

3) conjugations: hollow tube (pilus) transfers genes between organisms  
gene transfer agents (GTAs) transfer small genome segments are prokaryote species to another

jerome frissen: when symbiotic prokaryotes use we come under eukaryotic

HGT has formed web of life model over tree of life, many of life also in the mix theme: limitations of models + scientific advances

A question : how is this at all w/i the scope of an class? what do I actually need to know for the purposes of this class have?

## 27.4 Evolutionary History of the Animal Kingdom

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What a specific fossil listing do I actually need to know?

Century explosion- rapid diversification of animals, west unlution of new animal phyla and mal delivery ever.

New ecological widest adaptation of existing spaces uncommment changes.

New wires speciation and divinity mars extinction some ways the state diversity change and geological time speciation and extinction equilibrium of species on planet birth to death marks of evolution of species on earth.