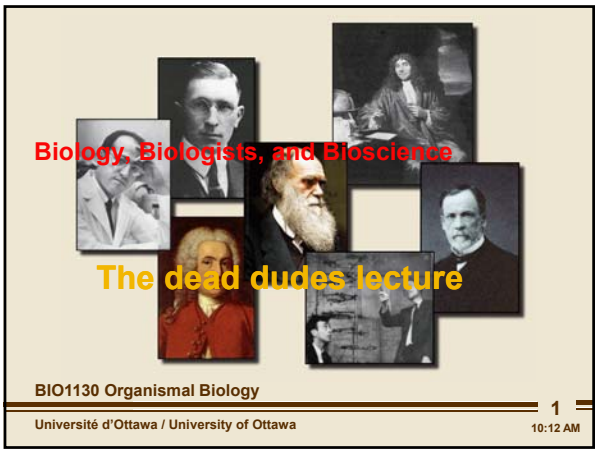
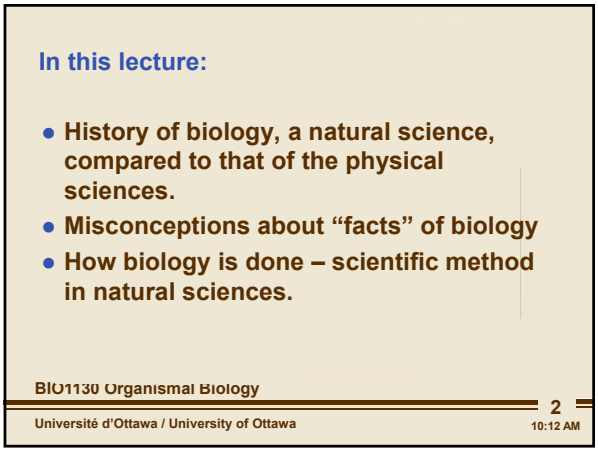
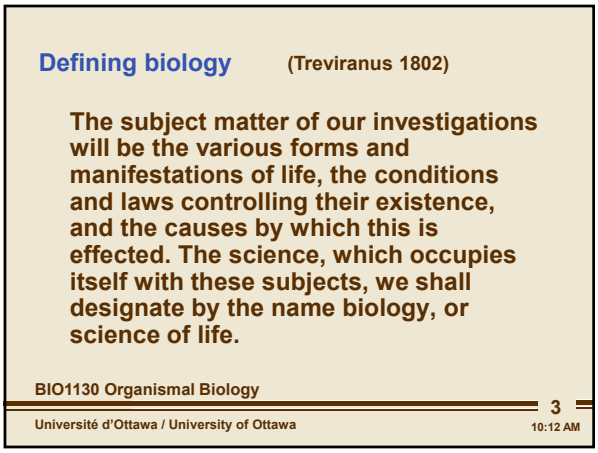
Biology, biologists and Bioscience







biology first defined in the early 19th century

Important stages in the history of Biology

- 400 BCE – 450CE: Greek and Roman ages
- 450 – 16th century: Medieval ages
- 16th-18th century: Renaissance and the scientific revolution
- 19th century
- 20th century
- 21st century

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4
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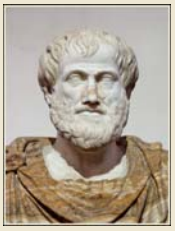
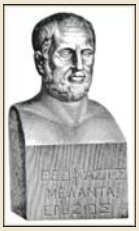
Important stages in the history of Biology

400 BCE – 450: Greek and Roman ages

Hippocrates
(460-370 BCE)



(384-322 BCE)



Theophrastus
(371-287 BCE)

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6 major periods of time in biology history
greek and roman ages : huge industrial civilizations
roads, commerce, wealth which leads to knowledge
Hippocrates first philosopher to observe human biology, "father of medicine" hippocratic oath
Aristotle Student of Hippocrates, kept a record of all animals seen as the greeks explored europe. Important for commerce. Prioritizes the animals superior and inferior. Scala Naturae (scale of the living world)
Theophrastus, Same as aristotle but with plants for medicinal benefits. plants become specialist at creating chemicals and poisons to protect against predators. Puts together a compendium of all medicinal plants and their uses. Notices the similarities in plants. catalogues by how the plants are pollinated. Father of classification and taxonomy. Wrote ten books, nine still exist. Books still used 1000 years later in medieval ages.

Important stages in the history of Biology

400 BCE – 450: Greek and Roman ages

- *Scala naturae* the great chain of being
- Essentialism

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Aristotle gave us Scala naturae. Most superior beings are the Gods. then lower gods, then tier 1 angels (archangels) then tier 2 angels, then man, then birds and things that fly, then fish, then mammals, then plants, then insects, then hell. All this unchanging diversity arranged in hierarchies. thought process : there is no change. this is how it is and it will always be this way.

Important stages in the history of Biology

450-16th century: Medieval ages

- **Europe**
  - 400-700 Early middle ages (Dark Ages)
  - _____- _____ High middle Ages
  - 1300-1500 Late middle ages

Black plague (1347-1351)

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7

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at 450 CE roman empire starts to collapse. rome starts to pull back it's empire. costing too much to mine and defend their colonies so they just left. goths were attacking romans, so romans shrunk down (turtled). economy collapsed because they lose their commerce. no money to fund and education, research, etc... romans become extinct. took 300-600 years for europeans to rebuild economy and commerce, etc. 1200 huge economy, cathedral competitions. 1300s Plague hits because people start to do commerce and move around a lot. spreads quickly. between 1-3 or 1-2 people died from the plague in a period of 6 years. Another stall in scientific advancement. in about 300 years, europe recovers and becomes a power house again. beginning of the massive explorations. christopher columbus. Golden age of science.

Important stages in the history of Biology

450-16th century: Medieval ages

- **Byzantium**
  - Al-Jahiz (781-869)
  - Al-Dinawari (826-896)
  - Avicenna (980-1037
  - Al-Baitar (d. 1248)
  - Abu al-Abbas al Nabati (13th century)

Avicenna

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8

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Islamic nations were not affected by the plague. when europe shuts down, the islamic world doesn't and they keep growing. Islamics have their golden age while europe crashes do to the plague.

Al-Jahiz : certain animals eat other certain animals. animals can be bread to improve agricultural stock.

Al-Dinawari: adds more plants to the compendium of theophrasus. starts to see relationships in plants through their relationships. the isnt nec. fixed strata

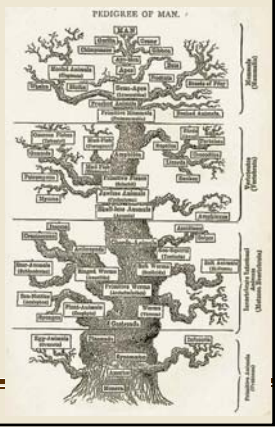
Avicenna: Take all that greeks and romans knew about medicine and combines it with india and middle-east. compendium so huge, used until the 1600s. used by everyone.

Al-Baitar: continues the plants. figures out dosages. used til 1700s. dif dosages do different things.

Abu al-Abbas al Nabati: beginnings of scientific method. Europe attacks islamic world (crusades) islamic culture collapses and europe gets all that research by the end of the 16th century.

Special creation

- **Pattern**
  - Species don't change
  - Each species created on Oct 23, 4004 BCE
  - Species are not old
- **Process**
  - A designer of some sort



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Trying to understand why things are in those spots and why they aren't moving. Start to ask, where and when did they arrive. Either everything arrive at once or it was once there and it evolved. Trying to map the beginning with the bible. an Archbishop decides that everything arrived on Oct 23, 4004 BCE.

Important stages in the history of Biology

16th-18th century: The scientific revolution and the start of modern sciences

- Copernicus (1473-1543) earth not the center of the universe.
- Kepler (1571-1630) – planetary motion
- Newton (1643-1727) – laws of motion, gravity and thermal conduction
- Galileo (1561-1626) – further proof of earth revolving around the sub
- Boyle (1627-1691) – behaviour of gases
- _____ (1623-1662) – origins of calculus
- Descartes (1596-1650) – geometry

- Van Leeuwenhoek (1673) – first microscope,
- _____ (1650's) – Anatomy and physiology
- Linnaeus (1735) – Systema naturae.

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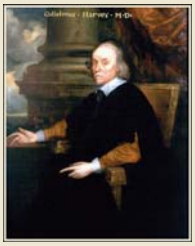
copernicus: trying to figure out the patterns in the sky. notices that some things are moving some things are stationary. conclusion, sun is centre of universe not earth. not accepted by the church, not politically correct at the time. writes it all in his book, keeps it a secret. while on his death bed he slipped into a coma. upon dying publishes his book.
galileo: adds to copernicus. telling everyone. excommunicated by the church.
still no biology.

Important stages in the history of Biology

16th-18th century: The scientific revolution

Van Leeuwenhoek
(1632-1723)



Harvey
(1578-1657)

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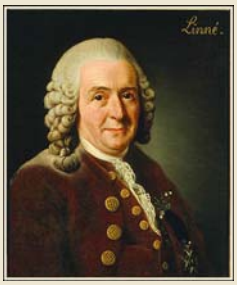
Van Leeuwenhoek: looked at little things. discovers that there are tiny things even lower on the scala naturae. starts a trend that if you look in more and more detail, you will learn new things. starts learning about cells
Harvey: father of phisiology. Studies the human body and sees how it works. cuts up cadavers. cuts up live animals.

The "scientific revolution" 16th – 18th century

Linnaeus – Systema naturae, 1735



- Taxonomic hierarchy
- Binomen and binomial nomenclature

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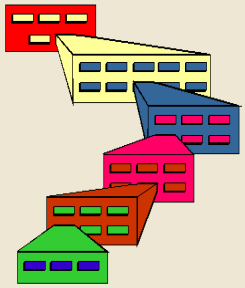
Linnaeus: two major contributions. gave us a way to organize the living world. gave us a nested hierarchy. ex: file folders on your computer. you can make predictions based on nested hierarchy.

The "scientific revolution" 16th – 18th century
Linnaeus – Taxanomic hierarchy



Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Rodentia
Family: Castoridae
Genus: *Castor*
Species: *canadensis*

13
10:12 AM

family wasn't there before.
acronym: king philip came over from germany for sex

Apis pubescens, thorace subgriseo, abdominae fusco, pedibus utrinque margine ciliatis

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14
10:12 AM

Binomial nomenclature

Apis mellifera
(Honey bee)

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16
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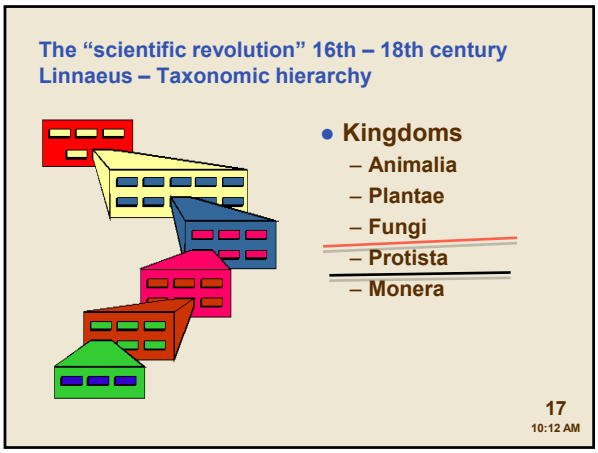
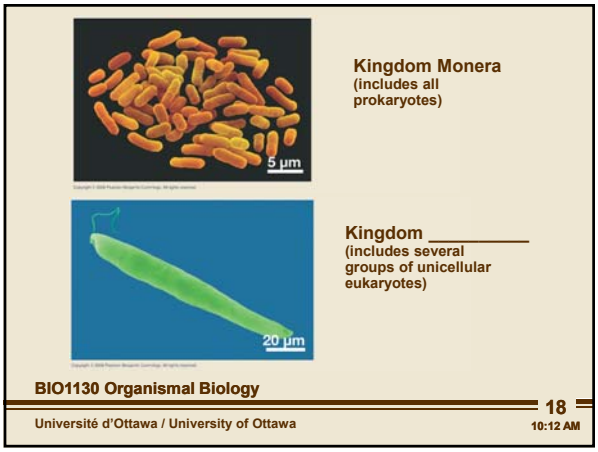


key division between animalia, plantae, fungi and protista, monera. (red line)
What separates them:
multi cell vs single cell

top half, cells specialize and communicate between each other (muscle cells, bone cells, etc..)

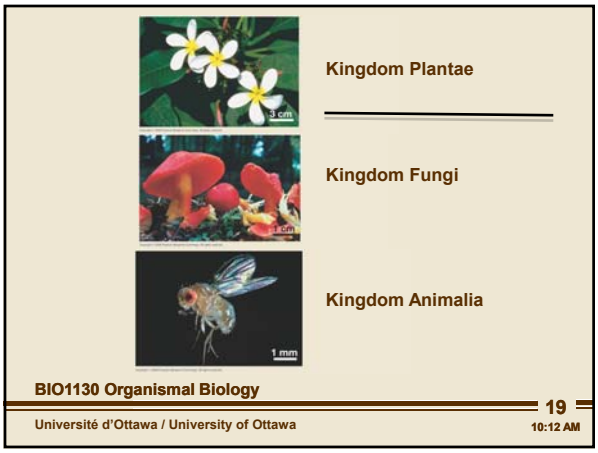
big difference = cell to cell communication

key difference between protista and monera (black line)
protista = procaryotes, monera = eukaryotes



Which came first?
prokaryotes : everything happens in the cytoplasm
eukaryotes : specialized environments that work together (ex: double membrane) complexity in the mechanics

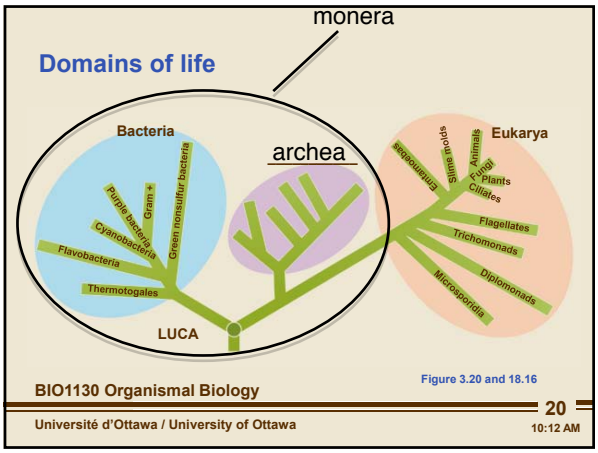
mitochondria came before chloroplast



next major division, the things that make food and the things that must co
autotrophes (self sustaining) vs heterotrophes (must feed)

fungi digest external and absorb nutrients
animalia consumes chunks and digest internally to get nutrients.

fungi cell wall is made out of chitin
animal cell wall is made out of cellulite



bacteria and archea used to be monera
when molecular biologist started looking at the bacteria they found that there were some very big differences between bacteria so they divided it into bacteria and archea (40 years ago)

living world gets divided into 3 different domains.
archea have only been found in the last 15-20 years. weird bacteria can live without oxygen, can live in extreme cold, very unusual, etc. extremophyles. thought to be remnants of the very first forms of life on the planet.

LUCA : Lowest Universal Common Ancestor

there are things that look like archea found in meteorites. one belief is that life started by a meteor hit the world oceans. oceans got contaminated by these archea and life started evolving from them.

biology is still just observation.
period of time introducing global travel
he notices that as he travels around, depending on the environment, certain animals have adapted to these environments. (ex: lions vs arctic cats) this shaped the appearance of the animals.
Biogeography : body depends on environment
believes that species changed : contradicts scala naturae
Continental drift still hasn't "come out" yet

Charles Darwin's grand-father
In his translations, he starts to see patterns. Begins to believe that there is some kind of common origin.
Looking at things such as bones and limbs.
Wrote a poem about it, and because it's a poem doesn't get in trouble with the church. (The temple of nature)

Georges Cuvier
(1769-1832)

- **Catastrophic theory**
- _____

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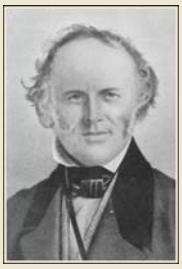
23
10:12 AM

digging up bones and such in quarries and mines.
bones attributed to mythological "nasties"
Cuvier starts to notice that when you systematically collect bones, you can put together an organism.
"if the scala naturae is so perfect, why did things disappear"
became acceptable that these were organisms that went extinct (contradicts scala naturae as well)
Proposes that there was a huge worldwide catastrophe that destroyed many animals (Noah's arc) Noah fucked up. Forgot the fucking unicorns. ass hole.. -_-

Charles Lyell
(1797- 1875)



- **Uniformitarian theory of geological change**
- **Stratigraphy and the geological time scale**

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24
10:12 AM

geologist
In his travels, he notices that rocks and deposits have stratas (layers) on them. Notices that the layers have certain patterns (like chapters in a book)
Finds these similar "profiles" all over the world.
Stitches them all together and gets a huge chain.
Represents history of sedimentation. Extremely slow process.
It is impossible that this all happened in 4004 BCE.
"wo!!! the world is a lot older than we thought"
contradicts Cuvier. (slow vs quick with extinctions)
Scala naturae has too many inconsistencies.

Jean-Baptiste Lamarck
(1744-1829)

- **Transmutation of species**

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25
10:12 AM

Tried to explain where the change would come from.
Traits are passed down through generations. Giraffe stretches it's neck to get food, kid is born with long neck, chain continues, final product, really long neck.
Inheritance of acquired traits.
His mistake : in complex multicellular organisms, a set of cells are set aside with their genetic content to be gametes. That genetic material is not being affected by the "stretching of the neck" because it is set aside. New generations come from what's set aside.
Species can change based on environmental pressure.
He wasn't right but at least he tried to explain it.

Essentialist explanation of change

- **Transmutation** (not Lamarck)
- **Transformation**
  - _____
  - **Environmental** (this is Lamarck)

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26
10:12 AM

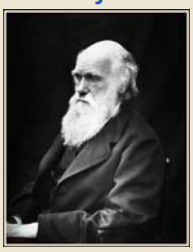
Two ways to accommodate change : there is slow and gradual change (transformation) or there is dramatic change (transmutation).
a cat is a cat and the next generation will still be a cat
Transmutation : essence undergoes a massive change, cat gives birth to a water buffalo. not so extreme

Also believed that over time the essence can better itself

transmutation here is different from Lamarck's transmutation which is trait inheritance.

Important stages in the history of Biology

19th century: Modern biology



Darwin
(1809-1882)

Wallace
(1823-1913)

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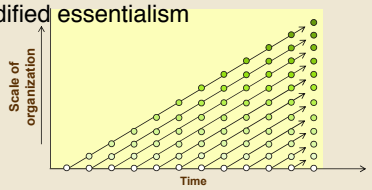
27
10:12 AM

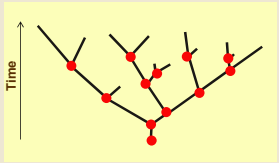
They changed our whole thought about where change came from. They recognize that in a population of organisms, they are not the same. The is inherent variation between them. Do not look at the individual, look at the population. Variation is important. Some individuals may be better adapted to their environment. darwin collects a lot of material throughout travels then spends his life studying them. believes there is natural selection. wallace came up with the exact same theory. afterwards darwin continued but wallace did not.

modified essentialism

~~Lamarck's theory~~



Darwin's theory



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28
10:12 AM

darwin's theory : if you have a population that has an advantageous trait, then that population will change as the trait is passed on to the next generation and it improves. big beak vs little beak. little beaks would eventually disappear is the seeds are too large.
within a population there will be a group that has an advantage and that group will strive and populate.

Darwin's five theories

- No constancy of species
- Common ancestry
- gradual changes
- Multiplication of species
- Natural selection

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29
10:12 AM

darwin never proposed a theory of evolution. he tried to explain it using five other theories.
Lyelle was his "supervisor" they were in constant communication.
family were very devout catholics, another reason to keep his theories a secret.
his first two theories were accepted right away but the other three were not.

Darwin's five theories
No constancy of species

- Fossils
- Extinction
- Transitional forms
- (Vestigial structures)

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30
10:12 AM

evidence of this theory is found in fossils, extinction, transitional forms and vestigial structures.

really old foot print

Darwin's five theories – No constancy of species
Fossils


Petrified wood


Invertebrate


Insects in amber

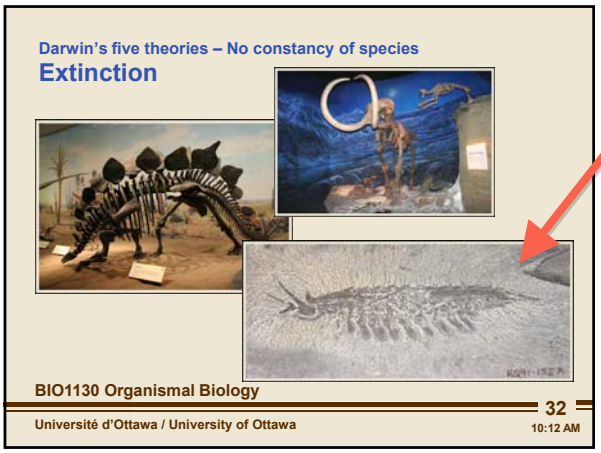
Figure 17.5


Mammoth in permafrost

31
10:12 AM

not all fossils are formed in the same way.
fossils are only made when the recycling of the world fails to work.

invertebrates are fossils from before the earth froze over dating of 650 million years ago.



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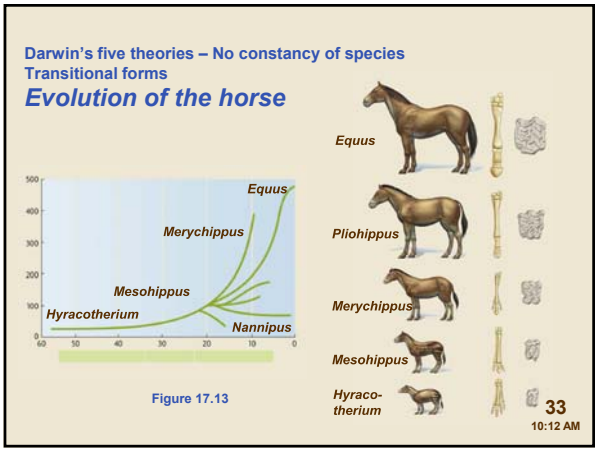
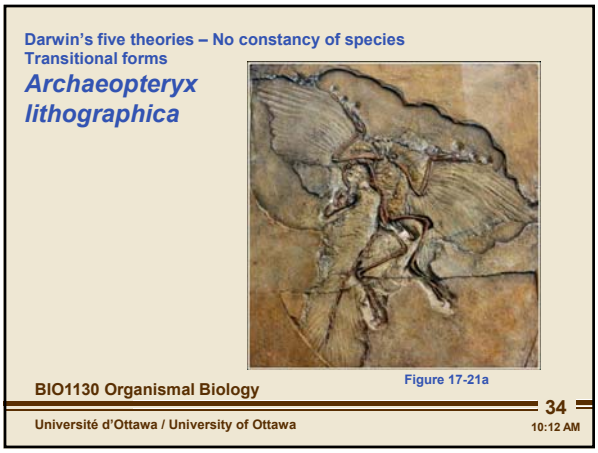
soft bodied fossils are possible. do not need to have bones.
soft bodied organisms were the beginning of life.
multicellular organisms started 540 million yea ago
these were found in the rocky mountains BC



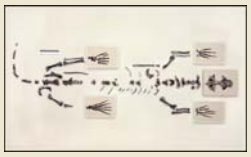
one of the very first transitions found was the horse.
global climate is changing and were changing from forest to grass lands. plants are bad to eat because the nutrition is the cytoplasm of the cell. this is completely surrounded by a hard to break down wall made of cellulose. eat these and don't get the nutrients. horse teeth become huge crushers that can crush theses walls to get the nutrients.
mastered how to feed on grass now need to master escaping predators. over time they are slowly eliminating fingers into hooves and can run faster.
we have all of the fossils to prove this along every step.



transition between birds and reptiles.
feathers were found in a lot of reptiles. they had feathers to keep warm.

Darwin's five theories – No constancy of species
Transitional forms
Puijila darwini

Meet the discoverer



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35
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transition fossil for the origin of the seal. lived on land then transitioned into water life.

Darwin's five theories
Common ancestry - evidence

- **Comparative anatomy**
- **Comparative embryology**
- Vestigial structures
- **Biogeography**
- **Molecules**

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36
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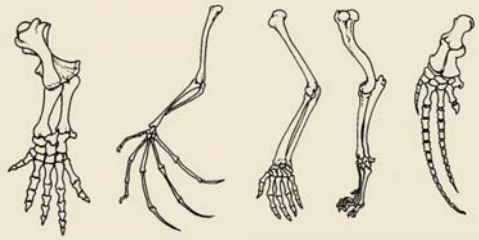
Darwin's five theories - Common ancestry
Comparative anatomy
Homology – Divergent evolution



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37
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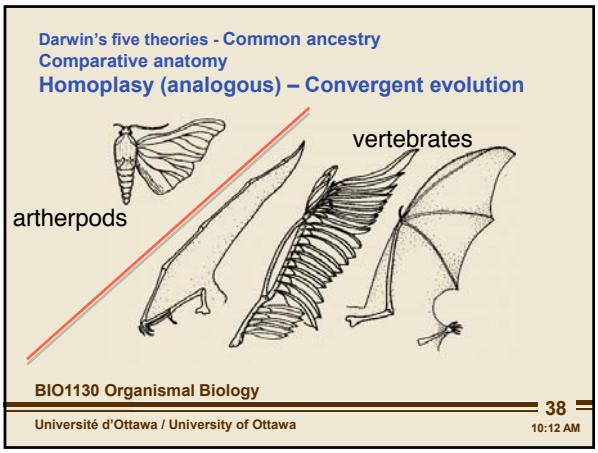
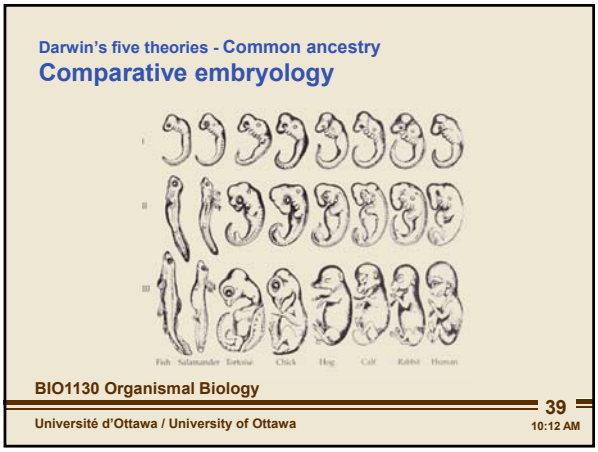
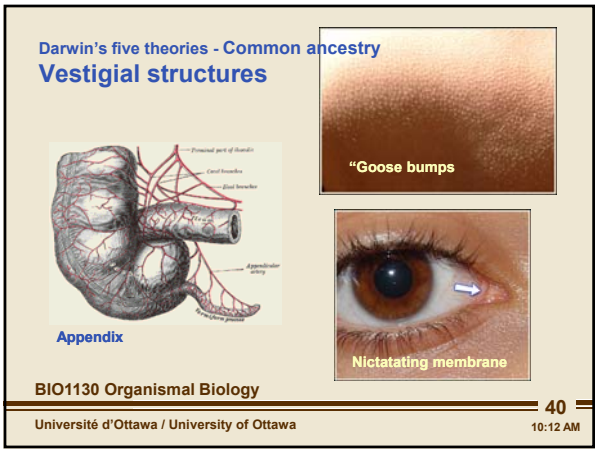
many organisms appeared to have different limbs to do different things. Even though they are different, they have the same underlying structure.
As time goes by, animals were able to adapt to do different things.



Flight evolved 4 times in the animal world. Insect, ancient pterodactyl, birds, bats.
Homoplasies start to disappear as we understand more and is replaced by homology.



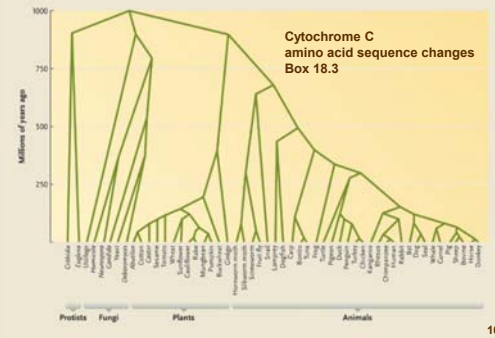
Very early on they were similar.
Spiral cleavage: the cells fit into the grooves of the cells beneath them.



Vestigial structures : things left over from our ancestors that serve little to know purpose.
Goose bumps : trying to erect hairs
Goose bumps come from ancient mammals trying to stay warm.
Also, when scared the coat enlarges to make the animal look bigger, goose bumps come from this too.
Ancestors used to have a membrane to cover over the eye for when underwater -> can still see well.
Appendix used to be used as an extra pouch to break down cellulose.

Darwin's five theories - Common ancestry

Molecules



41
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In textbook
~~Changes in amino acid sequences will tell us things about~~ the relationship of organism (ancestry).
~~Over time amino acids get replaced in protein sequences~~ and this change gets passed on so we can track ~~organisms that come from the same ancestor. It's~~ replaced in one group and everyone that descends from ~~that group has that replacement.~~
Now we look at genes. There's a group of chordates that ~~don't have jaws, one major change in that lineage is~~ getting jaws. When this happened, the whole genome ~~completely duplicated. Gave us backup genes to play with~~ and modify without losing the gene.

Darwin's five theories

- **No constancy of species**
- **Common ancestry**
- **Gradual changes**
- **Multiplication of species**
- **Natural selection**

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42
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Data was strong at Darwin's time and it just got stronger as time went on.
Need more evidence for the last 3

Pasteur (1822-1895)

- **Life from life not spontaneous generation**
- **Germ theory**

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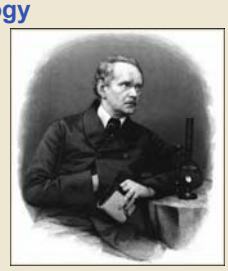
Most of the world still believe in spontaneous generation : life just arrives spontaneously.
Pasteur says that life does not come from spontaneous generation.

Important stages in the history of Biology

19th century: Modern biology

- **Cell theory**
  (Schleiden and Schwann – 1860)
  - **The basic unit of all organisms is the cell**
  - **Individual cells have all the characteristics of life and**
  - **All cell come from the division of other cells**



Schleiden (1804-1881)

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Everything you find when broken down has the same structure : membrane cell with a nucleus in the middle. Called this a cell.

It is now clear that the life comes from cells, and that cells can only come from other cells.

Mendel (1822-1884)

- **Rediscovered 1900.**
- **Law of segregation of characters**
- **Law of independent assortment**

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Studied peas and pea plants. Heritable traits are passed down through the generations in a discrete package.

If took all the tall and small ones, after a few generations you would only have the tall ones.

Dominant and recessive traits.

You get half your chromosomes from one and half form the other.

Darwin needed this for his theories but he was dead by the time these got discovered.

Mendel read Darwin's book.

Showed us how heritability occurs.

Important stages in the history of Biology

20th century

- Synthetic **theory of evolution**
  - **Population genetics and natural selection based on Mendelian genetics**

Huxley (1887-1975)

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Heritable traits received are genetic.

Darwin's theories are finally proved only 60 years ago.

Huxly pulled Darwin's theory together.

Darwin's five theories – Gradual change

Biogeography – gradual population changes

Thalassoma lucasanum
(Cortez rainbow wrasse)

Thalassoma bifasciatum
(Blue headed wrasse)

Continental drift 1
Continental drift 2

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Learned about continental drift. What animals we have on each continent depends on the descendants that were there?
There are no mammals in Australia!!! :o

Everything lives on Pangea and is spread out based on their environment and then it splits and those animals are now separated by continents.

Important stages in the history of Biology

20th century: Modern biology

- Cellular respiration, ATP and mitochondia (1930-1950)
- Ecology (1940's)
- DNA is the genetic materials (1943)
- DNA structure (1953)
- Gene regulation (1961)
- Genetic code (1960's)
- Recombinant DNA experiments (1970's)
- Cloning of a mammal (1997)
- Human genome sequence (2000)

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Types of Biology

- Molecular biology and biochemistry
- Genetics
- Cell biology
- Physiology
- Developmental biology
- Morphology
- Evolution and systemic biology
- Ecology
- Behavioural biology
- Nutrition
- Disease mechanisms
- Pharmacology
- Genomics
- Proteomics

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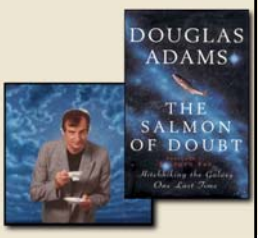
Important stages in the history of Biology

16th-18th century: The scientific revolution and the start of modern sciences

Douglas Adams 1952-2001

Four ages of sand

- –First - Telescope 1608
- –Second - Microscope 1678
- –Third -computer chip1961
- –Fourth - Fiber optics 1980s



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Some terms used in doing science

- **Theory and Fact**
- **Hypothesis**
- **Law**
- **Prediction (logical vs chronological)**

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Theory is the best explanation possible for a phenomena that's being observed.
Hypothesis are used to test an observation and the more they are right, the stronger your theory.
Theories are still open to interpretation depending on our knowledge at the time.
In science, always keep open mind that there may be something to prove you wrong. Open to the possibility of another interpretation that may adjust the theory. Theory is the closest we can get to fact. Theory is not just a best guess.
Hypothesis : way we question things around us. We always end up making a prediction.
Prediction in science is based on observation.
Law is a theory that can be applied universally.
Darwin's theory of natural selection can't be a law because we don't know if there is life on other planets and therefore cannot apply it to everything in the universe. Very few things, if any at all, in biology will become a law.

Physical science	Natural science
• Inanimate objects	• Animate objects
• Physical and chemical laws	• More than physical and chemical laws (Genetics)
• Universal	• Not Universal

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<-- Why natural science didn't advance as quickly.

BIO : No two living things behave the same way, everything is unique. This is what makes it so difficult in biology. No uniformity to work with.

Changing thoughts on what living things are

- Physicalists – with the exception of humans all living things are machines (Descartes, 17th century)
- Vitalists – physical and chemical laws apply but living things have a vital force (essence)

- Organicists (1930) – vital force replaced by genetic program and the importance of emergence (swarm behaviour)

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Difference in the living world is that the genetic code decides how the physical and chemical laws work in a living organism.

The whole is more than the sum of it's parts : The complex structure facilitates things.

Physical science

- Inanimate objects
- Physical and chemical laws
- Universal
- Based on empirical observations
- Experimentation preferred method

Natural science

- Animate objects
- More than physical and chemical laws (Genetics)
- Not Universal
- Based on historical narratives
- Induction most used method

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Darwin's origin of species has absolutely no equations in it.

Induction vs. Deduction

- Deduction (from the general to the specific): All insects have wings and this animal is an insect. This animal has wings.
- Induction: (from the specific to the general) This animal is an insect and it has wings therefore all insects have wings. (many multiple observations!)

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Natural scientists can't observe everything in the universe therefore their science is done by induction.

Physical science	Natural science
• Inanimate objects	• Animate objects
• Physical and chemical laws	• More than physical and chemical laws (Genetics)
• Universal	• Not Universal
• Based on empirical observations	• Based on historical narratives
• Experimentation preferred method	• Induction most used method
• Single theory	• Multiple theories
• Single falsification enough to abandon a theory	• Single falsification not necessary to abandon a theory

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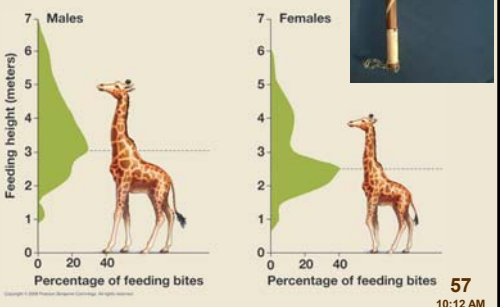
If you have an equation in physical sciences, it must always work. If it doesn't work, you must throw away the law.
In natural sciences, because of the variation and nothing is uniform, you can have multiple theories to explain everything. If one theory gets falsified, we don't throw it away because we haven't found everything. Maybe there are multiple theories that work at different times in different circumstances.

Multiple theories

Video 1, 2

- Food competition
- Sexual competition



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Giraffes are not using their long necks to feed. The theory that their necks grew to eat high vegetation is being questioned.
Alternate hypothesis, the long neck is used as a weapon on the end of a long coil. Makes the hack a lot stronger. (Like a mace)
In natural science, we will accept that at some times it is used as a weapon and other times it is more advantageous to feed on higher vegetation.

Side note : giraffes are one of the few animals that will fight to the death, the weaker animal usually withdraws.

Anatomy of a scientific explanation (theory)

- **Two parts**
  - Pattern
  - Mechanism or process
- **Questions to be asked**
  - What?
  - How (proximate cause)? or Why (ultimate causes)?

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Proximate causes
(Physical science-like biology)

- Phenotype – morphology and behaviour
- Mechanical (predictable)
- Here and now
- Genes in action
- Experiments

Ultimate causes
(Natural science-like biology)

- Genotype - Genes and history
- Variable (probabilistic)
- Evolutionary past
- Changes in genetic programs
- Historical narratives

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MIDTERM
proximate ultimate deduction induction
VERY IMPORTANT CONCEPTS

Additional experimental components

- Controls
- Control of variables
- Sampling error
- Repeat the test

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Controls: a part of what you are observing that you will not manipulate. if you are going to experiment, always take half and don't manipulate it so that you can compare it to the manipulated part.

Control of variables: variables such as temperature, season. you need to sample all your things at the same temperature and season, etc.

sampling error : you will never get a perfect measurement. the more time you measure, the more accurate the average value will be in determining the actual value.

Always repeat, if what you got what sound, you should get the same result.

Stages in an investigation.

- Observations
- Questions of how and why
- Hypothesis
- Test (experiment)
- Conclusion

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Shift from proximate to ultimate causes.
this insect is a blood feeder. it should be able to process blood very effectively.
Observation : didn't perfectly digest blood.

podcast for good example of stages in an invetigation

Darwin's five theories – Natural selection

Natural selection – Industrial melanism

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Importance : first demonstration that gene frequencies were varying over time. there was change over time with the variability within the population. the frequencies of in inheritable trait can change over time because of the changes in the environment. (adaptation)

Peppered moth

- **Observation 1:** Original museum collections had all white peppered moths and by 1900 traps collected 90% black.
- **Question 1:** Why did the moths shift from light to dark morphs?

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white used to be dominant, black became dominant. why?

Peppered moth

- **Hypothesis 1:** Fitness decreased when the moths that were more visible against the background colour of the trees.
- **Null hypothesis1:** Fitness remains the same and is not affected by the background.
- **Hypothesis 2:** The bark colour of the trees has changed.
- **Null hypothesis 2:** The bark colour of the trees has not changed.

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fitness : how many progeny you can create in the next generation.

Peppered moth

- **Experiment 1:** Artificially rear light and dark morphs and place on tree and observe survival (fitness)
- **Experiment 2:** Locate light and dark coloured trees.

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Peppered moth

- **Result 1:** Birds selected most visible moths
- **Result 2:** Dark trees showed same distribution as coal based industry

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Peppered moth

- **Question:** Do moths "rest" on backgrounds that match their colouration?
- **Question:** What impact would the clean air act, that reduced pollutant immisions have on the moth population morphs?
- **Question:** What happens to other moths with light and dark colour morphs

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moths select the proper background to be most hidden.

clean air act : trees all turned white, white both became dominant.

still proves hypothesis

what huxley calls : population genetics driving natural selection

Distribution of scientific facts

- **Journal selection**
- **Manuscript preparation**
- peer review
- **Revision**
- **Publication**

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first decision : where to publish paper. select one thats good for the area you work in.
two most prestigious journals : Nature (Europe), Science (North America)
Mendel didn't find a good journal, work got lost for a long time.

Types of literature – what's the diffence

- **Primary**
- **Secondary**
- **Tertiary**

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primary : original publication

secondary : review articles. someone get commissioned to write a paper on a subject to "review" it. lots of references to primary literature.

tertiary : drawn from all over the place to publish paper. writer is not an expert on all they are writing about. tend to have poor references. ex: text book. good because easier to read and much more generalized. chapters are sent to experts to review, makes text book good.
wikipedia example of tertiary literaure.