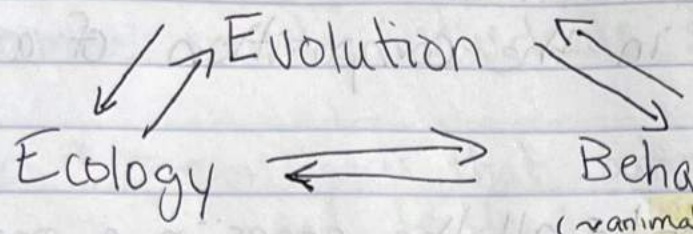
Biology (8/28/23)



Ecosystem services

(things we get for free from ecosystems)

- oxygen
- water supply
- soil
- wood & fibers
- water purification
- element cycling
- UV sheild
- wild genetic material
- climate moderation
- flood prevention
- air purification
- pollination
- recreation
- inspiration

what is evolution & how does it work?

1. Outline

Evolution - 3 circumstances & 2 consequences

observations of evolution in progress.

- artificial selection: intentional
- artificial selection: unintentional
- beak depths of Galapagos finches
- sickle back armor

Evidence of past evolution.

- fossils
- molecular homologies
- anatomical homologies
- convert evolution
- species diversity on archipelagos

Evolution: definition
A change in the composition of a gene pool.

Gene Pool = all the genes in a population of a species.

Gene = a unit of heredity

Population = a group of members of the same species with opportunities to interbreed.

Theory of Evolution explains:
1. how species change 2. how new species arise.

Selective Breeding - Picking preferred traits and breeding those animals. Don't breed the ones that have undesired traits.

"Artifical" Selection* - people determine which individuals reproduce.

Charles Darwin: called evolution "decent with Modication"

Natural Selection: natural, ecological processes determine which individuals survive & reproduce.

The 3 circumstances that routinely occur in nature lead to the inevitability of natural selection which in turn results in evolution

1. More are born than the environment can support.
2. Individuals are not identical
3. Some of the differences are heritable.

2 consequences of those 3 circumstances

1. Individuals best suited to the environment are most likely to leave offspring (natural selection)
2. Because only the reproducers leave genes in the next gen., the composition of the gene pool changes (evolution happens)

Tons of Evidence for Evolution

Some of the real-time evidence:

- Artificial Selection
  - intentional artificial selection
  - unintention artificial selection
- Natural Selection
  - Beak depths of Galapagos finches
  - Armor of stickleback fish

Bio. (9-6-23)

Molecular Homology: Amino acids sequences. Human sequence most similar to similar speices.

Convergent Evolution: dissimilar organisms (without a recent common ancestor) subjected to similar seleetive forces develop similar adaptations.

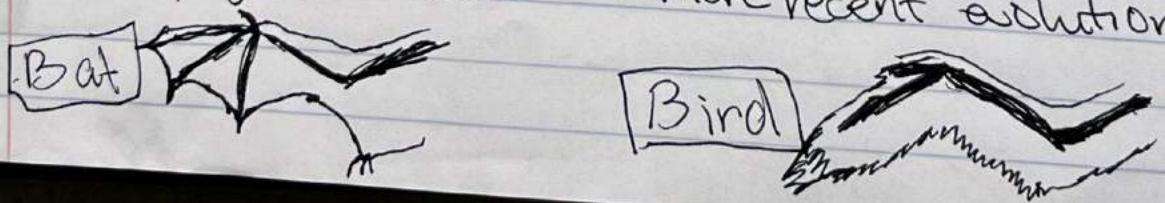
Historical evidence consistant with evolution by natural selection

- fossils
- molecular homologies
- Anatomical homologies
- Convergent homologies
- Species diversity on archipelagos

Study carefully: different aspects of the same pair of species can provide examples of both.

Anatomical homologies: bone structure (distant, non-flying ancestors)

Convergent Evolution: wings (skin vs. feathers - more recent evolution)



Species diversity on archipelagos

Galapagos habitat variation:
different ecological circumstances (selective forces) on different islands led, eventually, to enough evolution to give rise to different species.

An inconceivable amount of time for evolution to occur. (billions of years)

Inconcievable # of opportunities for beneficial genetic changes

Biology (9/11/23) Modes of Evolution

Next Level of Understanding Evolution
- Mutations
- inbreeding depression
- common patterns of evolution
- gene flow
- genetic drift

Outline
Basic genetics of inheritance
Fitness - formal definition
Processes that alter allele

Population: a group of individuals of the same species with opportunities to interbreed.

Species: a set of individuals with the potential to interbreed in nature

Gene: a unit of heredity made of DNA

Allele: a varient of a gene - e.g. a length of DNA that codes for a particular trait, such as black hair

Fitness

The relative contribution an individual makes to the gene pool of the next generation.

"Survival of the fittest" - (not the strongest individuals but the best suited to the environment.)

Processes that alter allele frequencies

("alter allele frequency" = "cause evolution")

- Mutation
  - creates new alletes = new genetic varieties = new possibilities
- Evolution by natural or artificial selection
  - adapts populations to current conditions
- Gene flow
- Genetic drift

Mutation- a change in a DNA sequence

- mutations occur randomly, not because they would be beneficial or for any other reason
- mutations often create new genetic varients
- Any specific mutation is extremely unlikely
- most mutations are inconsequential or harmful (random change to functional system)
- Rarer, beneficial mutations enable populations to develop genetic diversity + adapt to new circumstances

The problem with mutations for individuals

- Two copies of most genes - one from each parent
- Thus 2 alleles - same or different
- **Phenotype** = the expression of an individuals genotype. (genotype = individuals complete set of alleles)
- natural selection acts upon phenotype, not genotype
- One allele may be dominant over another, recessive to another, or related in a more complicated manner
- (dominant does not mean selected for.

Finches SimLab

Ex. 1

Smallest beak: depth: 9.75, width: 8.50 Largest beak: depth: 13.3, width: 6.75

7.1. Over the years the finches composition changes from having a little bit of every size beak to alot of them having bigger beaks

7.2 Yes the beaks got bigger over time

8. Selection strength: .05
Average B-depth: 11.5

9.1 Average B-depth: 12.1

9.2 It increased by .6

10. Selection strength: .15 or higher
Average B depth: 11.5

11.1 Average B-length: 12.6

11.2 B-length increased by 1.1

11.3 yes, the beaks get bigger faster

12. ~~Beak sizes stayed around the same~~
Beak sizes got smaller but slowly

Ex. 2

Wet	Dry
Optimal beak length:	Optimal beak length:
10 mm	14 mm

3.1 What is the Average Beak Depth?
11.5

3.2 What is range of beak depths?
9.75 — 13.3

3.3 Difference between largest v.s. smallest beak?
3.55 mm

4. Dry

4.1 Average Beak Depth: 12.7

4.2 range of beak depths 6.00 — 14.00

4.3 difference between biggest v.s. smallest beak: 8mm

4.4 How Composition has changed?
beaks got bigger

5. Wet

5.1 Composition actually turned out similar to in part 3.0

6.1 Did population evolve an average beak depth Well adapted for rainy conditions
The beak depth got smaller

7.1 Is it possible to drive them to extinction
yes, turn selection strength up all the way and switch between Dry + Wet.

7.2 Since beak depth has no effect on survival When faced with Dry Spells or wet spells they cannot immediately evolve to survive such conditions evolution takes time

Q1 Why are birds discussed called Darwins Finches

Q2 A Medium ground finch's ability to survive often ~~determines~~ depends on its beak size primarily because

Q3 Which statement best describes the pattern of natural selection on beak size

Q4 What can happen to our virtual finch population if environment changes from wet conditions to dry conditions too rapidly

Q5 What happend to beak depths in the finch population when selection on beak depth was eliminated (selection strength 0) and mutation rate for alles determining beak depth was greater than zero

Q6 The correlated traits exersize shows?

Q7 In the Mountains & Valleys ex which of the following parameters had the largest influence on whether the finch population evolved a bimodal distribution

Q8 The final ex., Large & Small seeds showed that?

Q9 Under which of the following conditions is a population most likely to evolve a bimodal distribution

Q10 In the lab, which of the following factors made it more likely that similar individuals would mate with each other

Wednesday

Biology (9/18/23)

Sexual Selection – Mate choice

- one sex is generally (in most species) choosier about mates Usually females (Why?)
  - Female fitness depends more on genotype of individual offspring than does male fitness - because females cannot reproduce as often
  - If a male makes a bad mate choice he can mate again - little impact of one bad choice on fitness

Exceptions

In species where males raise young, males are the choosier sex

In other species only or a few males mate. - females have no choice

What would happen to alleles that cause females to choose poorly?

- offspring would have lower fitness
- Alleles that led to such choices would be selected against

- Mate choice criteria (of wild species) Must lead to high fitness or alleles that lead to those choices would have been selected against

Do snail Q's

Processes that alter allele frequencies

- Mutation
- Natural Selection
- * Gene Flow
- Genetic drift

* movement of genes from one population to another

Gene flow critically important to prevent inbreeding depression in small population

Genetic Drift - Chance change in allele frequency - individuals

Genetic Drift can be important in very small populations but chance changes in allele frequencies are unlikely in large populations

Population Bottlenecks
- almost all individuals die, population regrows

Founder Events
- a few ind. found a new population in a new location

mutation	random
Natural Selection	kind of random
Gene flow	not random
Genetic Drift	random

Creatures are continually subjected to selection pressure

5 reasons why natural selection does not eliminate genetic variation

Diploidy = 2 alleles for most genes so recessive alleles are "hidden" in heterozygotes (not selected against)

Variable Selection Pressure (different alleles favored in different times and places)

Heterozygotes sometimes have higher fitness than either homozygote

Neutral variation (variation with no fitness consequence)

Mutations continually add new variants

Evolution Does NOT lead to perfect organisms

- Natural Selection involves trade offs (faster/Shrong)

- Natural Selection can act only upon existing genetic variation

- Mutations occur randomly, not because they would be adaptive

- Delay between when selective forces change and when allele frequencies change. Natural Selection always playing catch up

- Gene regulation problems (epigenetic Processes) interfere with fitness

Some imperfections of humans

- Pharanx used for both breathing & eating
- We can't synthesize vitamin C
- eptopic pregnancies
- babies heads to big

Fitness - The relative contrabution an individual makes to the gene pool of the next gen

"Survival of the fittest"
(not the strongest individuals, but rather the individuals best suited to the environment)

Processes that alter allele frequencies ("alter allele frequency" = "cause evolution")

- Mutation (creates new alleles = new genetic varieties = new possibilities)

- Evolution by natural or artificial selection adapts populations to current conditions

- Gene flow
- Genetic Drift

Mutation - a change in a DNA sequence
- occur randomly, not bc they'd be beneficial
- Create new genetic variants
- Any specific mutation is extremely unlikely

Speciation 9/20/23

formation of new species

Outline

- Species definition
- Species identification
- Origin of new species
  - Allopatric Speciation
  - Sympatric Speciation
- Mechanisms that prevent hybridization between species
- Major changes due to evolution of genes that regulate development

A species is a group of individual organisms that have the potential to breed and produce fertile offspring under natural circumstances

If members of 2 different species breed they do not produce fertile offspring

Thus, members of seperate species are reproductivly isolated.

In practice - it is often impossible to test whether two individuals can breed & produce fertile offspring so...

Species identified on basis of

- morphology (unique features or combinations thereof)

or

- genetics (unique DNA sequences)

Suggest unique features implies reproductive isolation

Morphological features that do not vary from individuals to individual within a population and distinguish populations with those features from other populations (of closely-related species)

In some cases biochemical data, such as DNA sequences, must be used to identify species with any certainty.

"barcoding species"

Thus, 2 methods for distinguishing species

1. Reproductive Isolation
2. Distinctive morphological or biochemical features.

Problems with these methods

#1 often cannot be tested

#2 can confuse long-isolated populations and actual seperate species

How do new species arise?

-1. Seperate populations experience different selective conditions that favor different alleles

- changes accumulate until 2 populations of one species become 2 different species

or

-2 Much rarer but common in plants: reproduction "error" produces a new species in one generation

For 2 populations to diverge into seperate species they must be sufficiently reproductively isolated that their gene pools can diverge

Biology 9/25/23

How did you study for the quiz?
I went over notes as well as reviewed all power point slides.
Was that how you intended to study?
No. I was hoping to get to study with a friend and make flash cards
If not, what was the difference?
I didn't have enough time.
Were you confident that you were ready for the exam?
No I had a lot of anxiety before and after.
Have you identified any ways to improve your methods for studying and learning? looking at slides is useful for memorizing but not for when you need to explain in other ways. I need to practice explaining the ~~topics~~.
Would you change your procedure for next time? If so, how?
I'll start earlier and use more methods than memorization.

Speciation cont.

If there is substancial gene flow between populations, they will not diverge genetically

Allopatric Speciation - Speciation involving geographic isolation

Sympatric Speciation - two populations become isolated even though they occur in the same area.

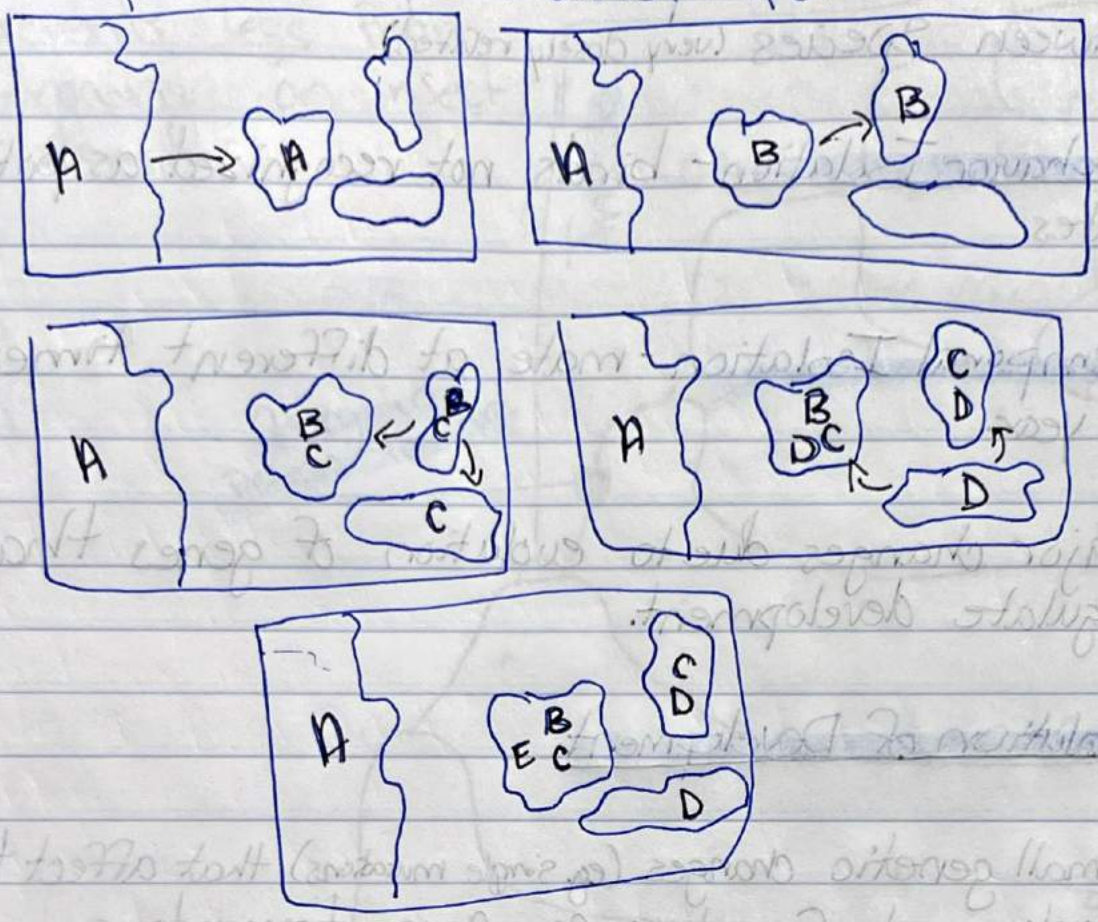
Factors that increase likelihood of Allopatric Speciation

1) Different selective pressures in different locations
2) Many different populations
3) Initial allele frequency differences among populations.

Island chains are often sites of **adaptive radiation**.

- isolation from mainland
- Small founder populations.
- Different selective pressures on different islands
- Infrequent movement from island to island

Adaptive Radiation on island chain



Sympatric Speciation

- Speciation without geographic isolation
  - possibly common, difficult to detect
  - (ambiguity of "geographic" isolation?)

Sympatric speciation due to nondisjunction of chromosomes during meiosis - common in plants

Mechanisms that prevent hybridization between species (very closely related).

Behavior Isolation - birds not recognized as potential mates

Temporal Isolation - mate at different times of year.

Major changes due to evolution of genes that regulate development.

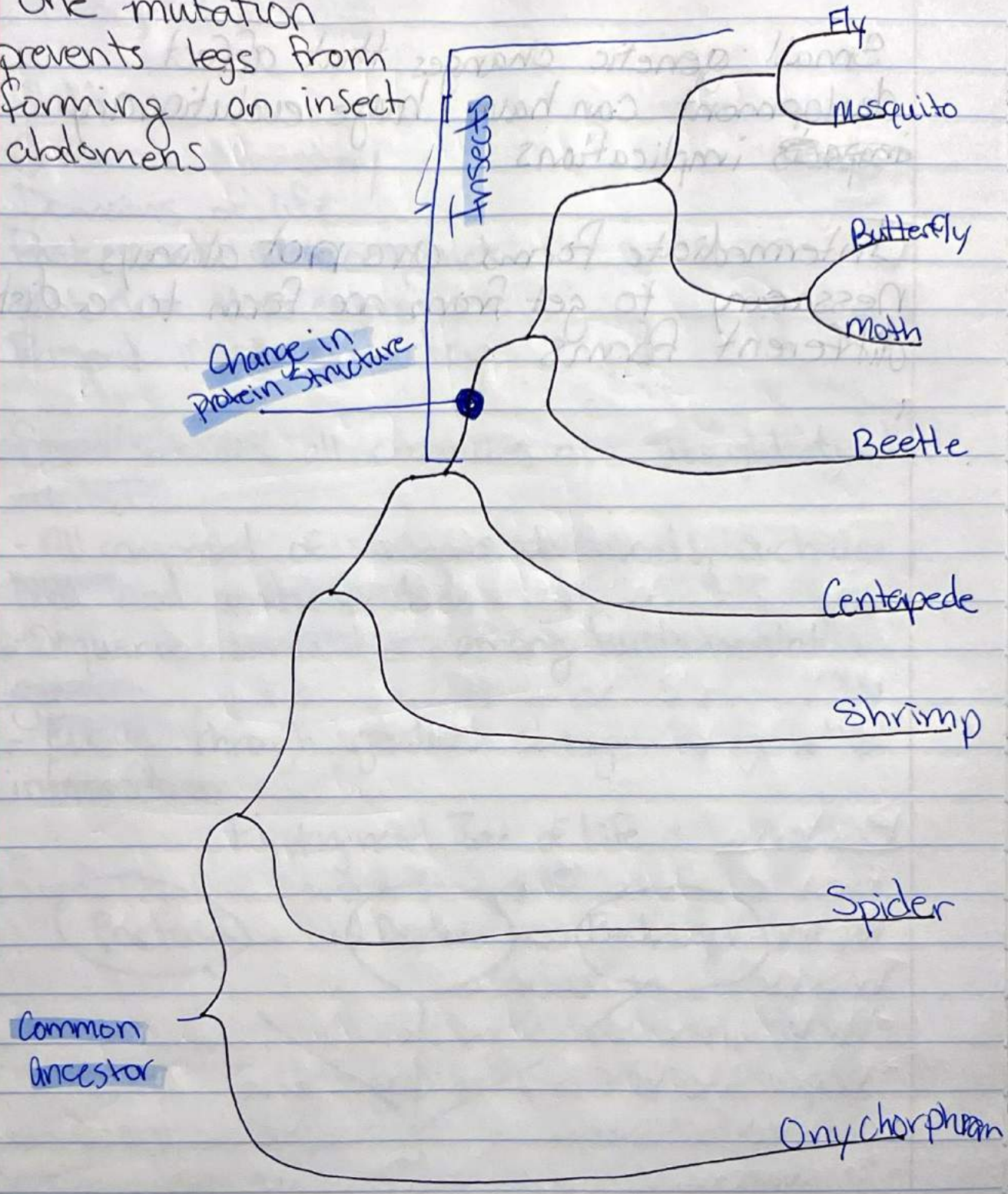
Evolution of Development

- Small genetic changes (eg. single mutations) that affect the development of embryos can cause tremendous morphological changes.
- In other words, a small genetic change sometimes causes a major phenotypic change.

2 genes determines whether a birds foot is webbed.

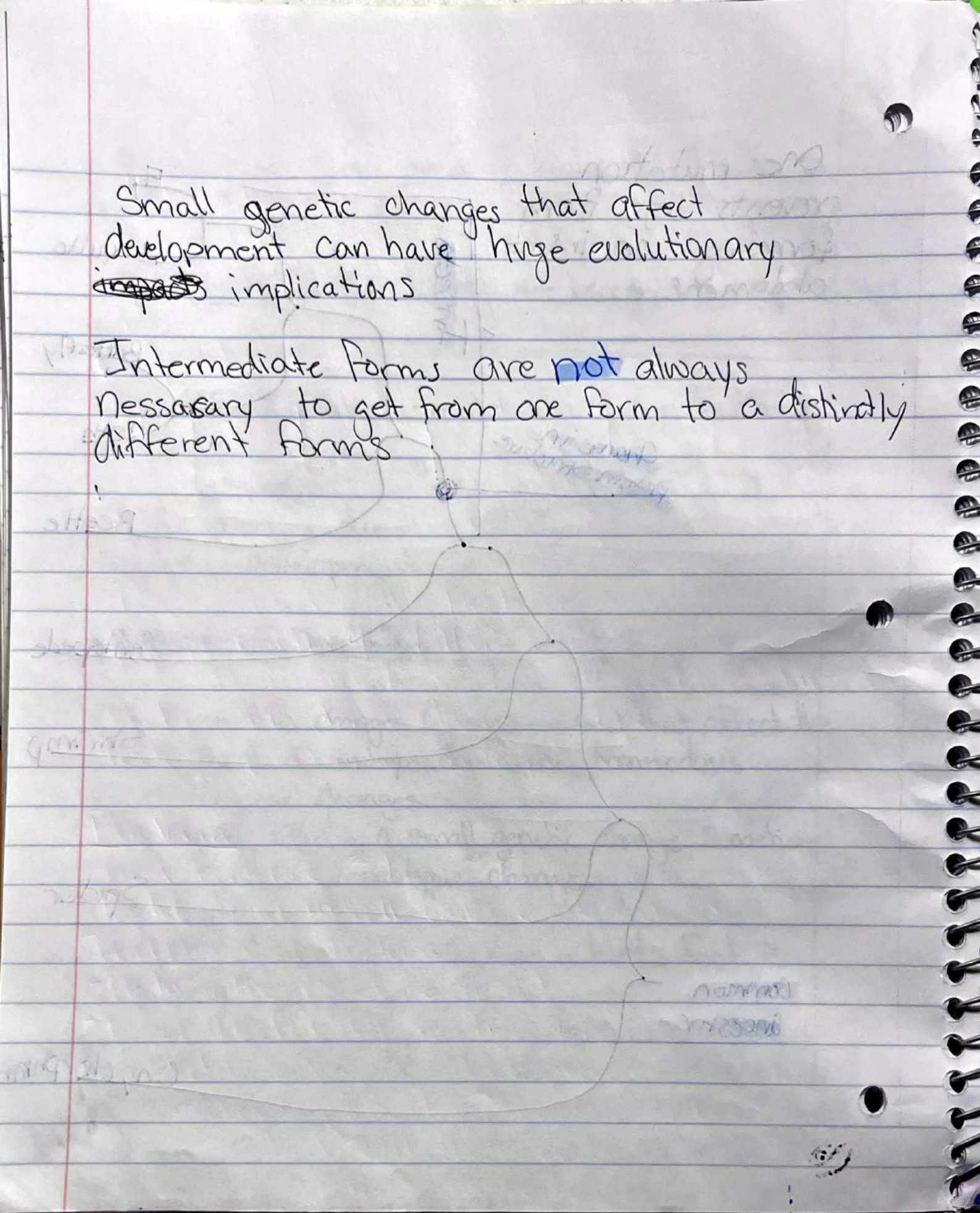
A single mutation prevents armor formation in stickle backs

One mutation prevents legs from forming on insect abdomens



Small genetic changes that affect development can have huge evolutionary ~~impacts~~ implications

Intermediate forms are not always nessasary to get from one form to a distinctly different forms

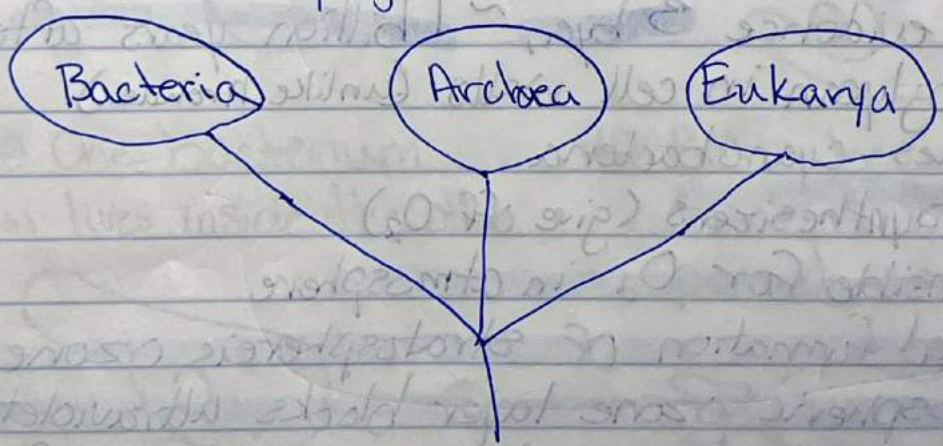


History of life

Outline
Common Ancestray
Domains of life
Past conditions on planet
Historical Mass extinctions
Present Mass extinction

Some reasons all creatures are thought to be related:
- All composed of same biochemicals, such as DNA and amino acids.
- Sequence similarities among fundamental genes
- Evolve through gradual changes in genetic information.

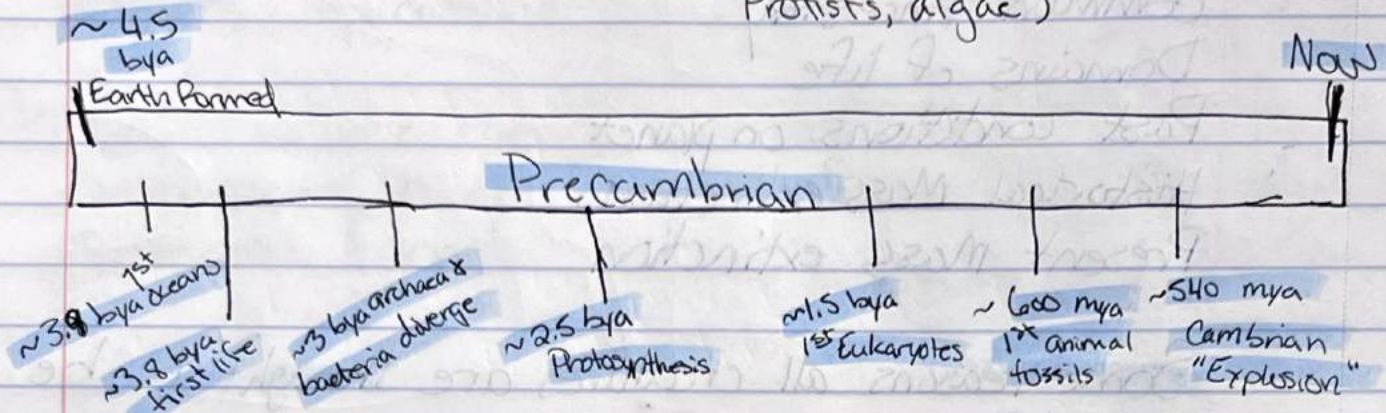
Phylogenetic Tree of Life



3 Domains

Bacteria
Archaea
Eukarya

Prokaryotes - no nuclei (archaea + bacteria
Eukaryotes - cell nuclei (fungi, animals, plants, protists, algae)



The earliest Cells: Archaea
Age of Earth: 4.5 billion years
First life occurred: 3.8 bya, descendants still around
Archaea + Bacteria diverge 3 bya
Todays Archaea occur in "harsh" environments

Bacteria

First evidence 3 bya, ~ 1 billion years after Archaea
Peptidoglycan in cell walls (unlike Archaea)
Includes cyanobacteria
- Photosynthesizers (give off O_2)
- responsible for O_2 in atmosphere
- enabled formation of stratospheric ozone layer
- Stratospheric ozone layer blocks ultraviolet light
- no life on land until the ozone layer formed
- So, we owe our lives to pond scum. (real) (dad)

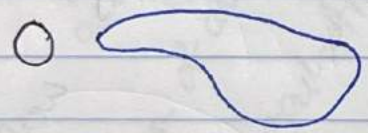
Prokaryotes (organisms whose cells lack nuclei, archaea, bacteria) had the planet to themselves for more than 1 billion yrs.

Eventually the first eukaryotes arose (organisms with chromosomes enclosed inside the membranes of cell nuclei)

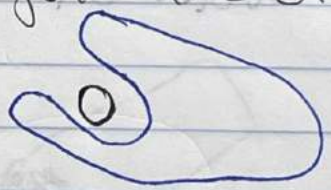
Prokaryote (Archaea, bacteria)
Eukaryotes (everything Else)

Endosymbiont hypothesis for origin of Eukaryotes

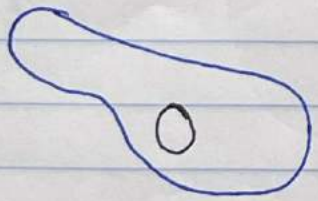
1) Start w/ 2 independent baeteria



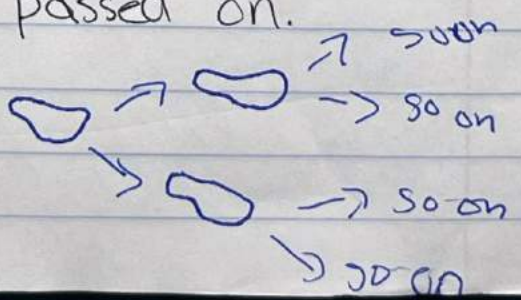
2) One bacterium engulfs the other



3) One bacterium now lives inside the other



4) Both bacteria benefit. So bacteria passed on.



Evidence

chloroplasts & mitochondria are similar in size to bacteria

Chloroplasts & Mitochondria reproduce by splitting, like bacteria.

Chloroplasts & Mitochondria have their own circular DNA, like bacteria)

Chloroplast DNA include sequences very similar to cyanobacterial DNA.

4.5 bya ??

Evolution is a change in the gene pool

Human Ancestry

Primates

Tarsier Monkey Us (humans)

All primates have
1. binocular vision
2. Grasping fingers + toes
(No other mammal has both

Primate evolutionary tree

65 mya Mammals called archonta give rise to primates.
36 mya Some primates become diurnal - monkeys with opposable thumbs
25 mya First apes
5-10 mya Climate cools, African forests replaced by savanna + grasslands
4-5 mya Tool use
2 mya Brains get larger - presumably because of selection for intelligence due to potential to use tools.

Neanderthal genes live on in modern humans

Homo naledi - found in S. Africa in 2015, has characteristics of both Australopithicus & Homo

Immediate Ancestors of humans

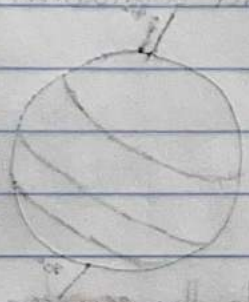
5 bya:	Hominids split from apes
4.5 bya:	"Lucy" - truly bipedal, survived 2m yrs.
2.1 mya:	Homo erectus in Africa, Europe, & Asia
500,000 ya:	H. neanderthalis in Africa
300,000 ya:	H. Sapiens in Africa & Middle East
100,000 ya:	H. neanderthalis in Europe & Siberia
200,000 ya:	(2019 Nature Report, Apidima 1)
28,000 ya:	H. neanderthalis still in Europe

Genetic Structure of Modern Human Pop.

"Within-population differences among individuals account for 93 to 95% of genetic variation; differences among major groups constitute only 3 to 5%."

Human "~~Races~~"

Genetic similarities among people from dif. areas.
No biological basis for conventionally identified races.
Criteria for race disti



* Midterm 2 next Wednesday *

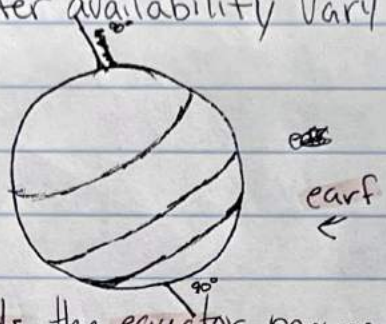
Biomes

Types
Distribution
Determinants of distributions
Human impacts on distributions

Biome - a type of ecosystem

Why does temperature and water availability vary around the planet?

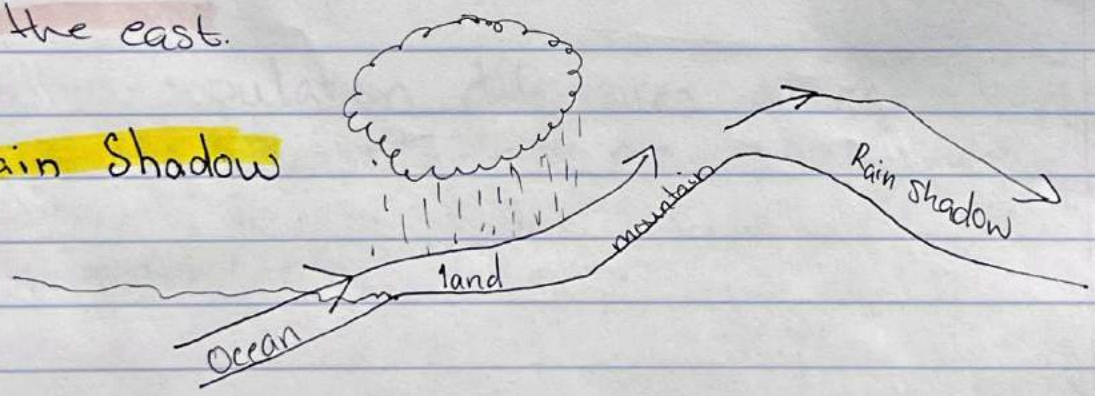
orbit = seasons



An air mass moving towards the equator moves more slowly than Earth's surface and is therefore deflected to the west

An air mass moving toward the poles moves faster than the Earth's surface and is therefore deflected to the east.

Rain Shadow



During the day as warm air rises, cooler air rushes in from the ocean to replace it.

[redacted]

Density dependent: Per Capita population growth rate depends on population density

Only density dependent processes can regulate population sizes.

Regulation occurs only per capita birth rate, death rates, or both vary with population density.

Biological interactions are often density dependent
eg. competition, predation, parasitism, (B/C of Population Density)
Abiotic factors are not generally density dependent
eg. extreme weather ([redacted] Happens Regardless of Population Density)

Current human population is maintained at expense of costs to future.

depleting a "one time inheritance of Natural Capital."

Phys. & Population Ecology

Summary

- Species maintain populations only where niche requirements met

- Adaptations broaden niche boundaries

- Some potential habitats are uninhabited due to failure to disperse to those sites.

- Once a population reaches a new site it may grow, but will not grow indefinitely

Population sizes tend to be regulated, but sometimes only loosely.

- The human population has grown dramatically, as if not regulated.

Community Ecology

Outline:

Types of interactions among species
- Competition
- Predation
- Mutualism
- Coevolution

Species Diversity
How does species diversity affect ecosystem functioning?
Factors that reduce species diversity succession

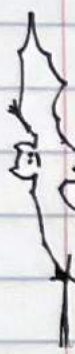
Community: An assemblage of organisms living close enough together to have potential to interact.

Types of interspecific interactions

- Interspecific competions - ≥ 2 species use same limiting resource, one or both suffer
- Predation (including parasitism): one individual benefits other suffers.
- Mutualism - both species benefit.
- Commensalism - one species benefits, other is unaffected

-Coevolution: reciprical evolution of ≥2 species in response to each other.

Fundamental vs Realized Niche



Fundamental niche - the set of conditions where a species could live in the absense of competitors & predators

Realized niche - the sets of conditions where a species actually does live in the presences of competitors.

Interspecific Competions & realized nichees

Predation

Selection favors individuals that survive and reproduce
Selection also favors individuals that obtain sufficient resources
thus
Almost all creatures are routinely at risk of predation or have effective defenses against predations