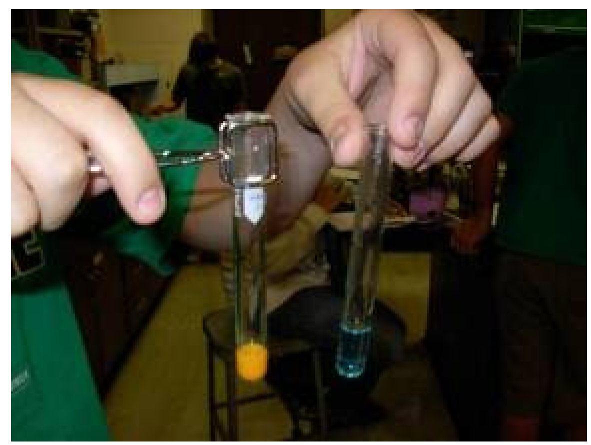
New York State Required Labs – Review

- Diffusion Through A Membrane
- Making Connections
- Beaks of Finches
- Relationships and Biodiversity

Diffusion Through a Membrane

Diffusion Through A Membrane

<u>indicator</u> – chemically indicates if a substance is present by changing color

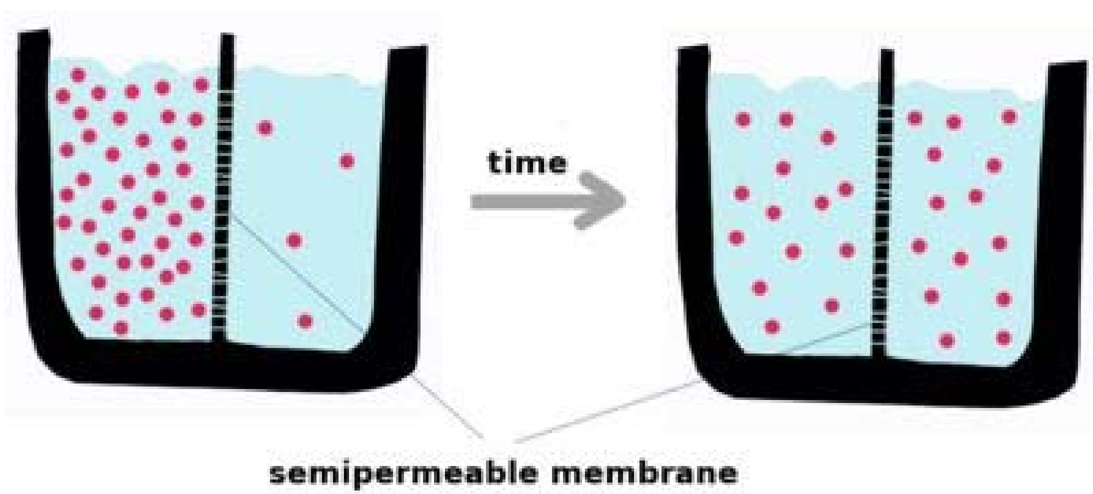


<u>iodine</u> = starch indicator solution

<u>Benedict's solution</u> = glucose indicator solution – must be heated

Diffusion Through A Membrane

<u>diffusion</u> – movement of molecules from a region of high concentration to a region of low concentration – no energy needed (passive transport)



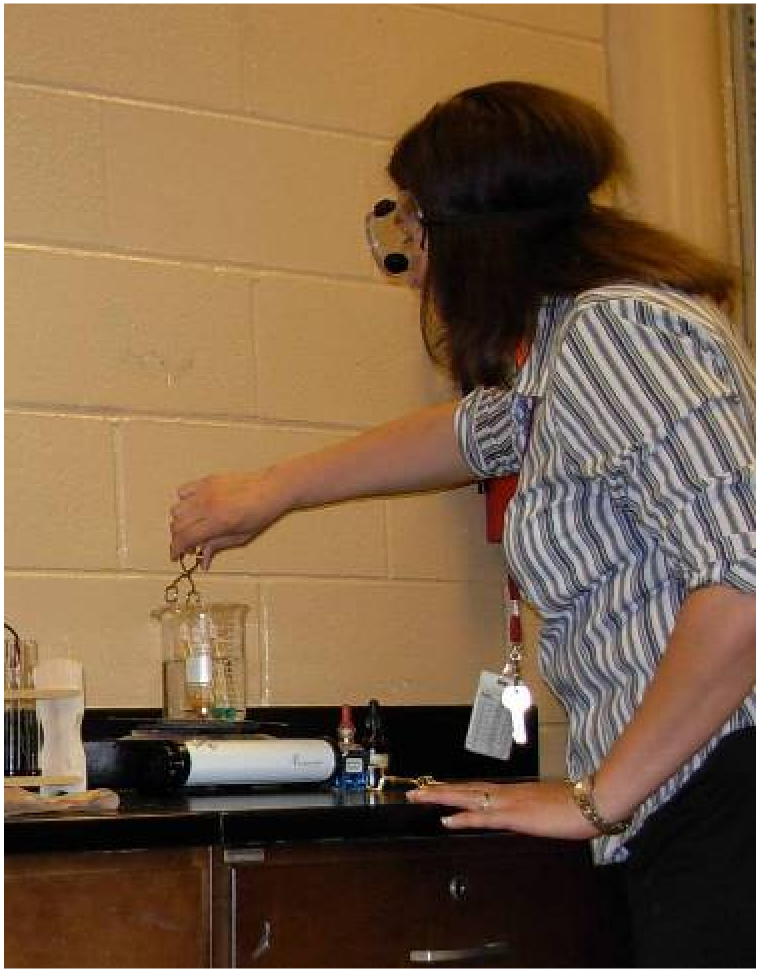
Diffusion Through A Membrane

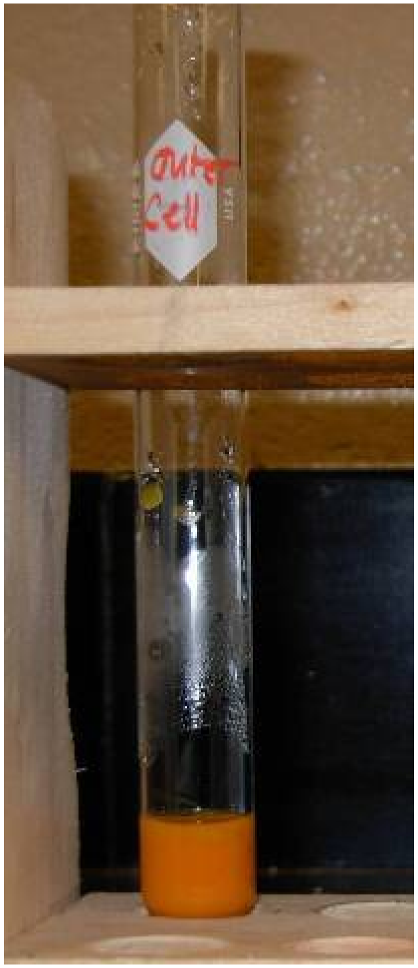
- we used a dialysis tube to simulate a semi-permeable cell membrane
- the dialysis tube was filled with glucose solution and starch solution, sealed and rinsed with water
- it was placed in a beaker with water and iodine and allowed to sit

Diffusion Through A Membrane

results of
starch test –
inside and
outside of cell

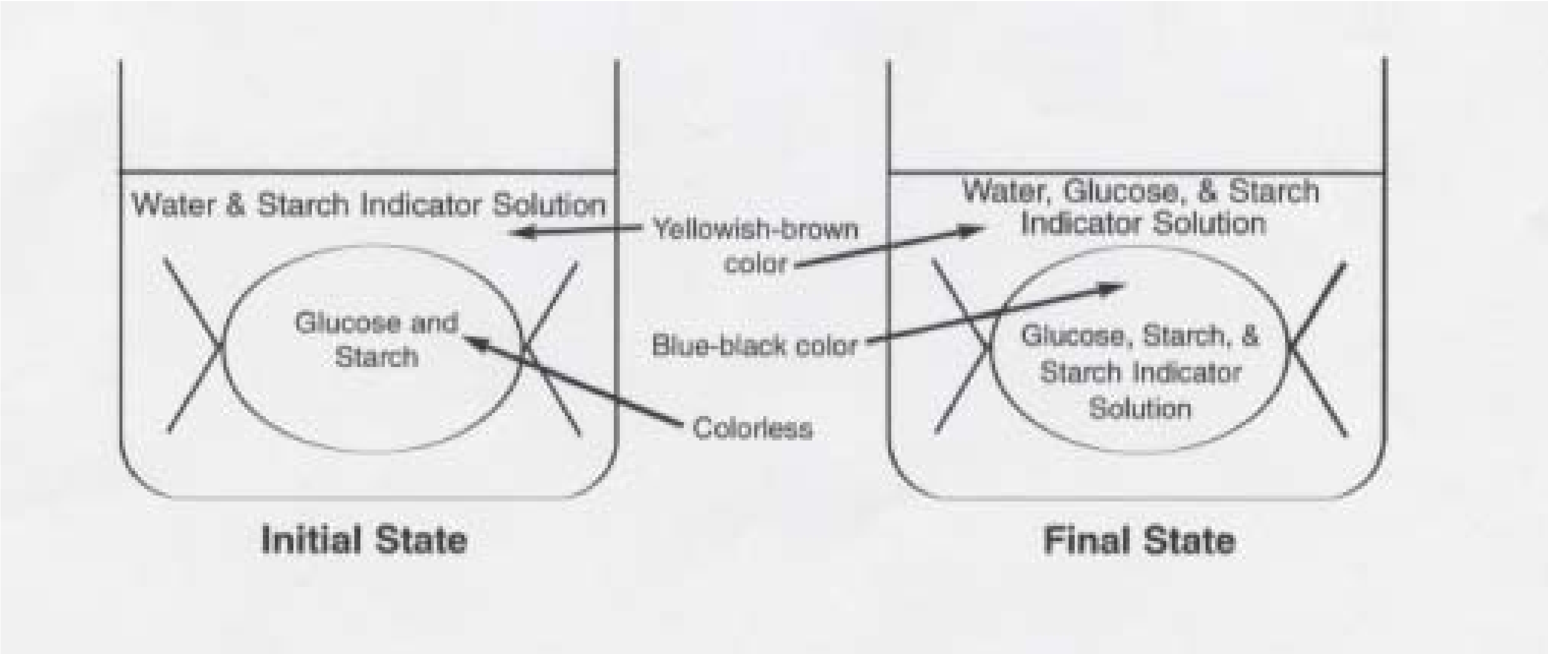
Diffusion Through a Membrane



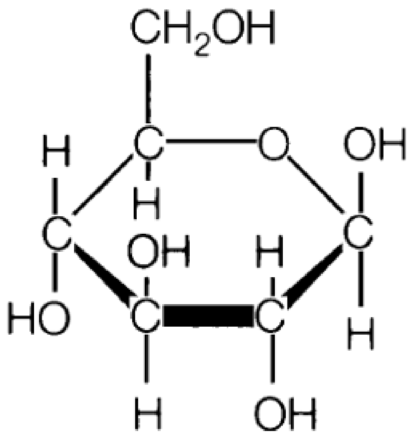


results of glucose test – outside of cell

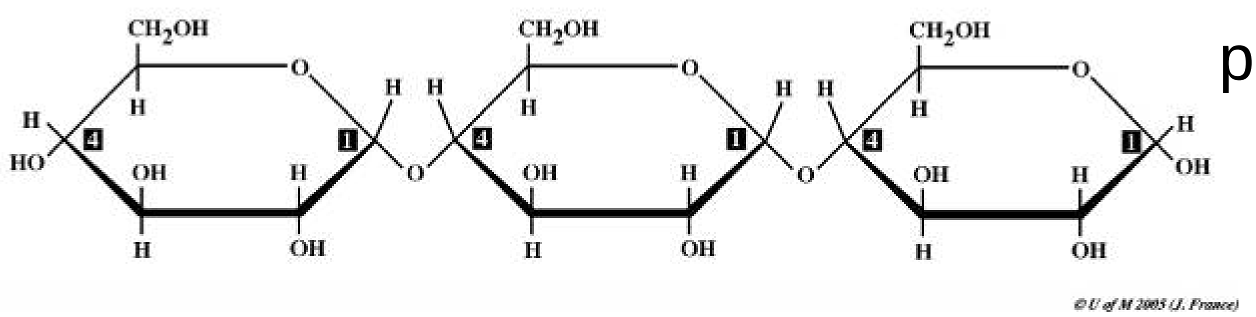
Diffusion Through a Membrane



Diffusion Through A Membrane



glucose molecule

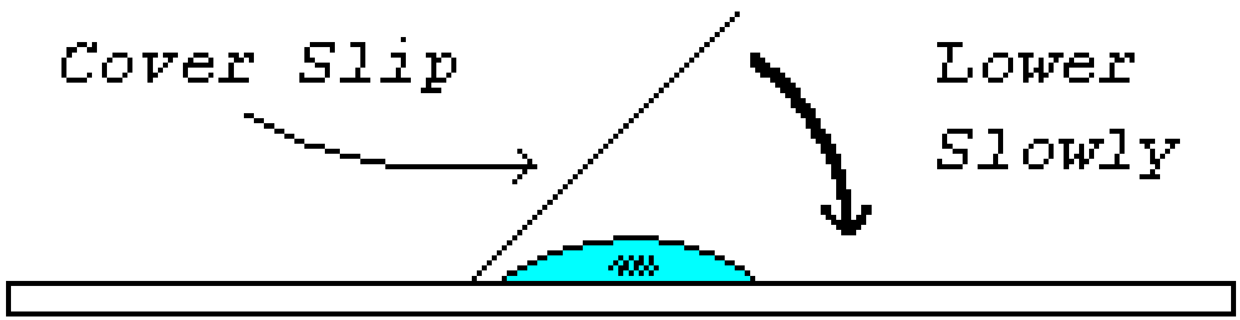


part of a starch molecule

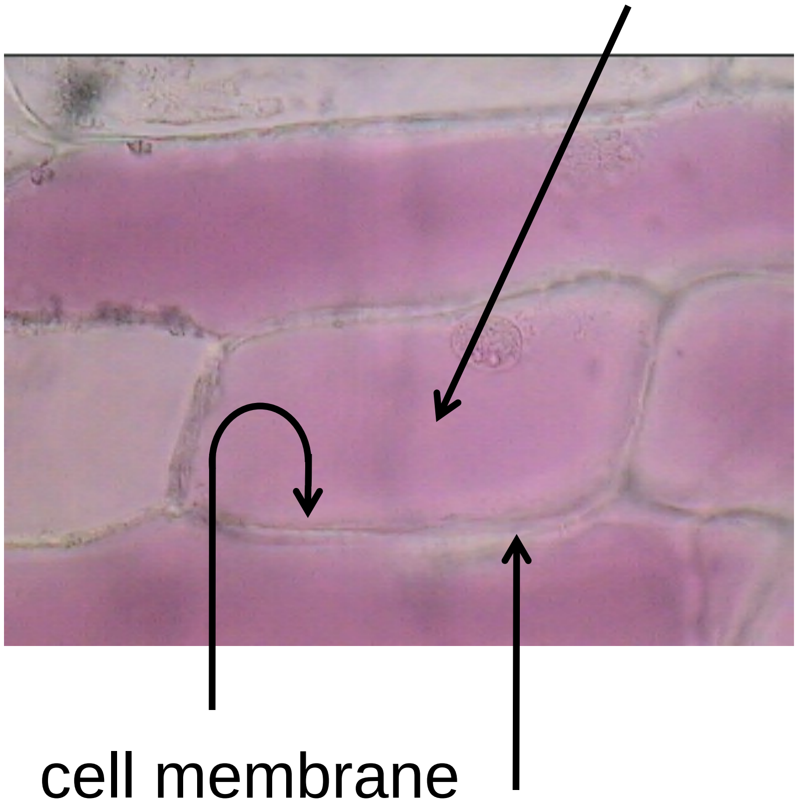
Diffusion Through a Membrane

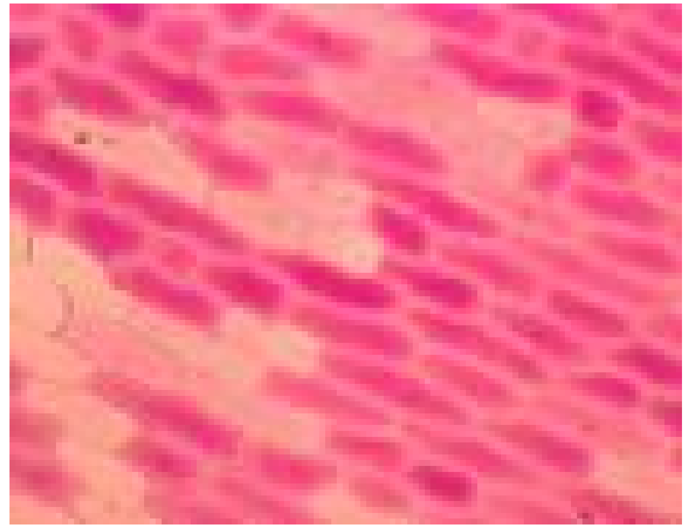
osmosis – diffusion of water across a semi-permeable cell membrane from region of high concentration to a region of low concentration – no energy needed (passive transport)

Diffusion Through a Membrane



Diffusion Through a Membrane

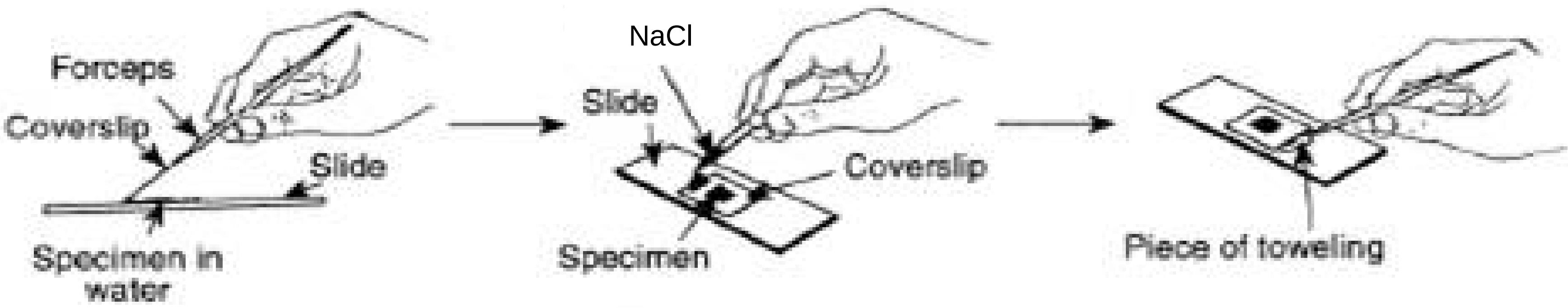




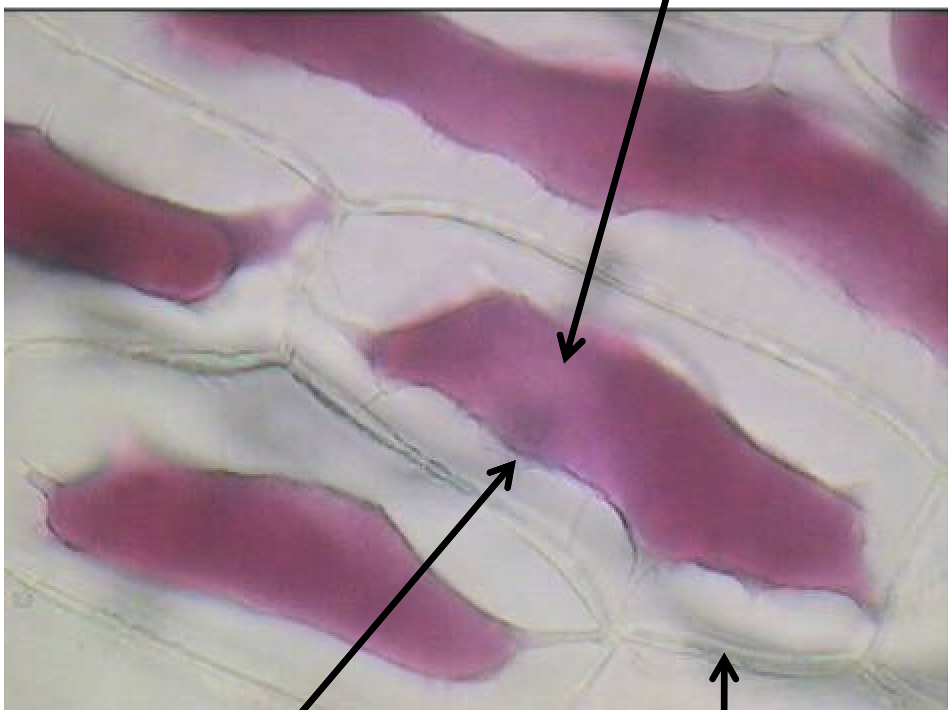
red onion cells
in tap water

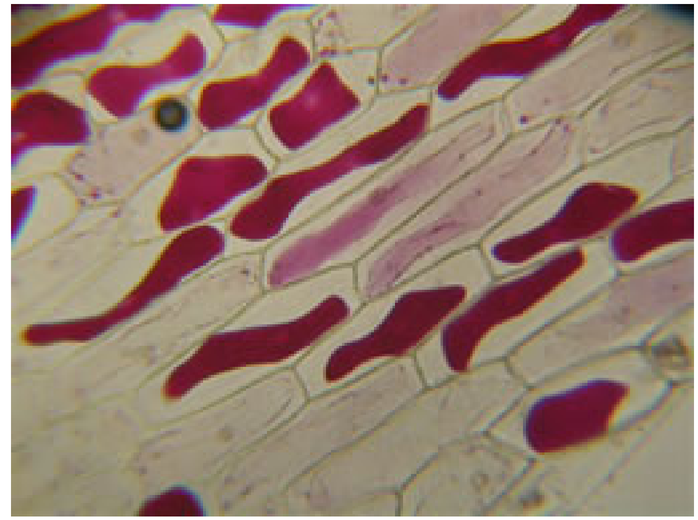
Diffusion Through a Membrane

bathing the cells in 10% NaCl = salt water, by “wicking” it through



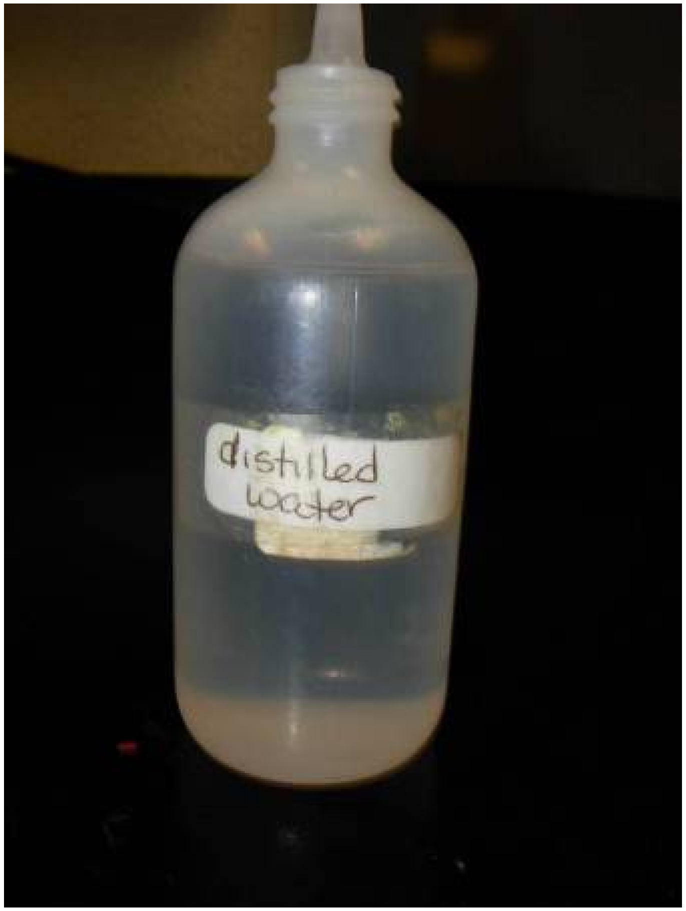
Diffusion Through a Membrane





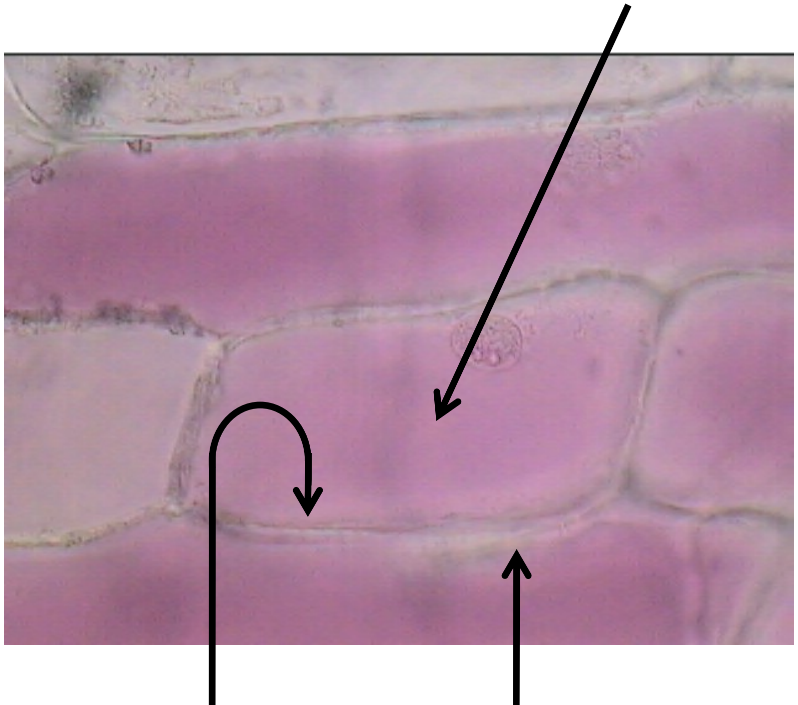
red onion cells in salt water

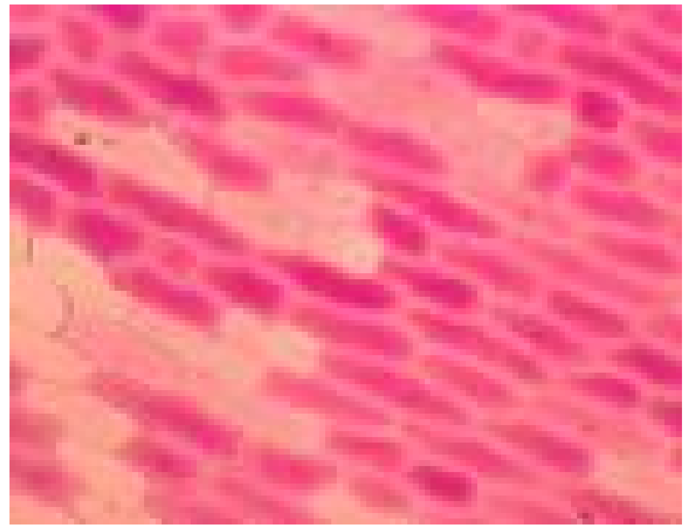
Diffusion Through A Membrane



bathing the cells in distilled water, by “wicking” it through

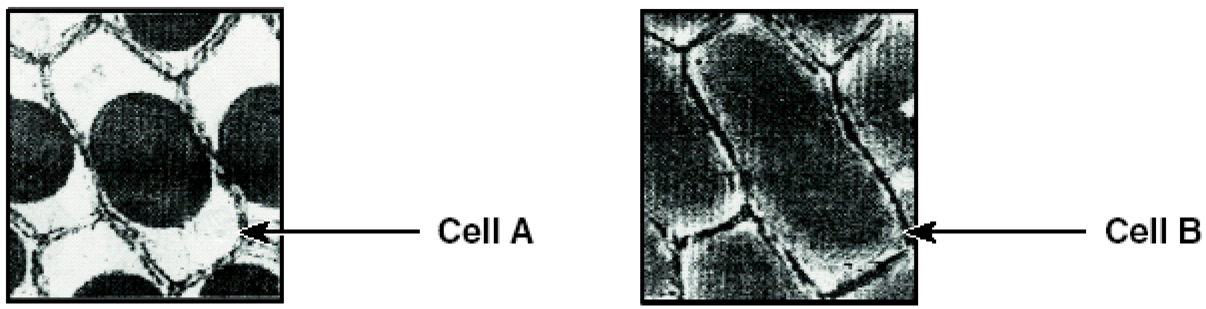
Diffusion Through a Membrane





red onion cells
in distilled water –
returned to normal

Diffusion Through A Membrane



Which is in distilled water and which is in salt water?

Diffusion Through A Membrane

Applications –

- salt on roads to melt snow
- intravenous saline solutions
- salty foods make you thirsty
- salt on slugs to kill them
- salty foods do not spoil as easily
- gargling with salt water
- digestion of starch to glucose

Making Connections

Making Connections –

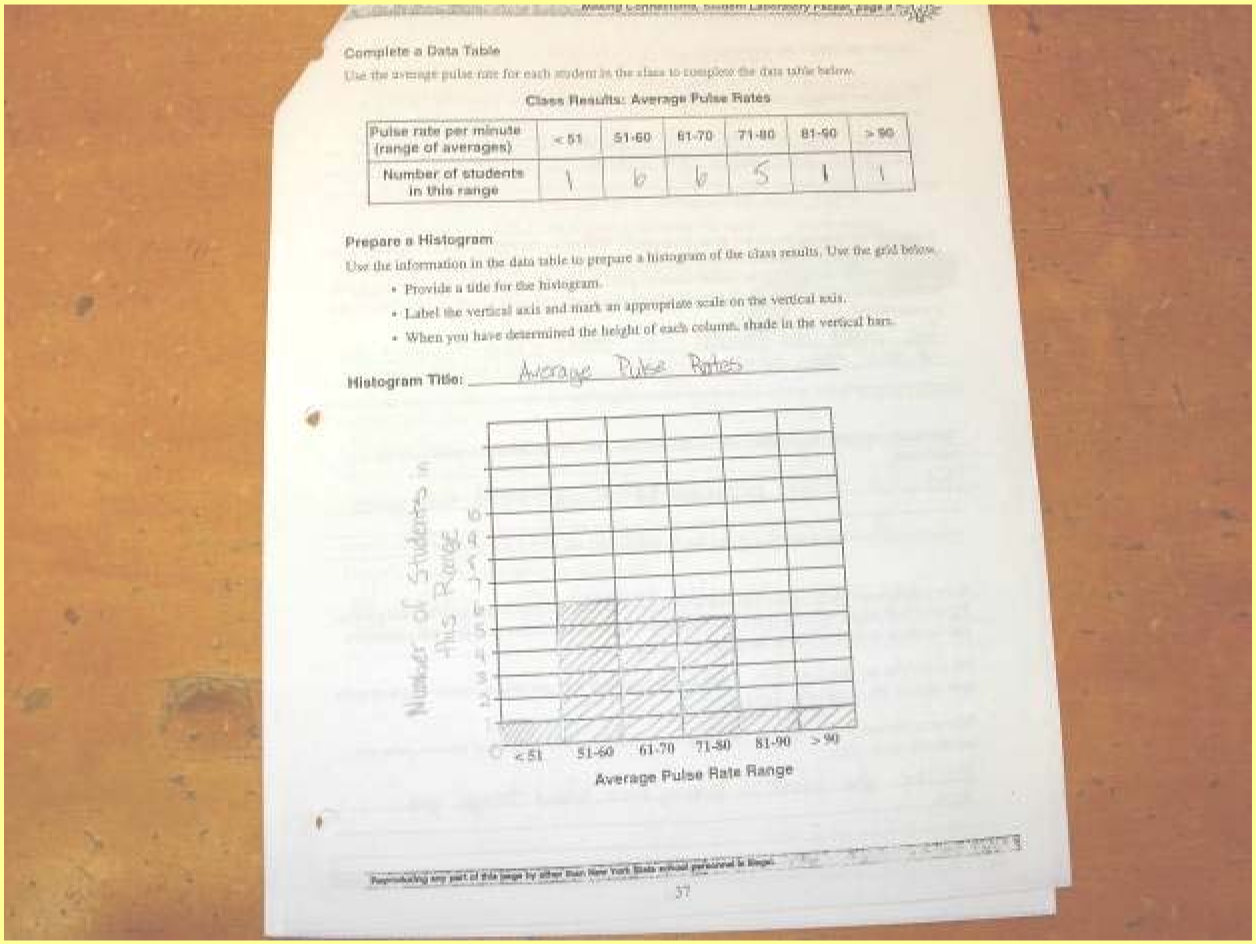
Part A: Looking for Patterns   A1. What Is Your Pulse Rate?

<u>pulse</u> – results from expansion of arteries each time your heart beats to send a surge of blood through your body

- measured pulse three times and found average pulse rate
- tallied class average pulse rates

Making Connections –

Part A: Looking for Patterns A1. What Is Your Pulse Rate?



Complete a Data Table

Use the average pulse rate for each student in the class to complete the data table below.

Class Results: Average Pulse Rates

Pulse rate per minute (range of averages)	< 51	51-60	61-70	71-80	81-90	> 90
Number of students in this range	1	6	6	5	1	1

Prepare a Histogram

Use the information in the data table to prepare a histogram of the class results. Use the grid below.

- Provide a title for the histogram.
- Label the vertical axis and mark an appropriate scale on the vertical axis.
- When you have determined the height of each column, shade in the vertical bars.

Histogram Title: Average Pulse Rates

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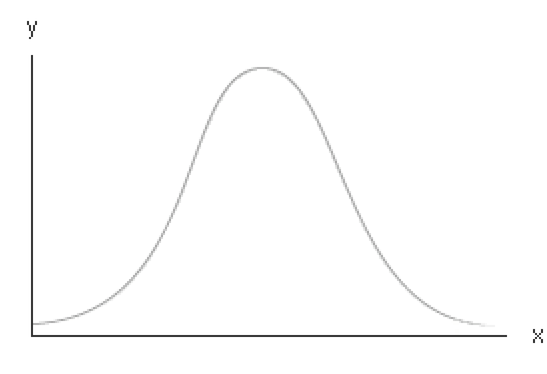
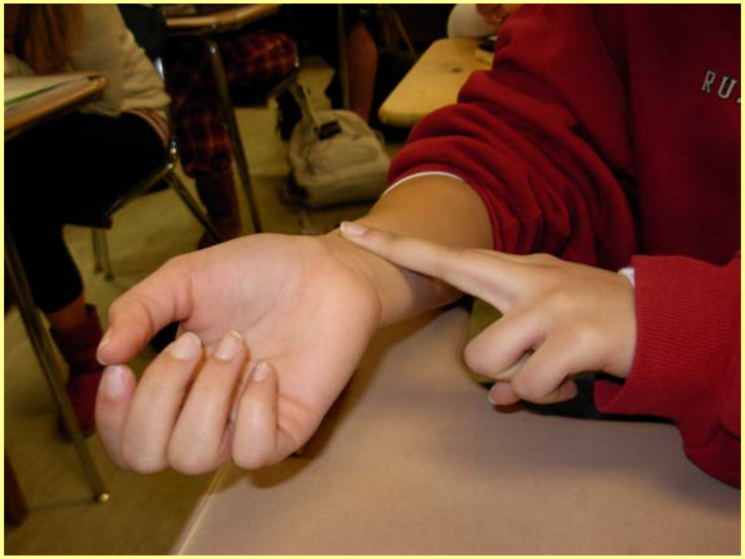


Bell-Shaped Curve

Making Connections –

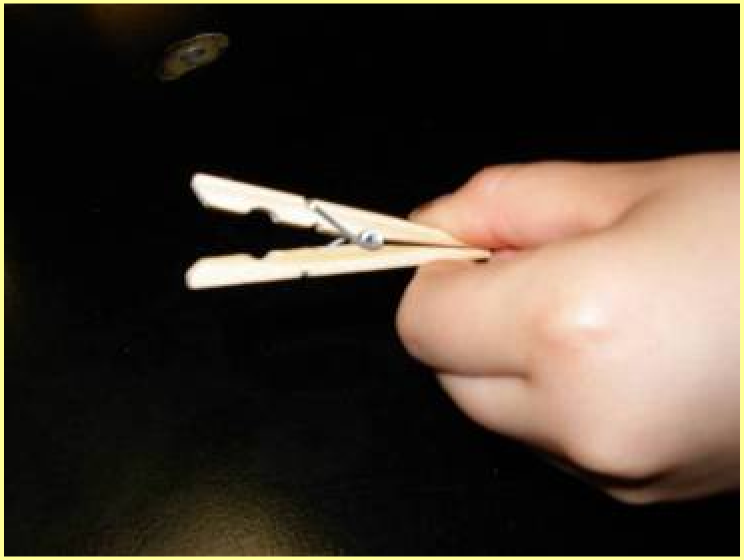
Part A: Looking for Patterns   A1. What Is Your Pulse Rate?



- after exercise, pulse increased
- heart beats faster - increasing circulation - to carry more oxygen and nutrients to the cells of the body
- breathe faster to obtain more O_2 and release CO_2
- respiratory and circulatory systems working together to maintain homeostasis

Making Connections – Part A: Looking for Patterns

A2. How Does Fatigue Affect Muscle Performance?



- squeezed clothespin for one minute – counted
- squeezed again for one minute using same hand
- the second time number of squeezes was lower due to **<u>muscle fatigue</u>**

Making Connections – Part B: Investigating Claims

claims are accepted if there is evidence to support them

Student A

claims more clothespin squeezes in 1 minute if exercises 1st – faster pulse rate, blood getting to muscles faster

Student B

claims more clothespin squeezes in 1 minute if rests 1st – exercise uses energy - resting person will have more energy

conduct a controlled experiment to determine which claim is correct

Making Connections – Part B: Investigating Claims

Experimental Design

Question: Can you squeeze a clothespin more times in one minute if you exercise or rest beforehand?

Hypothesis: (tentative statement about the expected relationship between the variables) You can squeeze a clothespin more times in one minute if you rest first.

Title: The Effect of Exercise and Rest on Clothespin Squeezing Rate

Making Connections – Part B: Investigating Claims

Experimental Design

Dependent variable: (what you measure) number of times the clothespin can be squeezed in one minute

Independent variable: (the one we vary to see how it affects the dependent variable) amount of exercise

Variables that must be controlled (kept constant):

- type of clothespin
- fingers used
- time of exercise/rest
- time of squeezing
- same hand for each trial

* use maximum sample size and number of trials in experiment *

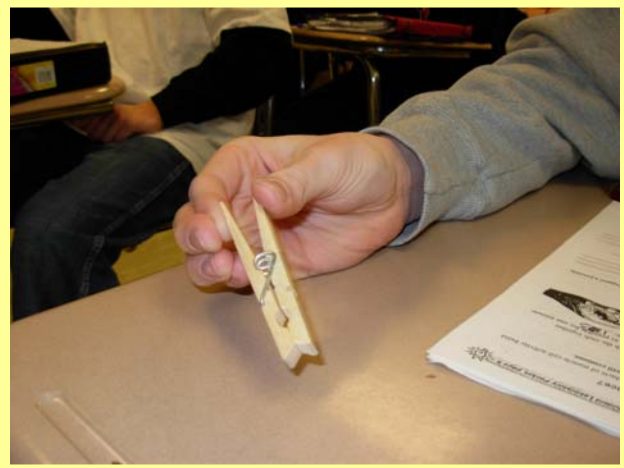
Making Connections – Part B: Investigating Claims

Experimental Design

- half of class rests and half of class exercises – then all count number of clothespin squeezes in one minute

OR

- whole class rests and counts number of clothespin squeezes in one minute – then whole class exercises and counts number of clothespin squeezes



Making Connections – Part B: Investigating Claims

Final Report

- Title
- Hypothesis
- Materials and Methods – materials used and what you did
- Data Collected – includes data tables and graphs
- Discussion and Conclusions – does data support or refute hypothesis and explanation
- Suggestions for Improvement – sources of error, variables that must be controlled and that influenced outcome
- Suggestions for further research – new research questions

Making Connections – Part B: Investigating Claims

Peer Review

Defending findings and conclusions to peers:

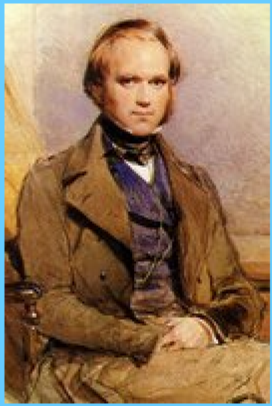
- presentation
- address final report
- answer questions
- visual aids

Results and conclusions accepted if they can be repeated by other scientists

Beaks of Finches

Beaks of Finches

Charles Darwin



Beaks of Finches

Darwin's finches show great **<u>variation</u>** in beak **<u>adaptations</u>** – shapes and sizes - due to isolation of bird populations on islands with different kinds and amounts of food

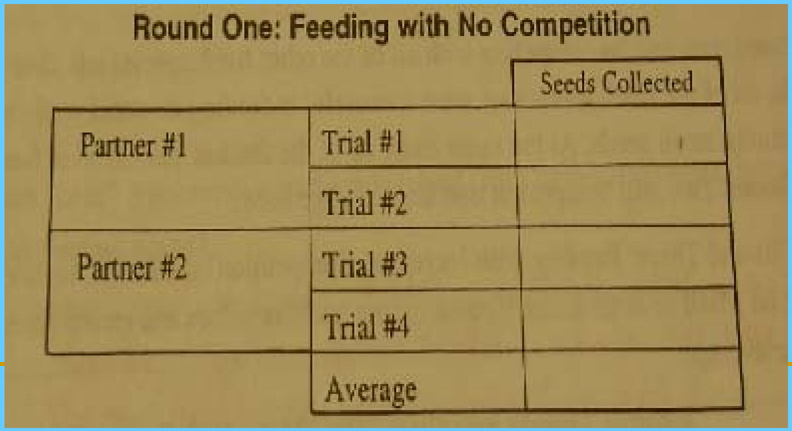
Beaks of Finches

- different tools represent different beaks
- seeds (small and large) represent food
- tray represents the island
- cup represents finch stomach

Beaks of Finches

<u>Round One: No Competition, Original Island</u>

- feeding with no competition - one person at a time
- feeding on small seeds
- as many as possible in given time
- repeated twice with each person = 4 trials total
- average of 13 or greater survived
- average of less than 13 moved to new island



Round One: Feeding with No Competition

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

Beaks of Finches

competition – interaction between two or more individuals to obtain a resource that is in limited supply

Round Two: Competition

- on original island with small seeds (if survived round 1)
- on new island with large seeds (if did not survive round 1)
- competition – feeding with another team from same dish

Round Two: Feeding with Competition

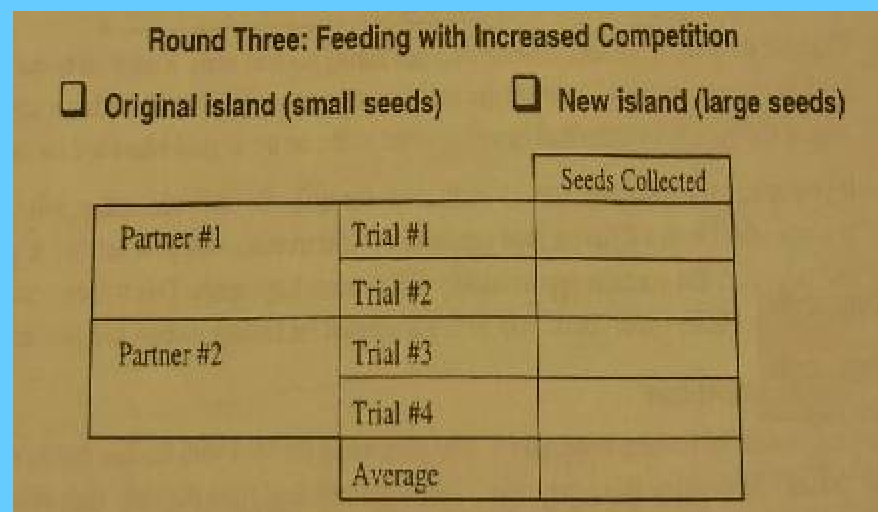
☐ Original island (small seeds) ☐ New island (large seeds)

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

Beaks of Finches

<u>Round Three: Increased Competition</u>

- competing with all other species left on your island
- all successful at feeding on small seeds at one dish
- all successful at feeding on large seeds at another dish



Round Three: Feeding with Increased Competition

☐ Original island (small seeds) ☐ New island (large seeds)

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

Beaks of Finches

This activity simulates concepts involved in natural selection:

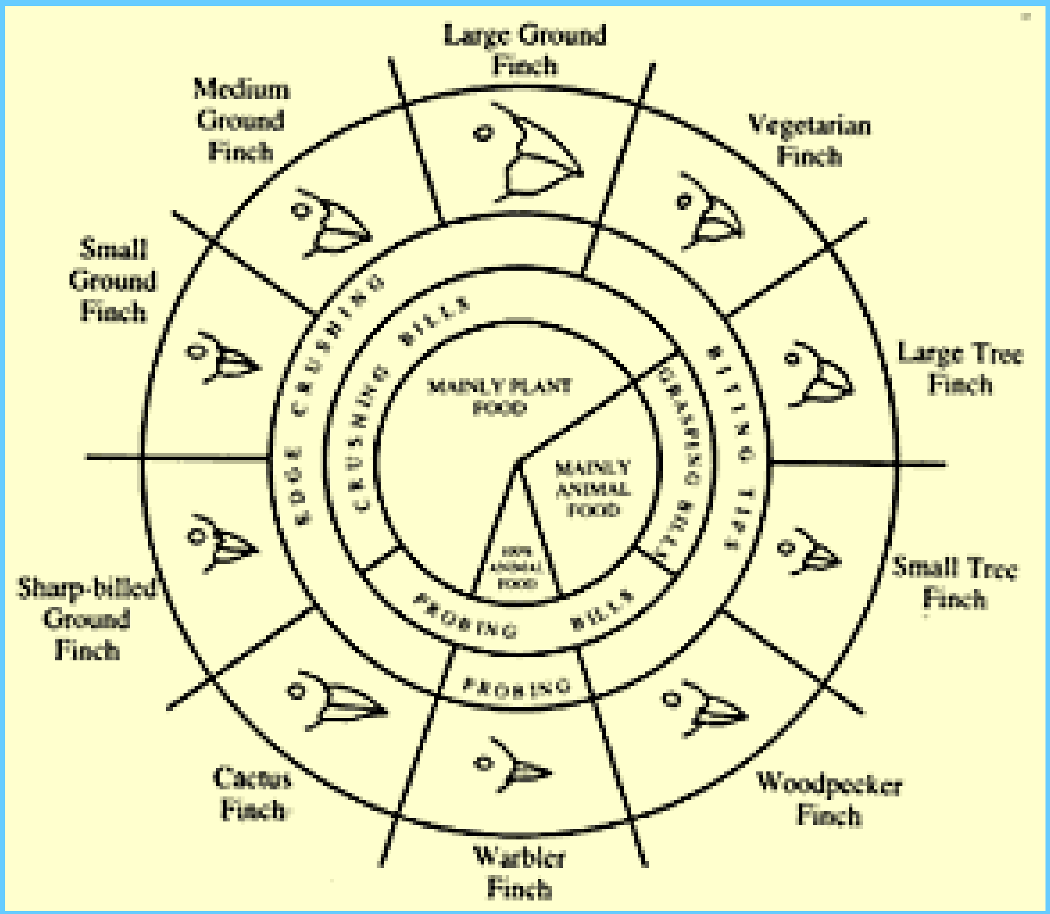
<u>variation</u> – different beak types and seed sizes
<u>competition</u> – more than one bird feeding at a time
<u>struggle for survival</u> – each bird trying to get enough to survive
<u>adaptation</u> – particular characteristics of each beak
<u>environment</u> – the birds, food and island
<u>selecting agent</u> – the size of seed available

Beaks of Finches

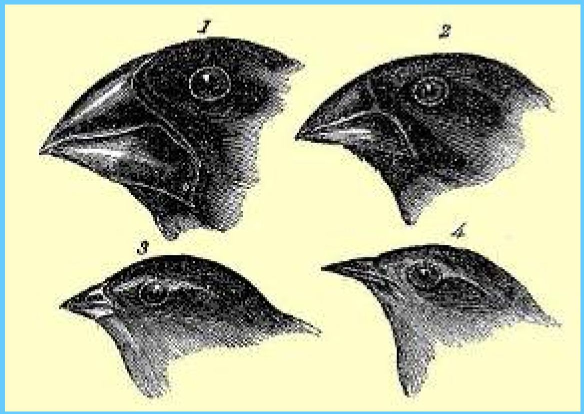
Overall:

- some birds had beaks that allowed them to survive on small seeds
  - if a bird survives it can reproduce
  - it may then pass its traits on to its offspring
- other birds could not survive on small seeds, but could survive on large seeds
- still other birds could not survive on either size seed
- over time **adaptive radiation** occurred - new species evolved from a common ancestor – each new species occupies a different habitat or ecological niche (in this case with different food)

Beaks of Finches



Different finches have beaks with different characteristics that allow them to compete successfully on different types of food – each species has its own niche, which limits competition



In order for a species to survive, the appropriate type of food must be available.

Relationships and Biodiversity

Relationships and Biodiversity

- *Botana curus* – hypothetical plant
- used to make Curol – for treating cancer
- *Botana curus* – endangered, grows slowly
- related species: X, Y and Z
- will determine which is most closely related to *Botana Curus* using structural and molecular evidence
- will decide which species (X, Y or Z) is most likely to produce Curol

Relationships and Biodiversity

Structural Evidence – Test 1: Structural Characteristics of Plants

Relationships and Biodiversity

Structural Evidence – Test 2: Structural Characteristics of Seeds

Relationships and Biodiversity

Structural Evidence – Test 3: Microscopic Internal Structure of Stems

examined cross section of stem under microscope to determine arrangement of vascular bundles

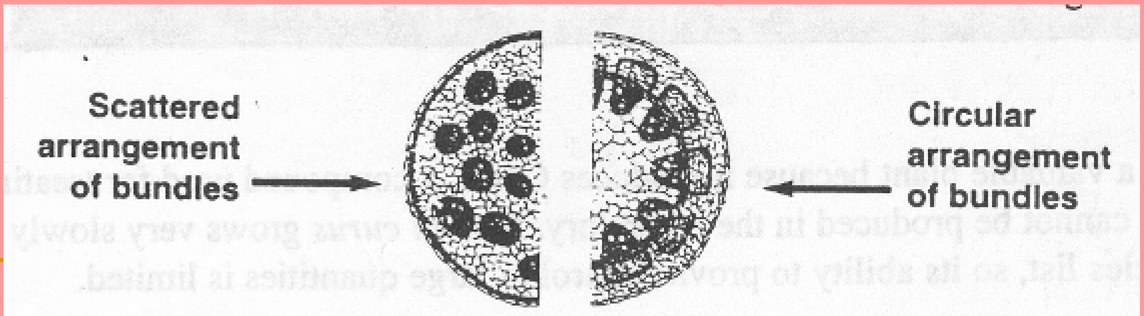
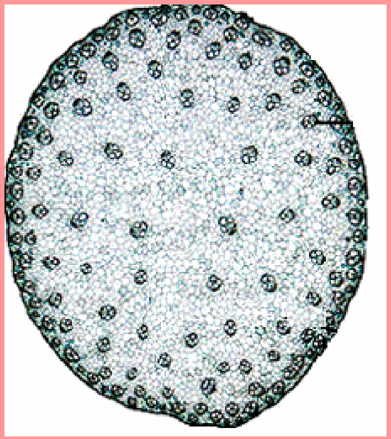


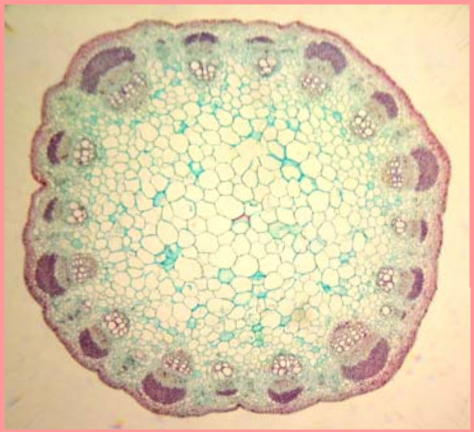
Figure 1

Relationships and Biodiversity

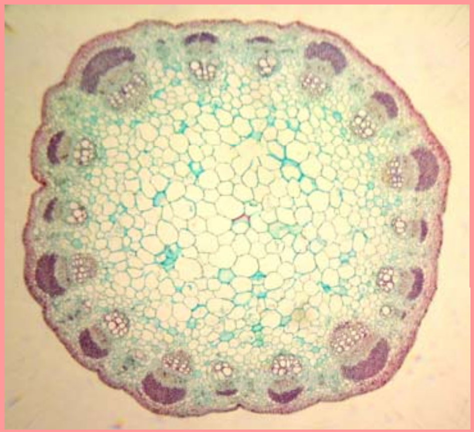
Structural Evidence – Test 3: Microscopic Internal Structure of Stems



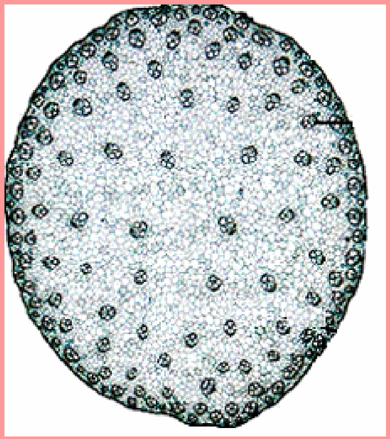
Botana curus
scattered bundles



Species X
circular bundles



Species Y
circular bundles



Species Z
scattered bundles

Relationships and Biodiversity

Hypothesis after examining structural evidence is that *Botana curus* is most closely related to species Z.

Relationships and Biodiversity

Molecular Evidence – Test 4: Paper Chromatography to Separate Plant Pigments

pigments – absorb sunlight in plants, give plants color, ex: chlorophyll

- pigments extracted from each species
- placed on chromatography paper
- chromatography paper placed in water

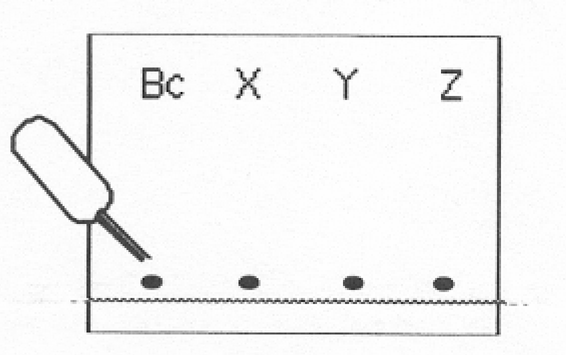


Figure 2

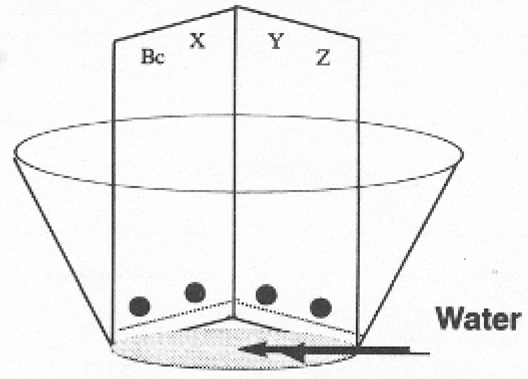
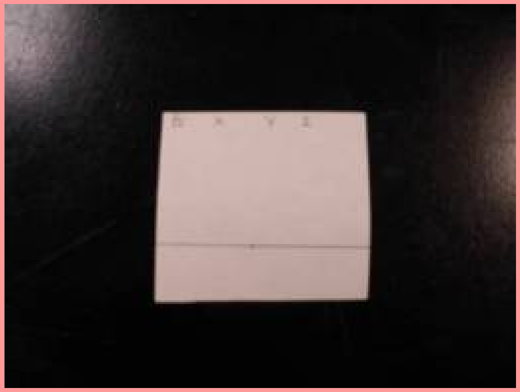
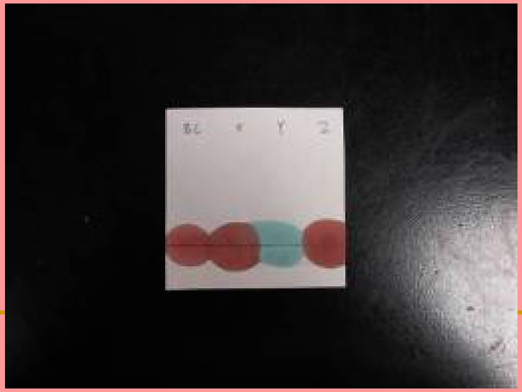


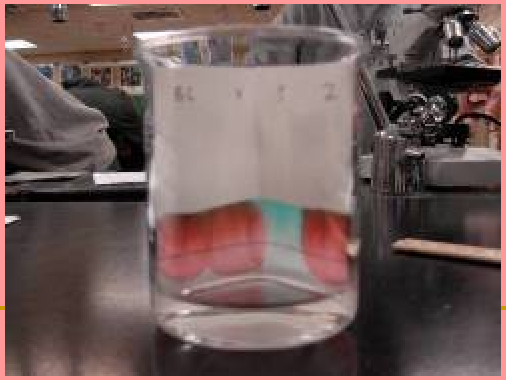
Figure 3

Relationships and Biodiversity

Molecular Evidence – Test 4: Paper Chromatography to Separate Plant Pigments

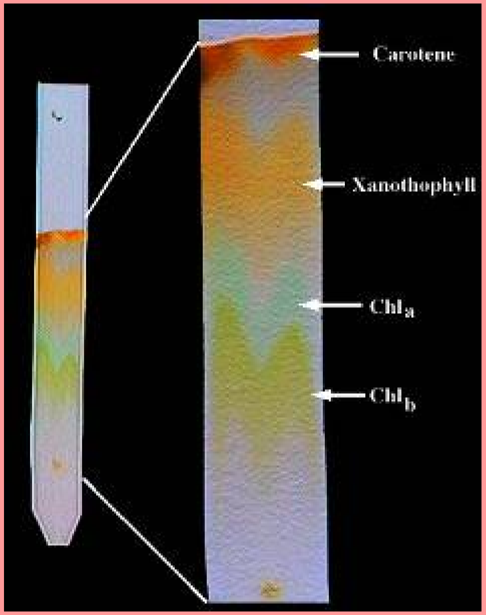






Relationships and Biodiversity

Molecular Evidence – Test 4: Paper Chromatography to Separate Plant Pigments



Relationships and Biodiversity

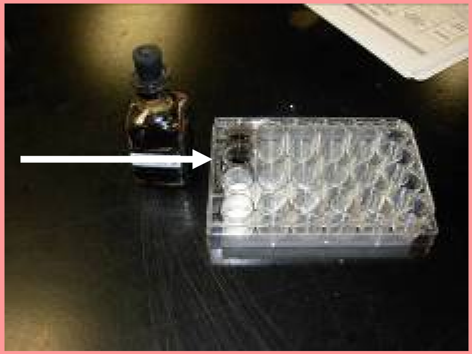
Molecular Evidence – Test 5: Indicator Test for Enzyme M

Relationships and Biodiversity

Molecular Evidence – Test 5: Indicator Test for Enzyme M

Botana curus
enzyme M present

Species X
enzyme M absent

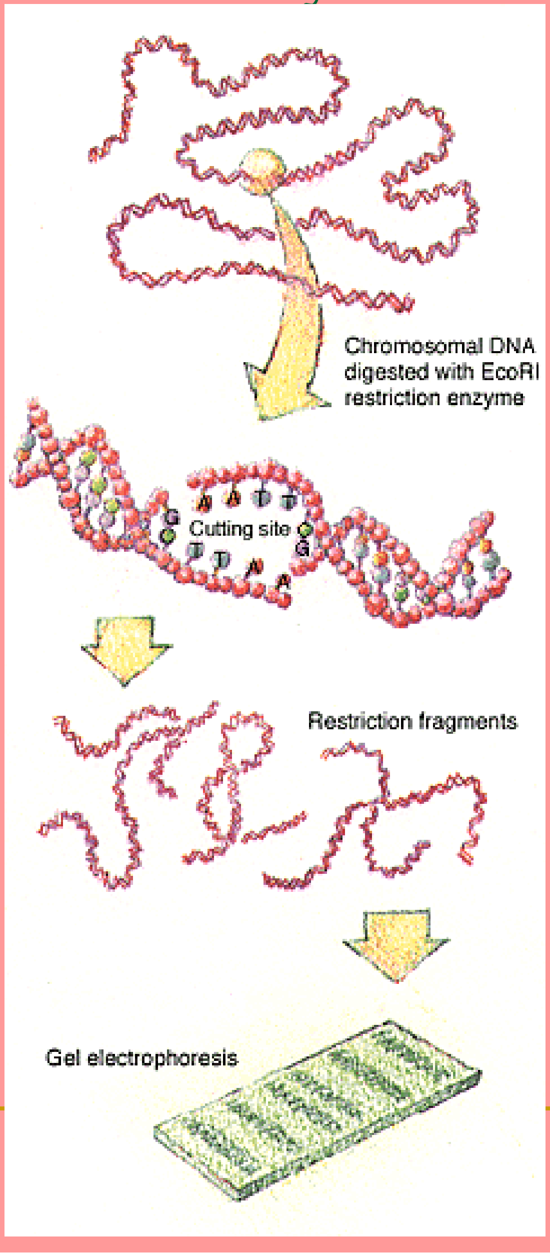


Species Y
enzyme M present

Species Z
enzyme M present

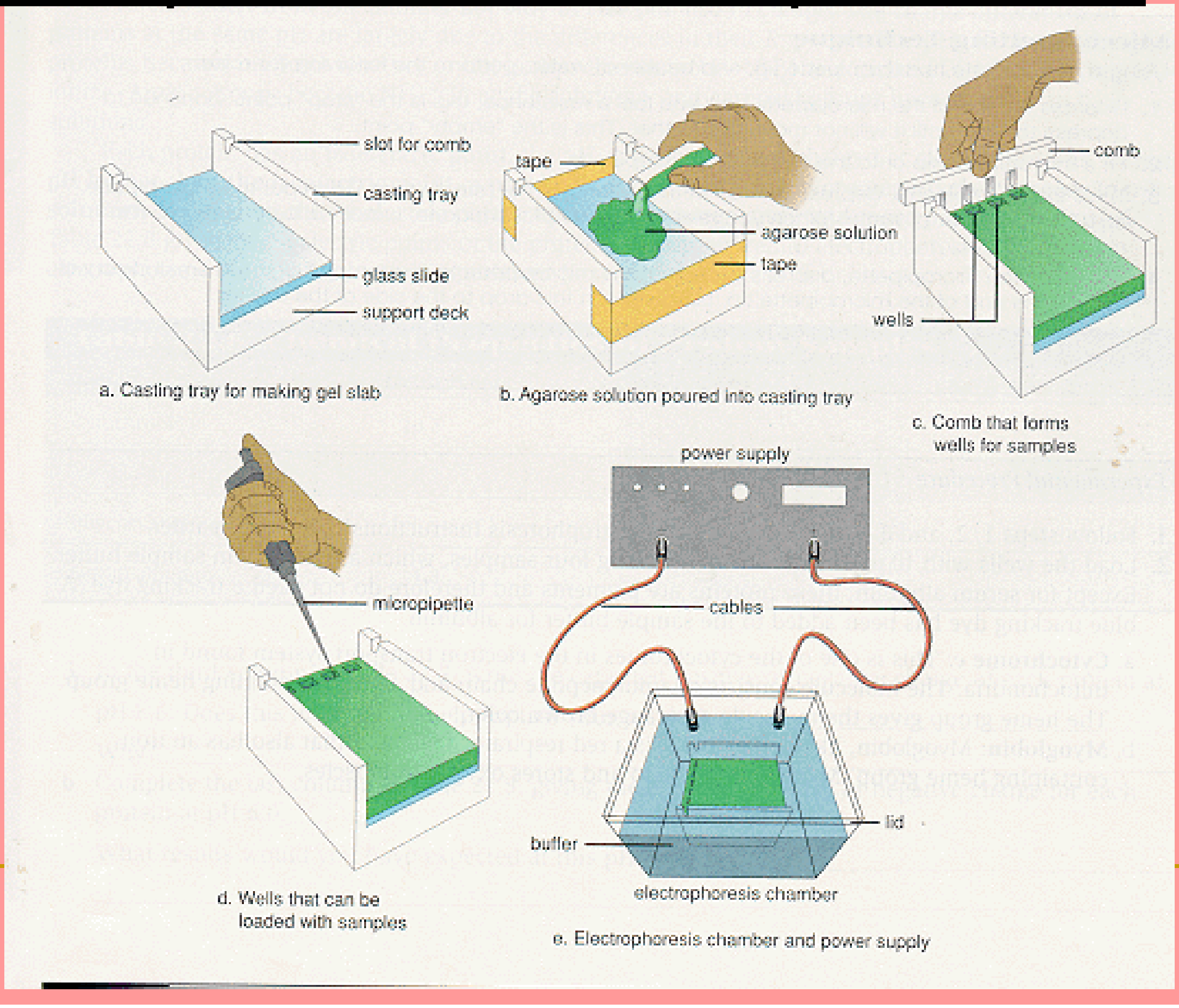
Relationships and Biodiversity

Molecular Evidence –
Test 6: Using Simulated
Gel Electrophoresis
To Compare DNA



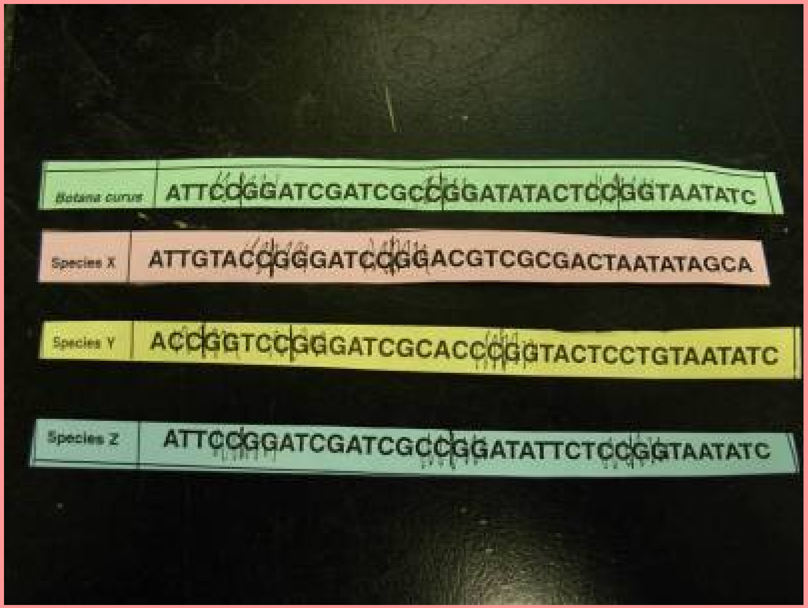
Relationships and Biodiversity

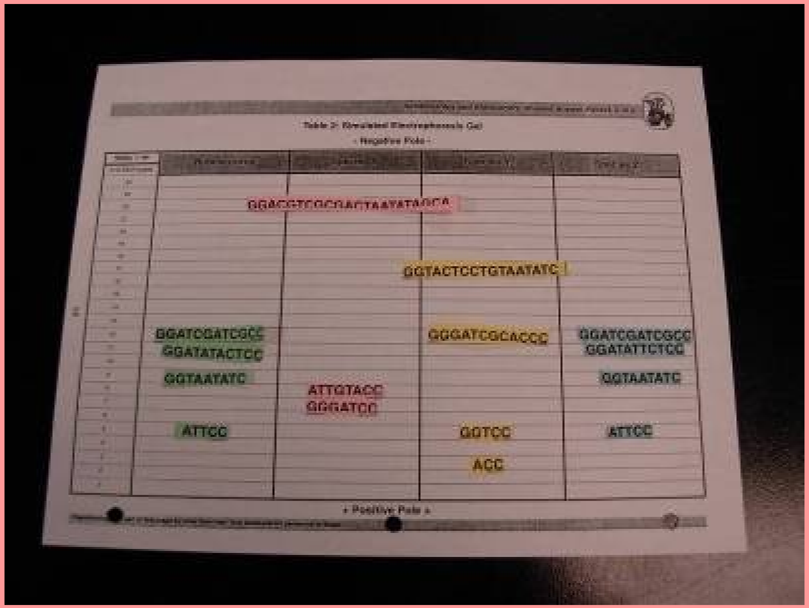
Molecular Evidence – Test 6: Using Simulated Gel Electrophoresis To Compare DNA



Relationships and Biodiversity

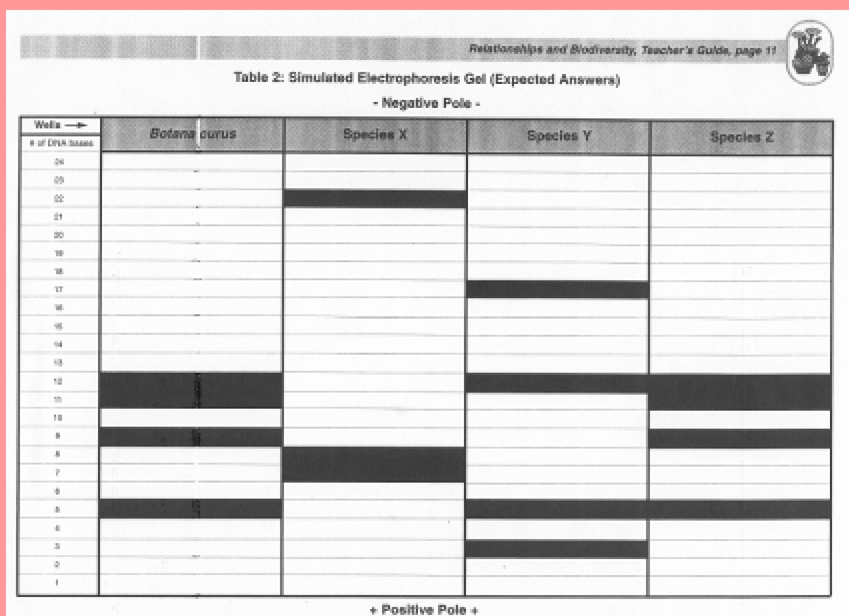
Molecular Evidence – Test 6: Using Simulated Gel Electrophoresis To Compare DNA

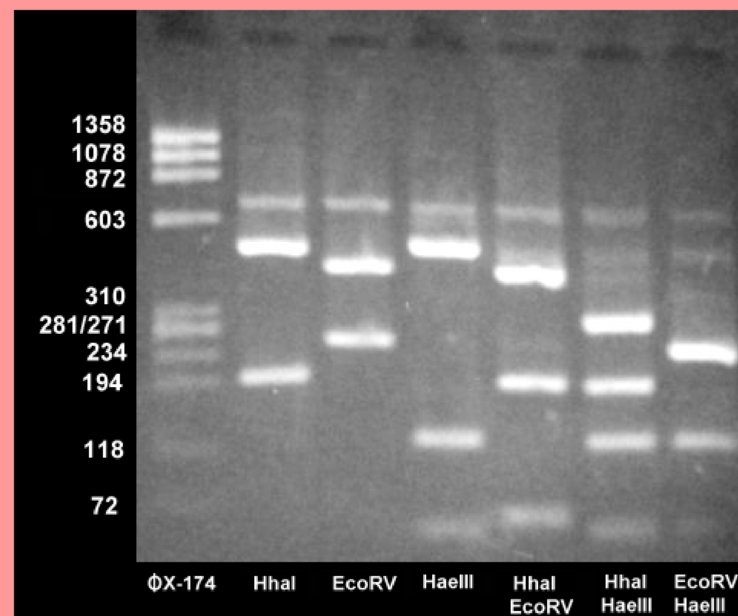




Relationships and Biodiversity

<u>Molecular Evidence – Test 6: Using Simulated Gel Electrophoresis To Compare DNA</u>





Relationships and Biodiversity

Molecular Evidence – Test 7: Translating the DNA Code to Make a Protein

Botana curus	CAC	GTG	GAC	TGA	GGA	CTC	CTC
Sequence of bases in mRNA produced	*GUG*	*CAC*	*CUG*	*ACU*	*CCU*	*GAG*	*GAG*
Sequence of amino acids in the protein	*VAL*	*HIS*	*LEU*	*THR*	*PRO*	*GLU*	*GLU*
Species X	CAC	GTG	GAC	AGA	GGA	CAC	CTC
Sequence of bases in mRNA produced	*GUG*	*CAC*	*CUG*	*UCU*	*CCU*	*GUG*	*GAG*
Sequence of amino acids in the protein	*VAL*	*HIS*	*LEU*	*SER*	*PRO*	*VAL*	*GLU*
Species Y	CAC	GTG	GAC	AGA	GGA	CAC	CTC
Sequence of bases in mRNA produced	*GUG*	*CAC*	*CUG*	*UCU*	*CCU*	*GUG*	*GAG*
Sequence of amino acids in the protein	*VAL*	*HIS*	*LEU*	*SER*	*PRO*	*VAL*	*GLU*
Species Z	CAC	GTA	GAC	TGA	GGA	CTT	CTC
Sequence of bases in mRNA produced	*GUG*	*CAC*	*CUG*	*ACU*	*CCU*	*GAA*	*GAG*
Sequence of amino acids in the protein	*VAL*	*HIS*	*LEU*	*THR*	*PRO*	*GLU*	*GLU*

Relationships and Biodiversity

Molecular Evidence – Test 7: Translating the DNA Code to Make a Protein

Universal Genetic Code Chart

Messenger RNA codons and the amino acids they code for.

FIRST BASE	SECOND BASE: U	SECOND BASE: C	SECOND BASE: A	SECOND BASE: G	THIRD BASE
U	UUU, UUC } **PHE** UUA, UUG } **LEU**	UCU, UCC, UCA, UCG } **SER**	UAU, UAC } **TYR** UAA, UAG } **STOP**	UGU, UGC } **CYS** UGA } STOP UGG } **TRP**	U C A G
C	CUU, CUC, CUA, CUG } **LEU**	CCU, CCC, CCA, CCG } **PRO**	CAU, CAC } **HIS** CAA, CAG } **GLN**	CGU, CGC, CGA, CGG } **ARG**	U C A G
A	AUU, AUC, AUA } **ILE** AUG } **MET** or START	ACU, ACC, ACA, ACG } **THR**	AAU, AAC } **ASN** AAA, AAG } **LYS**	AGU, AGC } **SER** AGA, AGG } **ARG**	U C A G
G	GUU, GUC, GUA, GUG } **VAL**	GCU, GCC, GCA, GCG } **ALA**	GAU, GAC } **ASP** GAA, GAG } **GLU**	GGU, GGC, GGA, GGG } **GLY**	U C A G

Note: Amino acid abbreviations are in bold type (*e.g.*, PHE, LEU, SER, etc.)

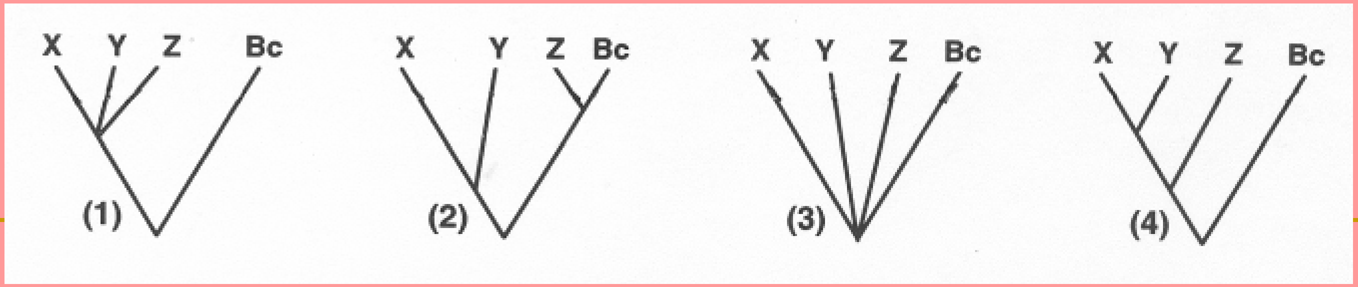
Relationships and Biodiversity

Sample Completed Table 1: Comparison of *Botana curus* with Species X, Y, and Z

	Structural Evidence			Molecular Evidence			
Species	**Structural Characteristics of Plants**	**Structural Characteristics of Seeds**	**Microscopic Stem Structure**	**Paper Chromatography**	**Test for Enzyme M**	**Differences in Amino Acid Sequences**	**Gel Electrophoresis DNA Banding Pattern**
Botana curus	*Answers will vary.*	*Answers will vary.*	*Scattered bundles*	*Blue Yellow Pink*	*Present*		*4 bands 5, 9, 11, 12*
Species X	*Answers will vary.*	*Answers will vary.*	*Circular bundles*	*Blue Yellow Pink*	*Absent*	*Two differences: SER not THR VAL not GLU*	*3 bands 7, 8, 22*
Species Y	*Answers will vary.*	*Answers will vary.*	*Circular bundles*	*Blue Yellow (see below*)*	*Present*	*Two differences: SER not THR VAL not GLU*	*4 bands 3, 5, 12, 17*
Species Z	*Answers will vary.*	*Answers will vary.*	*Scattered bundles*	*Blue Yellow Pink*	*Present*	*No difference*	*4 bands 5, 9, 11, 12*

Relationships and Biodiversity

- Which species – X, Y or Z - is most similar to *Botana curus* and is most likely to produce Curol?
- Which kind of evidence – structural or molecular – is most helpful to make decisions about relationships between species?
- Which evolutionary tree diagram best shows the relationships between species used in this lab?



Relationships and Biodiversity

biodiversity – a measure of the number and types of organisms in a location

- helps maintain ecosystem stability
- useful to humans for food, medicine, clothing, shelter, oxygen, soil fertility, future genetic variation, enjoyment
- we have no right to destroy

Relationships and Biodiversity

extinction – no more of a given species left on earth

causes of extinction and loss of biodiversity:

- destruction of natural habitats
- pollution
- overharvesting
- invasive species
- removal of predators

Relationships and Biodiversity

Human activities are reducing biodiversity and are causing the extinction of real organisms that have real uses, like the hypothetical *Botana curus*. Many people feel that it is important to preserve biodiversity. Some do not feel that it is worth the cost and effort.

New York State Required Labs

- Diffusion Through A Membrane
- Making Connections
- Beaks of Finches
- Relationships and Biodiversity