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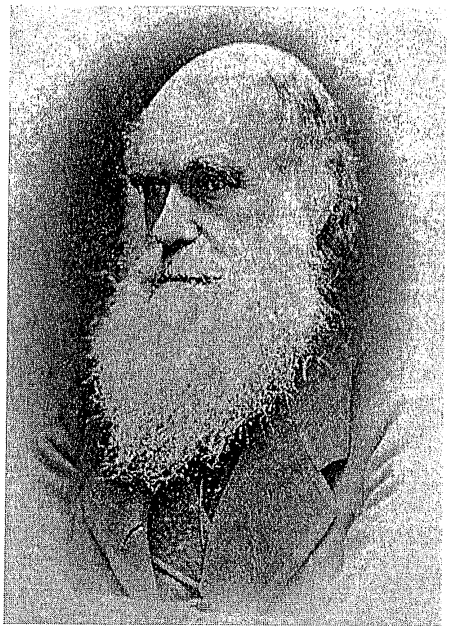
UNIT 9: CHANGE OVER TIME

Objectives



1. I can describe how mutations occur, what the outcome of a mutation could be and how a mutation can be passed to offspring.
2. I can analyze the amino acid sequences of homologous proteins in different organisms to determine the degree of evolutionary relatedness between those organisms.
3. I can define evolution and give concrete examples of evolution.
4. I can describe the patterns that Darwin saw among the finches and tortoises of the Galapagos Islands that led him to the idea of life changing over time.
5. I can calculate allele frequencies in a population and analyze those values to determine if evolution is occurring.
6. I can explain how natural variation occurs in a population, and how natural selection acts upon it.
7. I can describe how natural selection is related to a species' fitness.
8. I can identify common misconceptions about evolution and explain why they are not true.
9. I can describe the process of speciation, including the three isolating mechanisms; behavioral, geographic, and temporal.

Vocabulary

- Adaptation
- Allele frequency
- Behavioral isolation
- Evolution
- Extinction
- Fitness
- Gene Pool
- Geographic isolation
- Homologous proteins
- Mutation
- Natural selection
- Natural variation
- Population
- Scientific theory
- Speciation
- Species
- Survival of the fittest
- Temporal isolation

Evolution: Change in a population over time

Protein Synthesis and Mutations Review

PROTEIN SYNTHESIS REVIEW: Using the word bank, fill in the paragraph below.

• amino acids • anticodon • codon • complementary • cytoplasm	• DNA • mRNA • Nucleus • peptide bond • polypeptide chain	• protein • ribosome • transcription • translation • tRNA

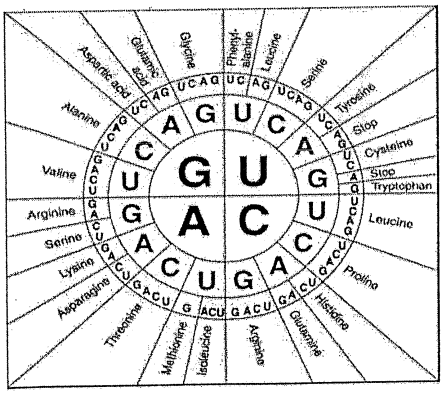
Protein synthesis begins in the nucleus where a section of the DNA is copied into a strand of mRNA. This process is called transcription. The mRNA leaves the nucleus and travels through the cytoplasm until it gets to a ribosome. The ribosomes reads the mRNA strand one codon at a time. The tRNA molecules will bring amino acids to the ribosome. The anticodon on the tRNA will attach to the complementary codon on the mRNA. The ribosome will attach each amino acid to the next with a peptide bond. This process is called translation. When the ribosome reads a stop codon the polypeptide chain will break off and fold into a protein.

Given the following strand of DNA, transcribe it into mRNA and then translate it into a protein.

DNA A A A|T A C|G G G|A G T|T T C|C G A|A C T|C C C

Transcribe UUU|AUG|CCC|UCA|AAG|GCU|UGA|GGG (AUG: Start; UGA: Stop?)

Translate Methionine, Proline, Serine, Lysine, Alanine,



MUTATIONS REVIEW

What is a mutation? A change in the nucleotide sequence of DNA

Why do mutations occur?

Mistakes happen randomly during replication. Radiation & chemicals can induce mutations. (Cause them to happen more frequently than normal.)

What is the result of a mutation? Use the following examples to determine the outcome of different mutations.

1. DNA (circle the mutation) A A A|T A C|G (A) G|A G T|T T d C G A|A C T|C C C

   Transcribe UUU|AUG|CUC|UCA|AAG|GCU|UGA|GGG (AUG: Start; UGA: Stop)

   Translate Methionine, Leucine, Serine, Lysine, Alanine

   Result One amino acid changed

2. DNA A A A|T A C|G G G|A G T|T T C|C G A|A C T|C C C

Transcribe UUU|AUG|CCC|UCA|AAA|GCU|UGA|GGG (start: AUG; stop: UGA)

Translate Methionine, Proline, Serine, Lysine, Alanine

Result No Change!

3. DNA A A A|T A C|G G A|G T T|T C C|G A A|C T C|C C (missing G)

Transcribe UUU|AUG|CCU|CAA|AGG|CUU|GAG|GG

Translate (no stop codon) Methionine (start), Proline, Glutamine, Arginine, Leucine, Glutamic Acid

Result Only the first two amino acids were the same the rest of the protein was completely different.

What tells an organism how to make a protein? DNA

Why are we so concerned with proteins, what's so important about them?

They are the building blocks for structures in living things and they control most of the processes of life.

What could happen to the proteins as a result of the mutations shown above?

Nothing, one small amino acid change or a complete change of the entire protein

Could these mutations be passed on to offspring?

Yes! But only if the mutation occured in a reproductive cell. (egg or Sperm)

How do we go from one minor change to an entirely different species?

Time! over long periods of time many, many mutations accumulate until the organism has changed so much that it is considered a new species.

What is change over time called?

Evolution

If two organisms have very similar proteins what can we assume about those organisms?

They have similar DNA, and are, therefore, very closely related. If organisms are closely related they must have a recent common ancestor.

AMINO ACID SEQUENCES AND EVOLUTIONARY RELATIONSHIPS

TRODUCTION

Homologous structures – those structures believed to have a common origin, but not necessarily a common function – provide some of the most significant evidence supporting the theory of evolution. For example, the forelimbs of vertebrates often have different functions and outward appearances, yet the underlying similarity of the bones indicates a common origin. Although homologous structures can be used to demonstrate relationships between similar organisms (two mammals), they are of little value in determining relationships between organisms with different structures (a mold and a spider).

Another technique used to determine evolutionary relationships is to study the **biochemical** similarity of organisms. Though molds, aardvarks, and humans appear to have little in common physically, a study of their proteins reveals certain similarities. Biologists can determine the sequence of amino acids in proteins. By comparing the **amino acid sequences** in **homologous proteins** for different organisms, evolutionary relationships that might otherwise go unnoticed can be determined. **The greater the similarity between homologous proteins in different organisms, the closer the evolutionary relationship!!!**

In this investigation, you will compare the amino acid sequences in proteins of several different organisms to determine how closely they are related.

PART ONE:

1. Examine Figure 1 which compares corresponding portions of hemoglobin molecules in humans and five other vertebrates. Hemoglobin, a protein composed of several long chains of amino acids, is the oxygen-carrying molecule in red blood cells. The sequence shown is only a portion of the protein, which is made up of 146 amino acids. The numbers in Figure 1 indicate the position of a particular amino acid in the chain, and the letters are the abbreviations for the amino acids.
2. Highlight (or circle) each amino acid in the chimpanzee hemoglobin that is DIFFERENT from the corresponding amino acid in HUMAN hemoglobin. If there are no differences, don't highlight anything.
3. Repeat #2 for the other 4 animals. Make sure that you are comparing each animal to the HUMAN amino acids, not the animal above.

A. What is the function of hemoglobin in your body?

B. On the basis of hemoglobin similarity, which organism appears to be the most closely related to humans? Why?

Which appears to be the least closely related? Why?

C. How did these differences in the hemoglobin protein occur?

PART TWO:

1. Another commonly studied protein is cytochrome *c*. This protein, consisting of 104 amino acids, is located in the mitochondria of cells. There it functions as a respiratory enzyme. Examine Figure 2.
2. Using Figure 2, construct a bar graph to show the amino acid differences between humans and other organisms.

A. On the basis of differences in cytochrome *c*, which organisms appear to be most closely related to humans?

B. Which organisms appear to be the least closely related to humans?

C. Check the pair of organisms that appear to be most closely related to each other.

_____ snapping turtle – tuna _____snapping turtle – rattlesnake _____snapping turtle – pigeon

Give a reason for your answer:

D. Name the pair of organisms that appear to be equally related to humans based on cytochrome *c* similarity.

E. Is it possible that the organisms in question D could be equally related to humans, but not closely related to each other? _____ Explain your answer:

CRITICAL THINKING:

A. There is a difference of only one amino acid in one chain of the hemoglobin of humans and gorillas. What caused this difference? BE <u>REALLY</u> SPECIFIC about how this could happen.

B. If the amino acid sequences in the proteins of two organisms are similar, will their DNA also be similar? WHY OR WHY NOT?

C. Biologists believe that the number of differences between the proteins of different species indicates how long ago the species diverged from common ancestors. Why do biologists believe that humans, chimpanzees, and gorillas diverged from a common ancestor only a few million years ago?

	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
Human	THR	LEU	SER	GLU	LUE	HIS	CYS	ASP	LYS	LUE	HIS	VAL	ASP	PRO	GLU	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Chimpanzee	THR	LEU	SER	GLU	LUE	HIS	CYS	ASP	LYS	LUE	HIS	VAL	ASP	PRO	GLU	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Gorilla	THR	LEU	SER	GLU	LUE	HIS	CYS	ASP	LYS	LUE	HIS	VAL	ASP	PRO	GLU	ASN	PHE	LYS	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Rhesus monkey	GLN	LEU	SER	GLU	LUE	HIS	CYS	ASP	LYS	LUE	HIS	VAL	ASP	PRO	GLU	ASN	PHE	LYS	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Horse	ALA	LEU	SER	GLU	LUE	HIS	CYS	ASP	LYS	LUE	HIS	VAL	ASP	PRO	GLU	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	VAL	LEU	VAL	VAL	ALA	ARG
Kangaroo	LYS	LEU	SER	GLU	LUE	HIS	CYS	ASP	LYS	LUE	HIS	VAL	ASP	PRO	GLU	ASN	PHE	LYS	LEU	LEU	GLY	ASN	ILE	ILE	VAL	ILE	CYS	LEU	ALA	GLU

FIGURE 1: Amino Acid Sequence in Hemoglobin

SPECIES PAIRINGS	# OF DIFFERENCES IN CYTOCHROME *C*
Human – Chimpanzee	0
Human – Fruit fly	29
Human – Horse	12
Human – Pigeon	12
Human – Rattlesnake	14
Human – Red bread mold	48
Human – Rhesus monkey	1
Human – Screwworm fly	27
Human – Snapping turtle	15
Human – Tuna	21
Human - Wheat	43

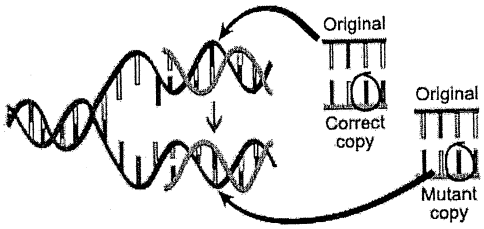
FIGURE 2

How Populations Change Over Time

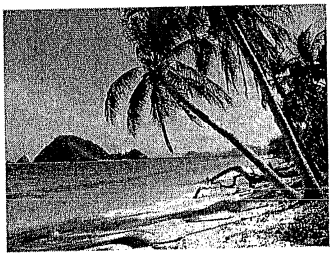
Evolution is...

- **Evolution** – a change in a population over time
  - Population – a group of individuals of the same species that live in the same area.
  - Species – individuals who can mate and produce fertile offspring.
- Evolution is a scientific theory, not simply a hypothesis.
  - A **scientific theory** is a well-substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed, and never disproven.
- **Example of evolution that we can see in a human lifetime:**
  - Penicillin – when it was discovered it was the miracle drug, killing all kinds of bacterial infections. Just 4 years later it was effective on only 25% of all infections.
  - **WHY?!** The bacteria had changed.

Conditions Necessary for Evolution to Occur...



- The Earth must be REALLY OLD
  - DNA is really good at replication – it doesn't make mistakes that often so it takes a Long time for DNA to change.
- Species must have variation – a difference in an organism compared to the rest of the population
  - **Variation is caused by** mutations
  - **If a mutation is beneficial to the survival of an organism it is called an** adaptation.
  - Not **all mutations are beneficial. Some mutations can cause an organism to be** _____ **suited to survive in their environment.**

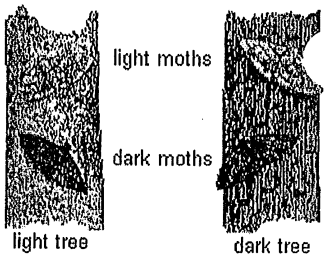


- Something must be DRIVING LIFE TO CHANGE - Nature!
  - Temperature, Precipitation, competition, predators/prey, ect are things that choose which organisms survive and reproduce, passing along their genetic information, and which organisms die and remove their genes from the gene pool.
    - **This is called** Natural Selection
  - Since humans have been on the planet certain species have been subjected to change based on human interest.
    - **This is called** artificial selection → we have already learned about this. What did we call it? Selective Breeding
    - Some examples are:

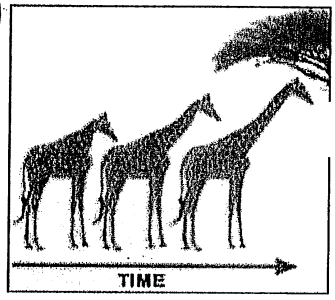
      Dogs Crops Pets
      Livestock Flowers

Theory of Evolution by Natural Selection....

- Which color of moth is better suited to a forest of trees with light colored bark? light colored moths
  Why? They blend in with the tree, making them more difficult for predators to spot.



- Which is the better moth overall? Neither! There is no such thing as a "better trait" because "better" depends on the environment.
- Organisms with favorable variations for their environment survive longer and reproduce more, passing their variations onto their offspring. (They are selected for.)
- Organisms without the favorable variation are less likely to survive and reproduce. (They are selected against.)
- Over time the entire population is made of organisms who have the favorable trait
- Fitness – the ability of an organism to survive and reproduce in its environment.
  - Not necessarily the biggest, fastest or strongest.
  - Survival of the Fittest – Those individuals best suited to their environment will survive and reproduce most successfully.



- If organisms do not have favorable traits, it is possible for a species to disappear from all of its geographical range; this is called extinction.
- Over a long period of time (thousands, or even millions of years), the neck of the giraffe became longer. Describe the sequence of events that would have had to occur for giraffes to have longer necks. In the giraffes environment having a longer neck allowed a giraffe to get more food, survive longer and leave more long-necked offspring. Any mutation that increased neck length would allow the giraffe to get even more food and leave even more offspring. Eventually the entire population had long necks.
- Populations evolve; individuals DO NOT!

How Evolution can be Observed.....

- **Gene Pool** – the combined genetic information of all the members of a population.
- **Allele** –
- **Allele Frequency** – how many times a particular allele occurs in a population
  - In a population of butterflies there are 20 red butterflies (RR), 18 orange butterflies (Rr) and 12 yellow butterflies.
    How many R alleles are there in the butterfly population? 58R
    How many r alleles are there in the butterfly population? 42r
    What is the frequency of the R allele? 58%
    What is the frequency of the r allele? 42%

$\% = \frac{\text{Part}}{\text{whole}} \times 100$

$= \frac{58R}{58R+42R} \times 100$

$= 58\%$

20 RR → 40R Or
18 Rr → 18R 18r
12 rr → 0R 24r
58R 42r

- **A change in the** allel frequency **in a population =** Evolution

History of the Theory of Evolution

Charles Darwin:

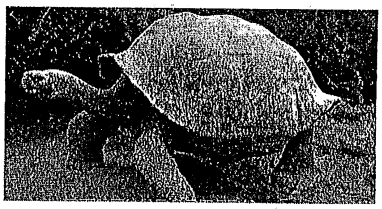
- Born in England in 1809. Worked on a ship called the H.M.S. Beagle in the 1830's. During his trip he made many observations and collected evidence that led him to explain how living things change over time.

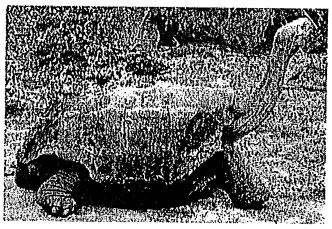
Darwin Saw:

- Patterns of diversity- Darwin noticed organisms seemed extremely well-suited for their different environments
- Living organisms and fossils - Darwin collected fossils of organisms that no longer exist but are similar to organisms that exist today.
- Galapagos Islands- Are a small group of islands that are close together but have very different environments (hot/dry with little plant life vs. high rainfall and lots of plant life).
  - **GALAPAGOS ISLAND TOROTISES: A CASE STUDY**
  - Darwin noticed that the tortoises' shells varied predictably from island to island. The shells could be used to identify which island the tortoise inhabited. He also noticed that the island tortoises all resembled the mainland tortoise. What did Darwin conclude about the tortoises based on these observations?

The island tortoises had once been members of the mainland population. Perhaps a storm transported the tortoises to the various islands over long periods of time mutations accumulated and natural selection occurred in the different environments

  - Other tortoise features were well suited to their environments such as their necks. The tortoise on the right comes from the island with the hot/dry climate and sparse vegetation. The tortoise on the left comes from the island with high rainfall and lush vegetation. Explain why the different neck lengths would be well suited to the two different environments.



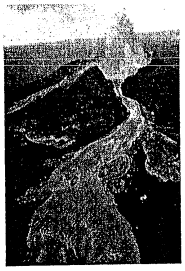


On the island with sparse vegetation only tortoises who could reach the food would survive and reproduce. Tortoises with longer necks survived & passed their long neck genes onto their offspring. Shorter necked tortoises died for lack of food, not passing on their genes. Any mutation causing a longer neck would allow the tortoise to survive longer and leave more descendents with the new mutation. Other island- food is easy to get so tortoises with best protection will survive longer.

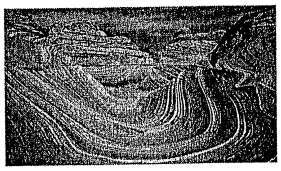
  - If all of the island tortoises came from a common mainland ancestor, how did they come to have such different features?

Random mutations occurred in each population. Beneficial mutations (adaptations) would be passed to a larger # of offspring. Harmful mutations would be passed to fewer (if any) offspring.

Darwin Concluded:



- Geologists in Darwin's time studying the natural processes that shape the Earth over time (erosion, volcanic activity, etc), concluded that Earth was very old. This conclusion, together with all of the observations Darwin had made on his voyage, led Darwin to conclude that if Earth could change over time, so could living things.



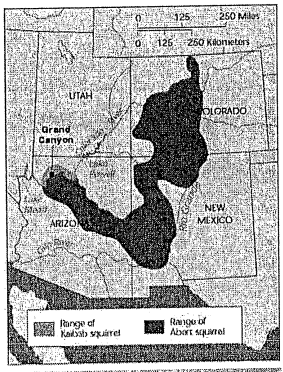
- Darwin's developed these ideas and published his famous work On the Origin of Species. Darwin's book described evolution and outlined a mechanism for how and why evolution occurs, called natural selection.

- Darwin was not the first person to come up with the idea of evolution, he was just the first to have his ideas published and widely recognized, which is why history (and textbooks) credit Darwin with this major contribution to biology.

Speciation

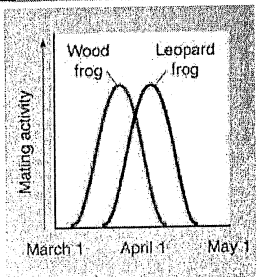
- What is a species?
  - A group of similar organisms that can mate and produce fertile offspring

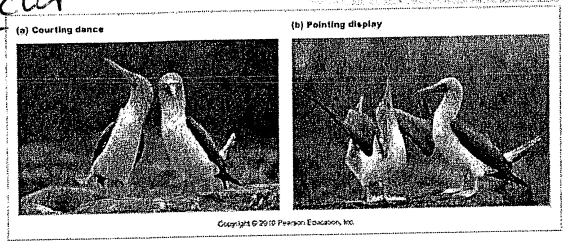
- Speciation is the evolution of a new species



- Speciation has occurred when members of a species... can no longer mate & produce fertile offspring.

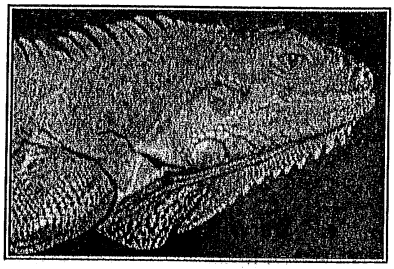
- Speciation usually happens when members of the same species are isolated from each other in some way:
  - Geographical isolation- organisms do not mate due to a geographic separation. (rivers, islands, canyons, mountains)
  - Temporal isolation- organisms do not mate due to differences in mating schedules. Orchids - release pollen on different days so organisms will not mate due to differences in mating rituals.
  - Behavioral isolation - (mating will not occur) Mating calls/dances/locations





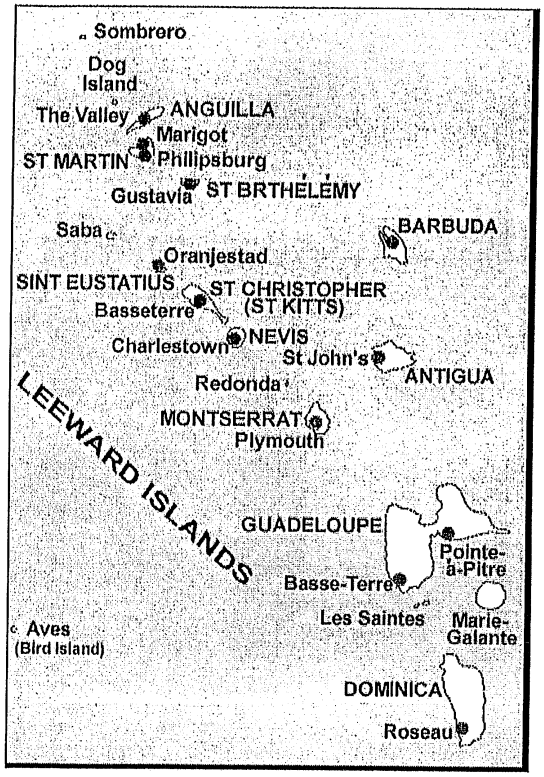
Hapless Iguanas Float Away - Voyage Grips Biologists

Fifteen iguanas on a tangle of waterlogged trees, tossed into the Caribbean Sea by a hurricane, apparently floated 200 miles from Guadeloupe to Anguilla and into biological history. This report has amazed scientists, who have been arguing since early this century about whether such journeys were even remotely possible, let alone observable.



By documenting the 1995 voyage of the 15 iguanas -- enough to form a new population -- the report provides the first clear-cut evidence in support of biologists who argue that seemingly impossible journeys like this could have been an important avenue for the dispersal of species around the world.

The journey of the iguanas, land-loving animals, began in September 1995 when two powerful hurricanes moved through the eastern Caribbean. A month later the iguanas, fearsome-looking creatures up to four feet long that resemble dinosaurs, washed up on Anguilla's shores on an immense raft of trees.



The lizards, which rest in trees, were probably blown down with them into the sea. She and her colleagues studied the tracks of the two hurricanes, Luis and Marilyn, and ocean currents and decided that the lizards probably came from Guadeloupe. Identifying the lizards, known as green iguanas, as outsiders was simple, researchers said. They have a blue-green coloration and dark rings around their tails, making them easily distinguishable from the other iguana species on Anguilla, which is brown and has a plain tail.

Though the arriving iguanas appear to have been weak, dehydrated and, in some cases, injured, some survived. In March, researchers said they found what appeared to be a pregnant female iguana, the last element of a successful colonization of a new species, which made the observation of the rafting significant. Because the animals appear to be reproducing, the researchers said they believed the new arrivals had established themselves, though other scientists said it was still too soon to tell.

Questions

1. How did the iguanas make it from Guadeloupe to Anguilla?

2. If only a very small number of these iguanas made it to Anguilla, what can you assume about the genetic diversity of this new population on the island?

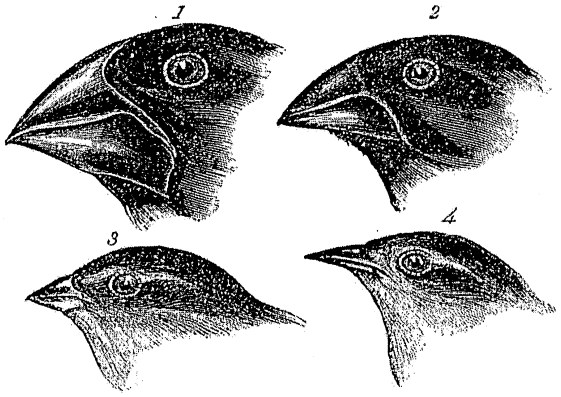
3. Considering that other species of iguana already inhabit Anguilla, how might natural selection act on the new population of iguana on the island?

4. Do you think that speciation of this group of lizards will eventually happen? Explain your answer.

Natural Selection Case Studies

Galapagos Finches

Scientists have long believed that the 14 species on the Galapagos Islands evolved from a single species of finch that migrated to the islands one to five million years ago (Lack, 1940). Recent DNA analyses support the conclusion that all of the Galapagos finches evolved from the warbler finch (Grant, Grant & Petren, 2001; Petren, Grand % Grant, 1999). Different species live on different islands. For example, the medium ground finch and the cactus finch live on one island. The large cactus finch occupies another island. One of the major changes in the finches is in their beak sizes and shapes as shown to the right.



1. Geospiza magnirostris. 2. Geospiza fortis.
3. Geospiza parvula. 4. Certhidea olivacea.

Choose the one answer that best reflects how an evolutionary biologist would answer.

1. What would happen if a breeding pair of finches were placed on an island under ideal conditions with no predators and unlimited food so that all individuals survived? Given enough time,
   a. The finch population would stay small because birds only have enough babies to replace themselves
   b. The finch population would double and then stay relatively stable
   c. The finch population would increase dramatically
   d. The finch population would grow slowly and then level off

2. Finches on the Galapagos Islands require food to eat and water to drink.
   a. When food and water are scarce, some birds may be unable to obtain what they need to survive
   b. When the food and water are limited, the finches will find other food sources so there is always enough food
   c. When food and water are scarce, the finches all eat and drink less so that all the birds will survive.
   d. There is always plenty of food and water on the Galapagos Islands to meet the finches' needs

3. Once a population of finches has lived on a particular island with an unvarying environment for many years,
   a. The population continues to grow rapidly
   b. The population remains relatively stable, with some fluctuations
   c. The population dramatically increases and decreases each year
   d. The population will decrease steadily

4. Depending on their beak size and shape, some finches get nectar from flowers, some eat grubs from bark, some eat small seeds, and some eat large nuts. Which statement best describes the interactions among finches and the food supply?
   a. Most of the finches on the island cooperate to find food and share what they find
   b. Many of the finches on an island fight with one another and the physically strongest one wins
   c. There is more than enough food to meet all the finches' needs so they don't need to compete for food.
   d. Finches compete primarily with closely related finches that eat the same kind of food, and some may die from lack of food.

5. How did the different beak types **first** arise in the Galapagos finches?
   a. The changes in the finches' beak size and shape occurred because of their need to be able to eat different kinds of food to survive
   b. Changes in the finches' beaks occurred by chance mutations, and when there was a good match between beak structure and available food, those birds had more offspring
   c. The changes in the finches' beaks occurred because the environment induced the desired genetic changes
   d. The finches' beaks changed a little bit in size and shape with each successive generation, some getting larger and some getting smaller.

6. What type of variation in finches is passed on to the offspring?
   a. Any behaviors that were learned during a finch's lifetime
   b. Only characteristics that were beneficial during a finch's lifetime
   c. All characteristics that were genetically determined
   d. Any characteristics that were positively influenced by the environment

7. What caused populations of birds having different beak shapes and sizes to become distinct species distributed on the various islands
   a. The finches were quite variable, and those whose features were best suited to the available food supply on each island reproduced most successfully.
   b. All finches are essentially alike and there are **not** really 14 different species.
   c. Different foods are available on different islands, and for that reason individual finches on each island gradually developed the beaks they needed.
   d. Different lines of finches developed different beak types because they needed them in order to obtain the available food.

Canary Island Lizards

The Canary Islands are seven islands just west of the African continent. The islands gradually became colonized with life: plants, lizards, birds, etc. Three different species of lizards found on the islands are similar to one species found on the African continent (Thorpe & Brown, 1989). Because of this, scientists assume that the lizards traveled from Africa to the Canary Islands by floating on tree trunks washed out to sea.

Choose the one answer that best reflects how an evolutionary biologist would answer.

1. What do you think happens among the lizards of a certain species when the food supply is limited?
   a. The lizards cooperate to find food and share what they find
   b. The lizards fight for the available food and the strongest lizards kill the weaker ones
   c. Genetic changes that would allow lizards to eat new food sources are likely to be induced
   d. The lizards least successful in the competition for food are likely to die of starvation and malnutrition

2. A well-established population of lizards is made up of hundreds of individual lizards. On an island, all the lizards in a lizard population are likely to....
   a. Be indistinguishable, since there is a lot of interbreeding in isolated populations
   b. Be the same on the inside bust display differences in their external features
   c. Be similar, yet have some significant differences in their internal and external features
   d. Be the same on the outside but display differences in their internal features

3. Which statement best describes how traits in lizards will be inherited by offspring?
   a. When parent lizards learn to catch particular insects, their offspring will inherit their specific insect-catching skills
   b. When parent lizards develop stronger claws through repeated use in catching prey, the offspring will inherit their stronger claw trait
   c. When parent lizards' claws become underdeveloped due to easy food sources being available, their offspring will inherit weakened claws
   d. When a parent lizard is born with an extra finger on its claws, its offspring can inherit a six-fingered claw.

4. Fitness is a term used by biologists to explain the evolutionary success of certain organisms. Given the data on four female lizards, which piece of data would best determine the fitness of the lizards
   a. Body length
   b. Offspring surviving to adulthood
   c. Age of death
   d. The information given in the comments

	Lizard A	Lizard B	Lizard C	Lizard D
Body Length	20 cm	12 cm	10 cm	15 cm
Offspring surviving to adulthood	19	28	22	26
Age at death	4 yrs	5 yrs	4 yrs	6 yrs
Comments	Healthy, strong, clever	Mated with many lizards	Dark-colored, very quick	Largest territor

5. According to the theory of natural selection, where did the variations in body size in the three species of lizards most likely come from?
   a. The lizards needed to change in order to survive, so beneficial new traits developed
   b. The lizards wanted to become different in size. As a result beneficial new traits gradually appeared in the population
   c. Random genetic mutations and sexual recombination both created new variations
   d. The island environment caused genetic mutations in the lizards

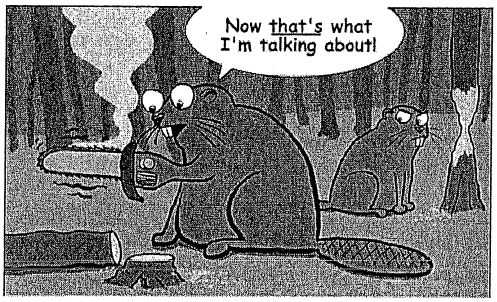
6. What could cause one species to change into three species over time?
   a. Groups of lizards encountered different island environments so the lizards needed to become new species with different traits in order to survive
   b. Groups of lizards must have been geographically isolated from other groups and random genetic mutations must have accumulated in these lizard populations over time
   c. There may be minor variations, but all lizards are essentially alike and all are members of a single species
   d. In order to survive, different groups of lizards needed to adapt to the different islands, and so all organisms in each group gradually evolved to become a new lizard species.

Common Misconceptions About Evolution

Keanu did not pay very close attention in high school Biology and is now very confused about evolution. Using what you have learned from this unit, explain to Mr. Reeves why each of his statements below is incorrect.

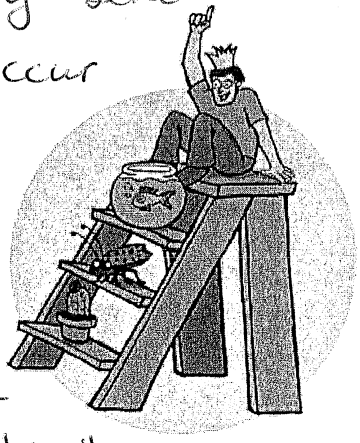
Misconception #1: **Evolution means that life changes by chance.**

The mutations that occur are random (or chance), but which mutations are kept in the population and passed on through the generations depends on the environment and how well-suited to the environment those mutations make the organism.



Misconception #2: **Natural selection gives organisms what they 'need.'**

Nature can't select what's not there. Nature cannot make a mutation occur or control mutations in any way. Nature can only select for or against the random mutations that occur in DNA.



Misconception #3: **Evolution is like a climb up a ladder of progress, organisms are always getting better.**

"Better" depends on the environment. Humans are pretty great, but we are not equipped to survive at the bottom of the ocean or in a hot spring. If our environment changed dramatically we could be wiped out while other species could survive.

Similar proteins in different organisms (such as hemoglobin).	An observation that has been confirmed repeatedly and is accepted as true	All of the combined genetic information in a population	Difference(s) in an organism compared to the rest of the population
How many times a particular gene occurs in a gene pool	Disappearance of a species from all parts of its geographical region	The ability of an organism to survive and reproduce in its environment.	Inherited characteristic that increases an organism's chance of survival.
Process by which individuals that are better suited to their environment survive and reproduce most successfully. (2 terms are appropriate, list both)	Individuals in the same species at the same location at the same time	Change in a DNA sequence that affects genetic information	Evolution of a new species happens when members of a population can no longer interbreed
A group of similar organisms that can breed and produce fertile offspring	An isolating mechanism in which organisms will not mate due to differences in mating rituals/courtship displays.	An isolating mechanism in which organisms will not mate due to differences in mating schedules.	An isolating mechanism in which organisms will not mate due to location (geographic barrier).