

- read syllabus and article on 08/25 before next class
- download copy of biology textbook

08/23:

# evolution, behavior, ecology

my initial definition of evolution: the reaction of an ~~entity~~ organism or species to an environmental stimulus over time

natural selection: the favoring 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 these topics in the first semester?

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

- species go extinct when they can't evolve as fast as the environment changes

most schools do cells and molecular biology in the first semester

- helps you to understand everything else; w/o that, you just have a lot of facts

- this is the why of biology

- the modern how is evolutionary history

- so much medical insight to be gained by knowing we evolved to be hunter gatherers

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

think

# notes & studying

## Feynman technique

- write what you know about topic by hand
- explain to a younger person (appropriately)
- notice what you can't explain
- followup and then repeat

## Notes

- don't dictate but paraphrase everything the professor says. They won't say anything that they think is useless.
- leave space on front for additions and leave back empty for later
- improve your notes w/ others after class
- work together to D main points, their relations, and how they relate to points in previous classes. shouldn't be laundry list of material
  - write these down on blank spaces.
- use readings to learn about the topics you all don't understand
- ~~runse over~~ run over in new notebook (w/ blank pages at front); develop
  - "Do not transfer anything you do not understand"
  - write in complete paragraphs; write out explanations in your words
- add outline of the day in beginning of book
- Keep up day by day!
- a list of topics and subtopics w/o any explanation
  - to study, look at the outline and see what you can do. Use that to guide your test prep.

read before 08/28 class

# ch. 18 Evolution and the Origin of Species

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

Evolution is the rationale for all biologic processes and drives current curiosity

## 18.1 Understanding Evolution

- evolution as a science precedes Darwin

- age of the earth integral in early evolution conversations

Galapagos tort: similar organisms on different islands with some distinct differences

Alfred Wallace and Charles Darwin independently thought of natural selection simultaneously

natural selection (survival of the fittest): the more prolific reproduction of individuals with favorable traits that survive environmental change because of those traits

- the how of evolution (adaptive evolution ... other types?)

① most traits of an organism are inherited

② competition for resources in every generation (from Malthus)

③ observable genetic variation; characteristics that compete better will be passed to progeny → descent w/ modification = "change in populations over generations"

- nongenetic variation not contribute to evolution b/c not inheritable

④ mutation = a change in DNA; new alleles; can have (+), (-) or no effect (neutral mutation) w/ varying degrees

⑤ sexual reproduction = unique mixing of parent DNA → unique combo

adaptation a heritable trait that helps an organism's survival and reproduction in its present environment

- genetic variation over time contributing to fitness

- favorability ← environmental conditions (not static); directions can shift

divergent evolution evolution in diverse (interesting) directions from a common point

"acts on individual organisms but shapes an entire species"



**convergent evolution** similar traits evolve independently in species that do not share common ancestry

- same ~~predator~~ destination, different journeys (group of tourists)

**homologous structures** same overall construction / synonymous parts in different species

**vestigial structures** unused structures w/o function (appendix)

**analogous structures** similarities not due to a close evolutionary relationship, ~~just~~ just common reaction to environment

- ex. many arctic animals white b/c arctic is white, not because of common ancestry

**Misconceptions**

- scientific "theory"  $\neq$  common usage "theory"
- an individual organism cannot evolve
- evolution not about the beginning of life
- evolution not intentional, just logical outcome
- the variation must already be present to be selected for

**Evidence:**

- fossils
- anatomy & embryology (homologous + vestigial structures)
- biogeography (like mainland / island similarities)
- molecular biology: similarity in DNA  $\propto$  similarity in ancestry

artificial selection: evolution driven by decisions of people (whether intentional or not); people determine which individuals reproduce and/or survive

- generation by generation; the preferable selected after e/ generation

- "artefact of human activity" Dr PS

- "descent with modification" Darwin

- modern fruits + vegetables great example of artificial selection

- most of what we eat is a product of intentional a.s.

natural selection: natural, ecological processes determine which individuals survive and reproduce

- doesn't have to be the predator/prey situation

- mechanism of evolution

- due to what circumstances does n.s. occur?

i. competition

3 Circumstances

ii. individuals not identical -> natural selection -> evolution

iii. some variation heritable - (only needs 1/3, not 3/3)

is far enough i. more born than environment can support

- not enough resources for all to survive; don't all survive to reproduce

ii. individuals aren't identical

- some differences genetic; not all differences genetic

iii. some of the variation among individuals is heritable

↓ - noted in genes (how is this different from the one above)

## 2 Consequences of these 3 Circumstances

1. individuals best suited to environment (fit) most likely to leave offspring (natural selection)

2. because only reproducers genes passed on, composition of gene pool changes (evolution)

- there is still room for bad luck in ecology; fit organisms can still die before reproduction, chance exists

wouldn't actually lead to evolution if there wasn't a genetic difference

individuals

vary genetically

is far enough

maybe sense  
nots and go  
his feedback  
during office  
hours

- over time, probability is truer
- "Evolution doesn't occur so that anything"
- evolution not on purpose & it's a result, not a goal. the consequences of evolution are not "why's" for evolution

Some of the real time evidence:

- look for evidence for hypothesis being wrong, not for reasons they're right
- try to reject hypothesis. If you can't, it's apt to be right
- unintentional artificial selection:
- ~~page 111~~ does this mean yielding unintentional effects on we didn't know we were selecting? or both?
- pups have trouble breathing. modern crops must be babied on a farm.

Why would a physician make you keep taking antibiotics even when you're feeling better?

## 08/30 Lecture

readings - don't develop the potential to evolve because of exposure to environmental pressure; relies on genetic variations that just happen to occur

- we don't write articles on unknown mutations (a lot)

Observations of evolution in progress:

unintentional artificial selection - may produce a superbug

EX 1 - antibiotics are for bacteria

- not enough antibacterial in your system to kill all the bacteria; leaving just a few over, they'll reproduce exponentially still

- why do some survive and some not? I

- bacteria aren't genetically identical (news to me)

no office hours on 08/31



- some more questions on 08/30 readings Google doc, ~~off the clock~~
- maybe come in Wed. office hours
- Q\* - how does bacteria even mutate if they reproduce asexually?
- 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 detract from fitness somewhere else
  - pretty much an inherent cost to mutated advantages
  - pre antibiotic, the bacteria compete with each other
  - antibiotic example analogous to superweeds example
  - taking all your antibiotics doesn't ensure all ~~antibiotic~~ bacterium are gone (answer to question)
  - resistance doesn't mean 100% resistance

ex 2

Why do commercially-harvested fish become reproductively mature at smaller sizes than previously?

- commercial fishers kept bigger fish and returned smaller fish
- net fishing removes more big fish; fish left to reproduce are the ones small enough to fit ~~in~~ the net
- again, relies on the leftovers just happening to mature at smaller size
- unintentional artificial selection

ex 3

Changes in beak depths of Galapagos finches following drought

- 400 miles offshore, not on a migration path, not visible from mainland
- lots of different examples of evolution w/ the G.I. because its initial cases drew a lot more researchers (less point load effort for researchers)
- under variety of finch species
- "evolves back and forth" w/ weather cycles; short-term

Geospiza  
fortis

/ environment changes  
evolution that frequently changes direction  
- islands far from mainland tend not to have many species  
b/c difficult for species to get there  
- Gal volcanic (from formerly underwater volcanoes); different  
islands vary a lot in biotic presence, differ in age etc  
- finches seed-eating birds; strong bill to break seeds open  
- how well its bill works massively determines fitness  
drought on island:

i. few seeds available are large (for whatever reason)  
- only big bills can bust it open

ii. small bills can't eat

iii. small birds don't survive / long-bills survive

↓ evolution

next generation from large billed parents mostly  
natural selection example (due to natural  
why / how does it switch back? How do small bills even  
have an advantage over large bills?  
evolution not a goal, rxn to conditions of environment

ex 4 Armor of 3-spined stickleback - ocean vs lake populations

- lake have less and less armor over time

- nowhere to hide in ocean so armor necessary

- lake pops have places to hide; being more mobile  
helps them to hide in the lake

- occurs due to already existing mutation  
break until 2:41

do the reverse on the slide

make sure you can explain a piece of historical evidence of  
evolution by natural selection

there is a reason for every slide ... → next page



- ask if hill be doing  
office hours on Wednesday,  
September 6, 2023

# see evidence of past evolution

fossils

sequential change in fossils w/ sensible intermediate

- gradual sequences

anatomical

descent from common ancestor

homologies

"legacy of structure multiplied by different environments"

- how does this prove common ancestry? could it, it

just be a sensible way for arms to be organized?

vestigial structures vestigial homology

- whales have hip bones with no limbs  $\rightarrow$  descent from ancestor that did have legs

"evolution doesn't make things perfect", not ecologically expensive for whales to have hip bones - will be very gradually lost / vestigial things don't get lost very fast since they're neither advantageous or disadvantageous

molecular

homology

amino acid sequences of humans most similar to organisms (logically) similar to humans

- due to descent from a common ancestor

- more similarity means more recent common ancestor

- necessity differ - more similarities

convergent

unrelated species evolving predictably due to shared environment

- more time for evolution

evolution

(relatively) mental pressures

- for evolution to occur w/ common ancestors

how exactly

- not unrelated species becoming ~~unrelated~~ related

$\rightarrow$  more differences

does qualify

- similar selective forces  $\rightarrow$  similar adaptations

something as

- whale (mammal) descended from land mammal but shark

dissimilar if

(fish) have similar overall shape (convergent evolution)

its relative

- similar  $\neq$  the same

since all

- can convergent species occur across ~~different~~ geography if

one c.a.?

selective pressures are the same?

$\rightarrow$  answer: yes!

- humans & octopus have common ancestor @ some point but dissimilar

- look similar but different development

- convergent evolution

10

- how are environmental pressures the same? are we thinking

way back or?

Bat/bird

\* be able to distinguish b/ the two

- anatomical homologies: bones in the wings

- wings: convergent evolution (common ancestor had a joint leg, not wing) but similar in the way a shark and mammal are similar

- CE → similarity but ah → same → similar  
same structure from same ancestor  
↳ similar features from similar pressures

sn: he will send old questions via email

- know definition of evolution and natural selection but generally knowing the meaning is enough

- mix of MCQ and SAQ

- anything discussed in class (review nonbio stuff too?)

species diversity (sn: evolution doesn't result in perfect form, it's the way that worked for survival in the past, could very well be better)

on archipelago

House Finch (seed-eating birds w/ big heavy bills)

G.I. lang (for a finch) way offshore of Ecuador

- finch doesn't fly there from mainland on purpose

- one finch species on mainland in Ecuador (more land area)

- 13 finch species in G.I. (less land area, volcanic islands of different ages)

- going b/ the islands (G.I.) would be rare too, even that too far and very unlikely that finches flew to G.I. to begin w/ but sn: unlikely events happen all the time

G.I. habitat variation

- islands different from each other + different environmental pressures

- two individuals surviving in different environments and different? d

- not one species / island different directions of evolution

- more than one on an island kind of just happens

slide 42 → are any of these species more or less related to the ancestral finch? does amount of divergences relate to amount of relatedness to ancestors? does it even matter?  
- resume at 2:25

~~beep beep beep beep~~

bacteria can mutate

mutations are evidence that biological processes aren't perfect