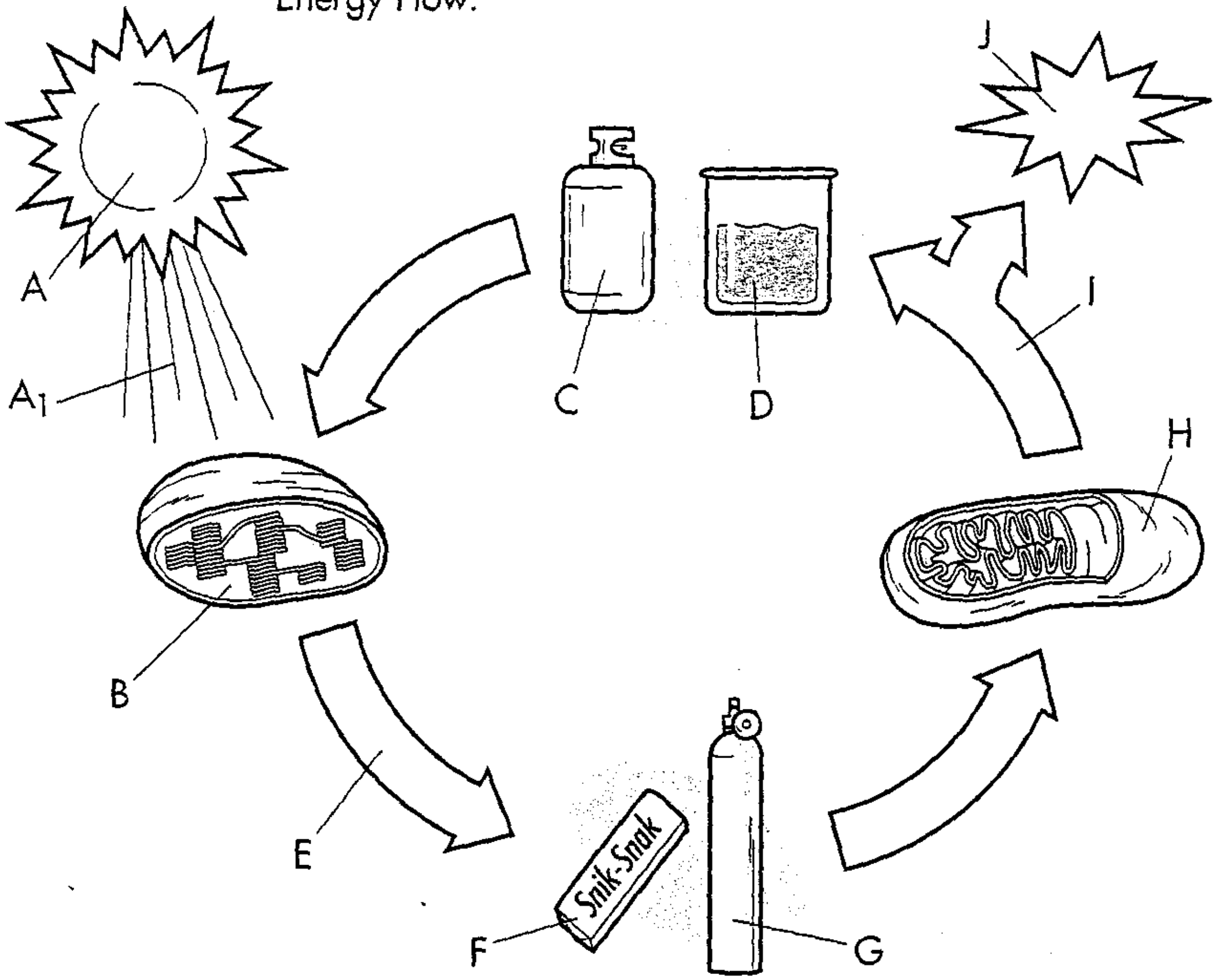
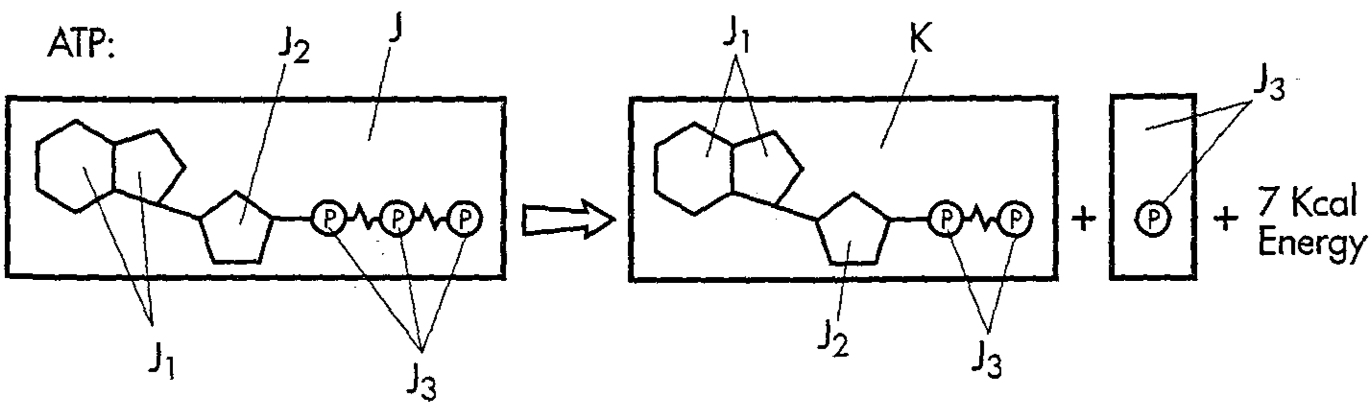
Energy Flow in Living Things

Energy Flow:



ATP:



Energy Flow in Living Things

- ○ Sun .... A
- ○ Sun's Energy .... A_1
- ○ Chloroplast .... B
- ○ Carbon Dioxide C
- ○ Water .... D
- ○ Photosynthesis .... E
- ○ Carbohydrates .... F
- ○ Oxygen .... G
- ○ Mitochondrion .... H
- ○ Respiration I
- ○ Adenosine Triphosphate .... J
  - ○ Adenine .... J_1
  - ○ Ribose .... J_2
  - ○ Phosphate Groups .. J_3
- ○ Adenosine Diphosphate .... K

Energy Flow in Living Things

The total amount of energy that exists in the universe remains constant, but energy can change from one form to another. For example, the chemical energy in gasoline can be released and transformed into heat energy and the energy of motion.

This type of transformation of energy occurs in many of the process that take place in living things. In this plate, we will examine the flow of energy through living things and identify the molecule that serves as the main energy source in all life processes.

All of the energy on the Earth comes from the **sun (A)**; the **sun's energy (A)**, is what drives chemical reactions and the processes of life. This solar energy is trapped in a photosynthesizing organelle of the plant called the **chloroplast (B)**; we discuss this organelle in detail later in the book.

A number of chemical reactions take place in the chloroplast to transform solar energy into chemical energy. **Carbon dioxide (C)** and **water (D)** are necessary for the process of **photosynthesis (E)**, and the products of photosynthesis include **carbohydrates** (F), which are represented by a candy bar, and molecular **oxygen (G)**. The bonds of the carbohydrates now contain some of the sun's energy; photosynthesis has transformed the sun's energy into the chemical energy of the carbohydrates. Oxygen is given off as a waste product of photosynthesis, and is expelled from the plant cell into the atmosphere.

Plants, humans, and many other living things use carbohydrates as their essential source of energy. Carbohydrates are transported to an organelle called the **mitochondria** (H), where they are combined with oxygen molecules in the process of **cellular respiration(I)**, illustrated by the arrow. During chemical reactions in the mitochondria, the energy from carbohydrates is released in and used to form the energy-rich molecule **adenosine triphosphate (J)**. (Adenosine triphosphate is commonly abbreviated as ATP.) Carbon dioxide and water are byproducts of respiration; notice that they are both essential for photosynthesis. To summarize, the energy of the sun is first transformed into the energy of carbohydrates and then into the energy in the ATP.

The adenosine triphosphate (ATP) molecule (J) is shown at the bottom of the plate. You should use a light shade to color the interior of the box, and darker colors should be used for the components of ATP. These components include an **adenine molecule (J_1)** and a **ribose molecule (J_2)**. Adenine is one of the four nitrogenous bases found in DNA and RNA, and ribose is a five carbon carbonate. Attached to the ribose molecule are three **phosphate groups (J_3)**.

Living things use energy in the form of ATP, breaking it down into **adenosine diphosphate (K)** and an inorganic phosphate group. Adenosine diphosphate (ADP) contains adenine (J_1) and a ribose molecule (J_2), but only two phosphate groups (J_3). During this breakdown, seven kilocalories of energy are given off for use by the cell.

Summary sentences of each paragraph.

Paragraph 1
Paragraph 2
Paragraph 3
Paragraph 4
Paragraph 5
Paragraph 6
Paragraph 7
Overall summary of reading

Cellular Respiration and Photosynthesis Activity

Background info: At the bottom of every food chain are producers ... those organisms which make food from ingredients readily available in their environment. Green plants are a good example ... they make their own food from sunlight. Photosynthesis is powered by energy from the sun and becomes trapped in the new carbohydrate. During cellular respiration, the trapped energy is released and transferred to the energy-carrying molecule ATP (adenosine triphosphate), which fuels reactions throughout the cell. In this way, the sun provides the ultimate source of energy for almost all life on Earth. (www.acslp.org)

Directions:

1. Create a poster that colorfully diagrams the following two equations, specifically showing how they connect (using arrows) to one another. Use diagrams and labels to represent the mitochondria, choloroplast, thylakoids, solar energy, and water.

$$CO_2 + H_2O + \text{solor energy} \dashrightarrow O_2 + C_6H_{12}O_6$$

and

$$O_2 + C_6H_{12}O_6 \dashrightarrow H_2O + CO_2 + \text{energy (heat)}$$

2. Do not forget an appropriate, thorough title that depicts the goal of the activity.
3. In a one sentence summary, describe both light and dark reactions in photosynthesis.
4. In a one sentence summary, describe both photosynthesis and cellular respiration.
5. Check rubric to ensure that you have not forgotten any crucial elements of the poster.
6. Cut out rubric.
7. Your instructor will indicate where to put the rubric.

Cellular respiration and Photosynthesis Activity Rubric

Names of Group members (First and Last):

	3	2	1	0
Title	Title can be read from 6 ft. away, demonstrates goal of activity and is quite creative.	Title can be read from 6 ft. away and describes content well.	Title can be read from 4 ft. away and describes the content well.	The title is too small and/or does not describe the content of the poster well.
Graphics - Originality	Several of the graphics used on the poster reflect an exceptional degree of student creativity in their creation and/or display. Arrows are appropriate.	One or two of the graphics used on the poster reflect student creativity in their creation and/or display. Arrows are appropriate.	The graphics are made by the student, but are based on the designs or ideas of others. Some of the arrows are appropriate.	No graphics made by the student are included. Arrows are incorrect.
Labels	All items of importance on the poster are clearly labeled with labels that can be read from at least 3 ft. away.	Almost all items of importance on the poster are clearly labeled with labels that can be read from at least 3 ft. away.	Several items of importance on the poster are clearly labeled with labels that can be read from at least 3 ft. away.	Labels are too small to view OR no important items were labeled.
Attractive-ness And Color	The poster is exceptionally attractive in terms of design, layout, color and neatness.	The poster is attractive in terms of design, layout, color and neatness.	The poster is acceptably attractive though it may be a bit messy. Poster may not be colorful	The poster is distractingly messy or very poorly designed. It is not attractive. Poster is not colorful.

Total: ___________ x 2 = ___________/24

Bio Technology

Biology/Life Science

Standard

5. The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept, students know:

Concepts

c. how genetic engineering (biotechnology) is used to produce useful biomedical and agricultural product

d. * how basic DNA technology (*restriction digestion* by *endonucleases*, *gel* electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.

e. * how *exogenous* DNA *can* be *inserted into* bacterial *cells in order to alter their* genetic makeup and support expression of new protein products.

Investigation and Experimentation

Standard

1. *Scientific progress is made by asking meaningful questions and conducting careful* investigations. As a basis for understanding this concept, and to address the content the other four strands, students should develop their own questions and perform investigations. Students will:

Concept

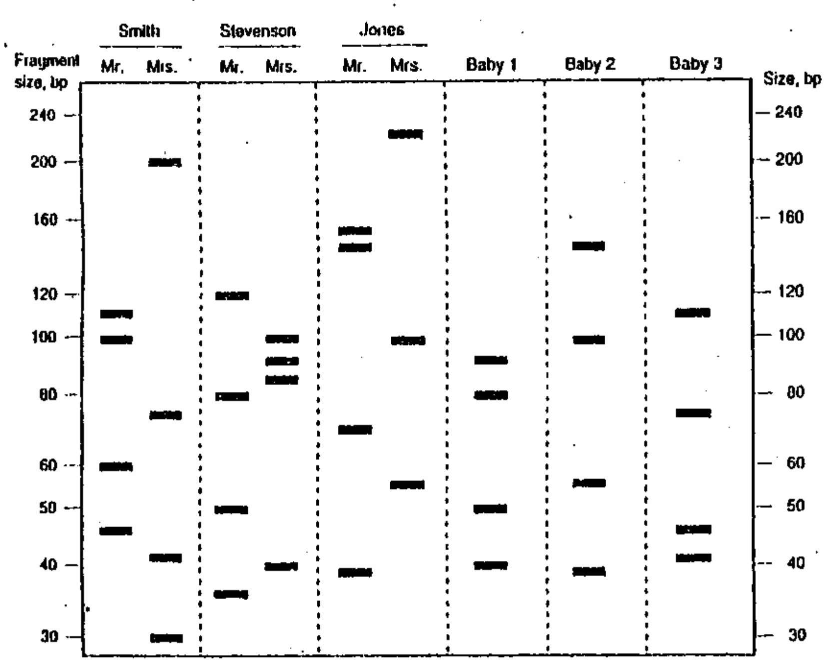
m. investigate a science-bases societal issue by researching the literature, analyzing data where appropriate and communication their findings. (Examples include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions (including California).

A Mix-Up at the Hospital

On June 6 at approximately 1:00 p.m., Mrs. Smith, Mrs. Stevenson, and Mrs. Jones each delivered a healthy baby boy at Metropolitan General Hospital. At 1:20 p.m., the hospital's fire alarm sounded. Nurses and orderlies scrambled to evacuate patients, and the three new babies were rushed to safety. After the danger had passed, the hospital staff was distressed to find that in the confusion, they had forgotten which baby was which! Since the babies were rescued before receiving their identification bracelets, there was no easy way to identify them. Dr. Anne Robinson, head of pediatrics, ordered that DNA typing be performed on the babies and their parents.

The DNA typing laboratory looked at two different highly variable chromosome regions. The DNA profiles are shown in Fig. 25.1. Your job is to decide which baby belongs to which set of parents. To assign a baby to a set of parents, every band in the baby's profile should match a band from either the mother or the father. Not all of the bands in the mother's or father's profiles will have a counterpart in the baby's DNA profile. Hint: Use a ruler or a straightedge to help you line up the bands.

Figure 25.1 DNA profile data from the Smith, Stevenson, and Jones parents and the three infants.



Which baby belongs to which couple? Show which bands each baby inherited from its mother and from its father by marking the bands M and F.

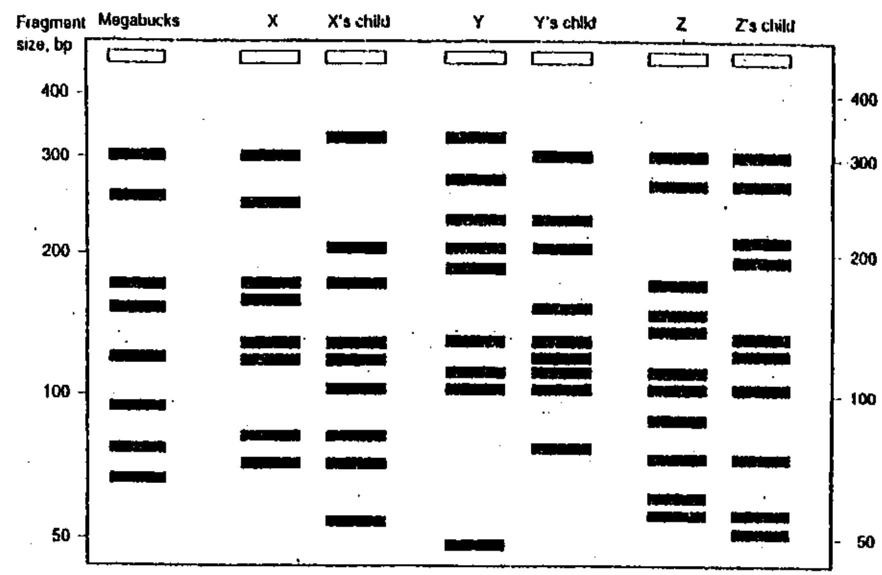
A Paternity Case

Mr. I. M. Megabucks, the wealthiest man in the world, recently died. Since his death, three women have come forward. Each woman claims to have a child by Megabucks and demands a substantial share of his estate for her child. Lawyers for the estate have insisted on DNA typing of each of the alleged heirs. Fortunately, Megabucks anticipated trouble like this before he died, and he arranged to have a sample of his blood frozen for DNA typing.

Laboratory technicians used the Southern hybridization method to look at three highly variable chromosome regions. The results of the blots are shown in Fig. 26.1. Your job is to analyze the data and determine whether any of the children could be Megabucks' heir.

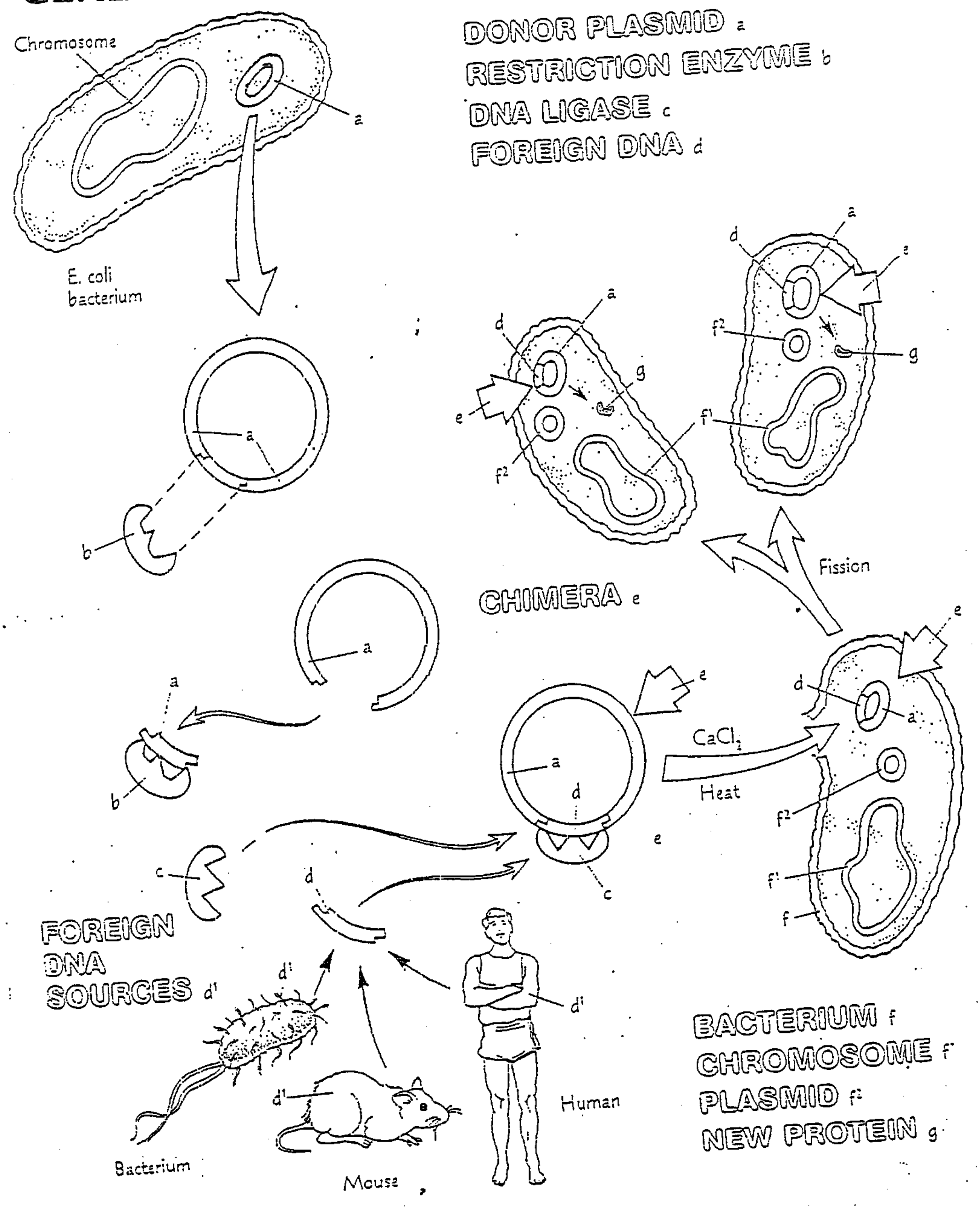
Remember that every person has two of each chromosome, one inherited from his mother and one inherited from his father. Half of every person's DNA comes from his mother, and half comes from his father, so some of the DNA bands showing in the Southern blots of the children will come from their mothers, and the rest will come from their fathers. The question is, could that father be Megabucks?

Figure 26.1 Results of hybridization analysis.



1. For the first child, identify the bands in the DNA profile that came from the mother. (Remember that not all of the mother's DNA is transmitted to the child; just one of each pair of chromosomes is transmitted.) Mark the bands that came from the mother with an M. Circle the remaining bands.
2. Compare the remaining bands with the DNA profile from Megabucks. If he is the father, then all of the circled bands in the child's profile should have a corresponding band in his profile. Use a straightedge to help you line up the bands accurately. (Remember that only half of the father's chromosomes are transmitted to a child, so not every band from the father would match the child's profile.)
3. Repeat the analysis for the other alleged heirs. Could any of them be Megabucks' children?

GENETIC ENGINEERING



GENETIC ENGINEERING

Experiments in bacterial transformation, conjugation, and transduction stimulated interest in the refinement of genetic insertion and deletion techniques. Such techniques are at the core of the process of genetic engineering. Was it possible to insert non-bacterial (foreign) genes into a bacterial chromosome? And would these altered bacteria establish a colony of cells that would produce proteins coded by these foreign genes?

In the 1960s, researchers discovered certain enzymes that would cleave bacterial DNA at designated points (restrictions) of the DNA strand. At these points of cleavage, foreign genes could be inserted. Research workers then found that specialized enzymes, called ligases, would secure the foreign genes to the strands of the bacterial chromosome. This same mechanism operates in DNA replication processes colored in the previous three plates.

As work progressed, scientists found chromosomal DNA difficult to work with, but noted that plasmids were much easier to manipulate. Using these small ringlets of DNA, research workers learned to maneuver genes and "engineer" new forms of bacteria that would synthesize specific proteins on demand.

Look over the arrangement of illustrations; note the counterclockwise progression of events. Set aside three shades of the color selected for (f). Use sharply contrasting colors for (a) and (d). Use a light color for (d). Color the titles and structures (a) through (g), beginning at upper left.

Note in the bacterium *Escherichia coli* the DNA-containing chromosome and the plasmid (a). The plasmid consists of a ring of DNA but a distinctly smaller amount than that found in the chromosome. Genetic engineering techniques begin with the breaking open of the bacterium and isolation of the plasmid (called the "donor plasmid"). The plasmid is cleaved at a desired point by a restriction enzyme (b). This cleaved part is removed and broken down; the plasmid is ready to receive a fragment of foreign DNA.

Foreign DNA (d) can come from a variety of sources, e.g., other bacteria, other animal tissues, even human cells. The foreign DNA is cleaved into fragments. The selected fragment is combined with the plasmid DNA at the restriction point with the aid of the enzyme DNA ligase (c). This combined plasmid is called a chimera (e: mythological lion-goat-serpent monster).

Chimeras are inserted into the bacteria by placing both bacteria and chimeras in calcium chloride ($CaCl_2$) solution and heating them quickly. This process opens the cell walls and membranes, permitting the chimera plasmids to pass through and enter the bacterial cytoplasm. Following cooling, the bacteria soon reproduce, generating a colony of cells each with a chimera plasmid. Soon a significant and measurable volume of bacterial protein (g) is produced. With this volume will be found a "new" protein whose genetic code is carried in the chimera plasmids within the bacterial cytoplasm. This new protein is available for harvesting.

Genetic engineering is the process of manipulating and collecting a known quantity of genes from a known source, opening the recipient DNA at the desired point in the linkage, and combining the strand of a known sequence of DNA with the recipient DNA of living organisms. The protein "factories" then synthesize the anticipated product which can be used for any number of purposes.

By the 1980s, the process of genetic engineering was well-established and biotechnology companies were mass producing proteins that could not be easily obtained otherwise. The process has yielded protein hormones vital to life, such as insulin and growth hormone, as well as vaccines, antiviral interferon, and blood clot-dissolving enzymes.

Genetic Engineering

P1

P2

P3

P4

P5

P6

P7

P8

OVERALL-(4 sentences)

Name Date Class

MiniLab *Applying Concepts*

Matching Restriction Enzymes to Cleavage Sites

Many restriction enzymes cut sequences of DNA that are palindromes. As a result of cuts to the DNA, single-stranded sequences of DNA are left dangling at the ends of a fragment. These ends are available for pairing with their complementary bases in a plasmid or piece of viral DNA.

Procedure

1. Use the data table below.

Data Table

DNA fragment	Enzyme letter (D–F)	Action of restriction enzyme	Cleaved fragment of DNA
—GGTACC— | | | | | | —CCATGG—	E	—GGTACC— —CCATGG—	—G GTACC— —CCATG G—
—CCATGG— | | | | | | —GGTACC—			
—CAATTG— | | | | | | —GTTAAC—			
—GATATC— | | | | | | —CTATAG—			

2. Figure out which restriction enzyme will cleave each DNA fragment. Use the following guides.

   Enzyme D cleaves at an A-A site and leaves 3 single-stranded bases on each end.

   Enzyme E cleaves at a G-G site and leaves 4 single-stranded bases on each end.

   Enzyme F cleaves at a G-A site and leaves 4 single-stranded bases on each end.

3. Draw in the action of each enzyme. Record its letter.
4. Diagram each fragment of DNA as it would appear if cleaved by the proper restriction enzyme.
5. Use the top row in the table as an example and guide.

MiniLab 13-1

Matching Restriction Enzymes to Cleavage Sites, *continued*

Analysis

1. Use the example provided in the data table to illustrate a single-stranded dangling end of DNA.

2. Record the DNA base sequence that must be present on a piece of viral DNA if these ends could "stick to" the dangling bases in the example shown in the data table.

____

3. Are restriction enzymes very specific as to where they cleave DNA? Explain your answer and give an example.

____

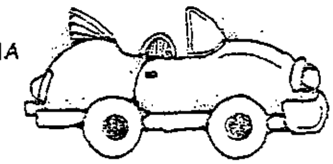
____

____

____

____

DNA Goes to the Races



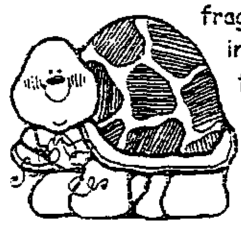
Purpose: To simulate the digestion of a sample DNA molecule with each of three restriction enzymes; To simulate gel electrophoresis of the restriction fragments.

Pre-Lab Questions: *Answer each question completely and thoroughly.*

1. What is the function of restriction enzymes?
2. Flow chart/outline the process of separating DNA using gel electrophoresis.

Activity:

1. Cut out the three strands of the DNA molecule. Color each strand a different color. Cut out the outline of the gel box and glue it into you lab book.
2. Simulate the activity of the restriction enzyme EcoRI on the DNA molecule that shows the EcoRI sites by cutting across the strip at the vertical lines representing EcoRI sites. You have now digested the molecule with EcoRI. Put your restriction fragments in a pile apart from the other two strands.
3. Digest the second DNA strip with BamHI. Put the BamHI fragments in a separate pile.
4. Digest the remaining strand with HindIII. Put these fragments in a third pile.
5. In our imaginary gel, you will separate the EcoRI, BamHI, and HindIII fragments as if you had loaded the three sets of fragments into separate but adjacent sample wells. Arrange your fragments as they would be separated by electrophoresis.

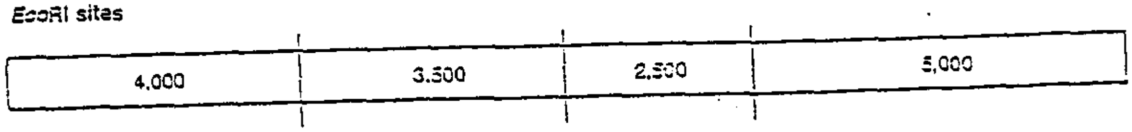


6. Look at the outline of the gel box. Notice that it has a size scale in base pairs on the left-hand side and that sample wells are drawn in. Using the gel outline and size scale as a guide for where to put your fragments, glue your cut out fragments to the appropriate place.

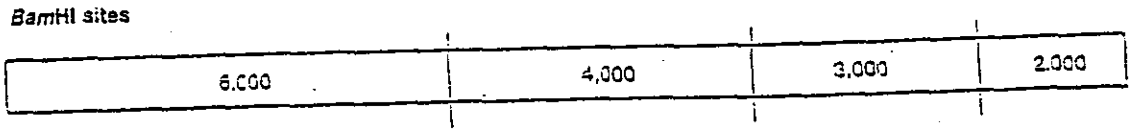
Restriction maps for *DNA Goes to the Races*

Below are three representations of a 15,000-base-pair DNA molecule. Each representation shows the locations of different types of restriction site, with vertical lines representing the cut site. The numbers between the cut sites show the sizes (in base pairs) of the fragments that would be generated by digesting the DNA with that enzyme.

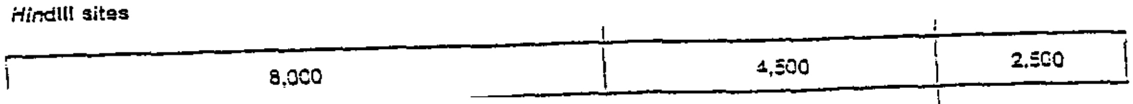
EcoRI sites



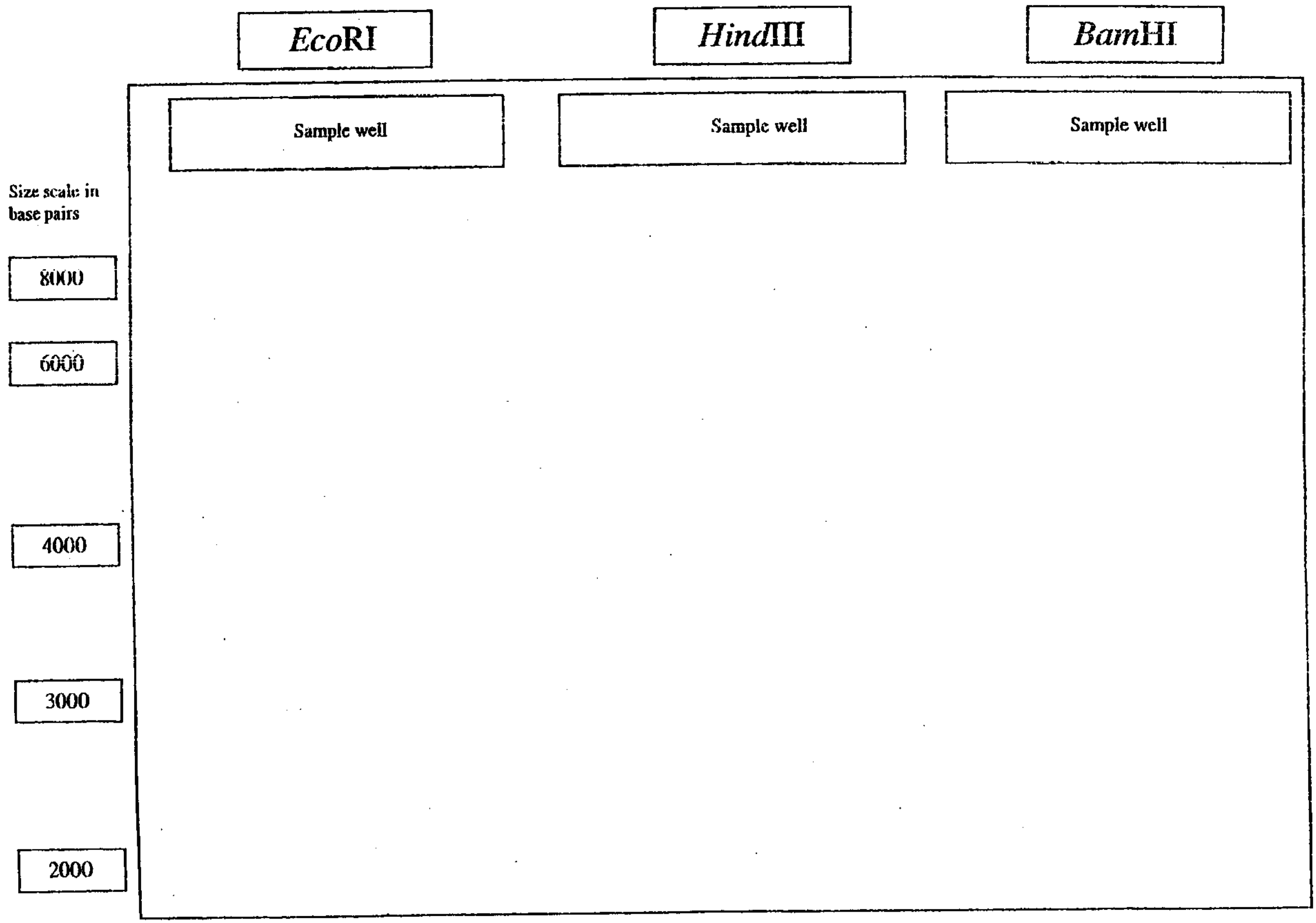
BamHI sites



HindIII sites



Gel outline for DNA Goes to the Races



CP Biology Final Exam Study Guide

Directions: Use the following sources to complete the study guide: textbook, work book, previous quizzes, and your brain. Then complete the study guide (typing your study guide is permissible and encouraged. Lastly, no study guides will be graded if the instructor cannot read your information. More importantly, this study guide will help you direct your focus when studying for the Biology Exam. However, the exam is not limited to just the information on this study guide.

Review

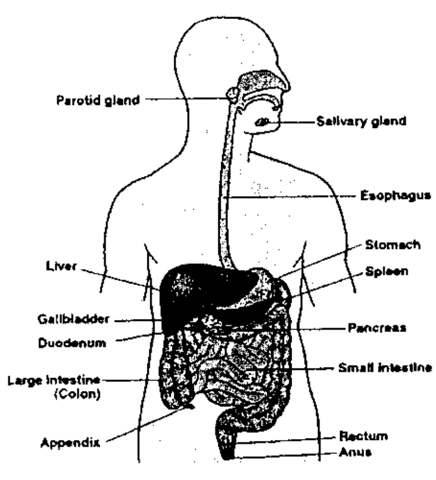
1. Define secrete.
2. Fill-in

Macromolecule (polymer)	Subunit (monomer)
Protein	
	Fatty acid
Starch (Polysaccharide)	

Enzymes & Digestive System (12 questions)

1. List the functions and properties of enzymes in living things.
2. Why is an enzyme called a catalyst?
3. How is an enzyme made?
4. A + B ⟶ C + D (What does X represent?)
5. Are enzymes used up in a reaction or recycled?

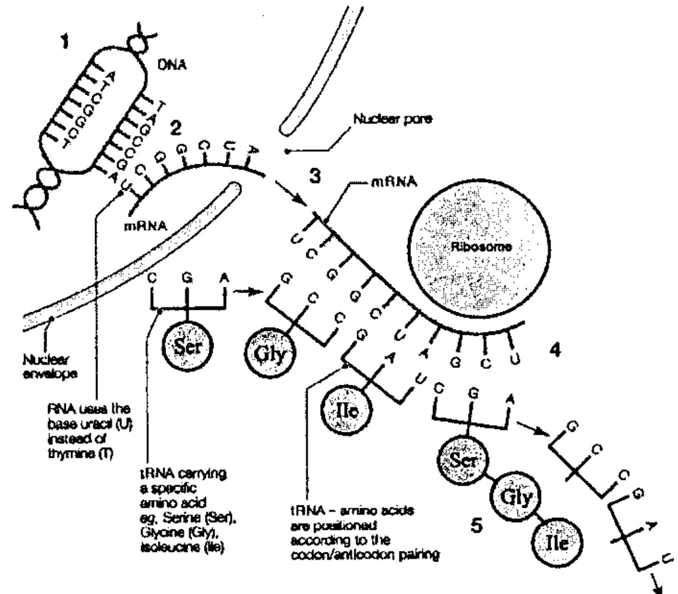
Digestive System



6. What acid is responsible for the low pH of the stomach?
7. What is the purpose of villi in the small intestine?
8. The wave-like motion that allows food to move through the digestive system is called ____________.
9. Water is absorbed in the __________, making the feces a solid substance.
10. Circle the three places digestive enzymes are secreted into the digestive tract.
11. Put a star next to the organ that helps in the breakdown of fat.
12. Highlight the two organs that secrete (release) digestive enzymes into the small intestine.

DNA, RNA, and Protein Synthesis (33 questions)

1. Name the three parts that make-up a nucleotide.



Source: Human Biology and Health Studies, Thomas Nelson, Walton-on-Thames, 1998

2. Using the picture above, label nucleus, cytoplasm, DNA, mRNA, tRNA, Amino acids, Ribosome, codon, and polypeptide (protein). In the same space provided, describe the job of the DNA, mRNA and tRNA.
3. Contrast DNA and RNA

	DNA	RNA
Sugar		
Strands		
Type of nitrogen bases		
Location		
Types		

4. Every three nucleotides codes for a(n) __________________.
5. The sequence of nucleotides, which codes for a trait, is called a __________.

Genetics & Biotechnology (31 questions)

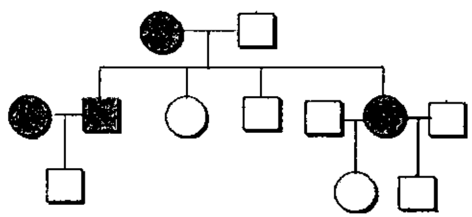
1. What is the function of meiosis.
2. Contrast body (somatic) cell and gamete.

M11

3. Fill-in table

Organism	Body cell	Gamete
Human	46	
Cat		16
Fruit Fly	8	

4. Define genotypes and give an example.
5. Contrast heterozygous and homozygous. Give a genotypic example of each.
6. Diagram two homologous chromosomes and two non-homologous chromosomes.
7. Complete a Punnett square: Rr x rr (give gentoypic and phenotypic ratios)
8. Describe incomplete dominance and give an example.
9. Cross a man with type AB blood and a woman with B (her father was blood type O). What are the possible blood types of their children.
10. Colorblindness is carried on the _________ chromosome.
11. Cross a colorblind woman with a normal vision man (his father was colorblind). What are the chances of having a daughter that is colorblind? (Show your work)



12. Is this pedigree dominant or recessive? __________ How do you know?
13. Give genotypes for all family members.

14. Diagram two chromosomes crossing over.
15. Diagram an addition, deletion and substitution mutation on a strand of DNA.
16. The failure of homologous chromosomes to separate is called __________.
17. List some causes of mutations.
18. Karyotypes are used to determine __________ and reveal ______________.
19. While analyzing a karyotpe, you notice that an individual has three of chromosome 21. What does this individual have?
20. Define genetic engineering and give some examples.

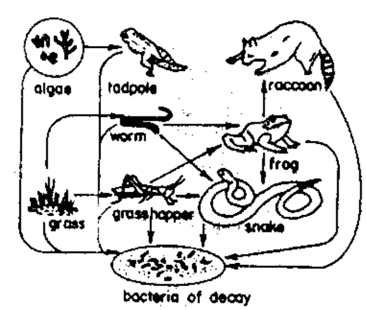
Natural Selection/Evolution (11 questions)

1. Define evolution
2. Define variation
3. Define adaptations
4. Define speciation
5. Natural selection acts of phenotype or genotype? (Give an example)
6. Evidence of Evolution: (describe the following)
    - homologous structures
    - biochemistry
    - embryological data
7. List Darwin's ideas for Natural selection
8. Contrast geographic isolation and reproductive isolation.
    a. both lead to ____________________.
9. Define adaptive radiation
10. How does variation occur in populations?
11. What patterns did you notice when completing the comparative embryology lab?

Ecology (13 questions)

1. Fill-in the chart.

	Definition or Diagram
Abiotic factor	
Biotic factor	
Population	
Ecosystem	
Succession	
Habitat	
Niche	
Water Cycle	
Decomposers	
Parasitism	
Mutualism	
Commensalism	



2. The following diagram of energy flow is called a _______________.
    a. The bacteria are known as ____________ because they recycle inorganic materials.
    b. Algae and grass are called __________ because they make their own food via photosynthesis.
    c. As trophic levels increase the amount of energy __________.
    d. If only 10% of the energy is passed from one feeding level to the next, what happens to the other 90%?