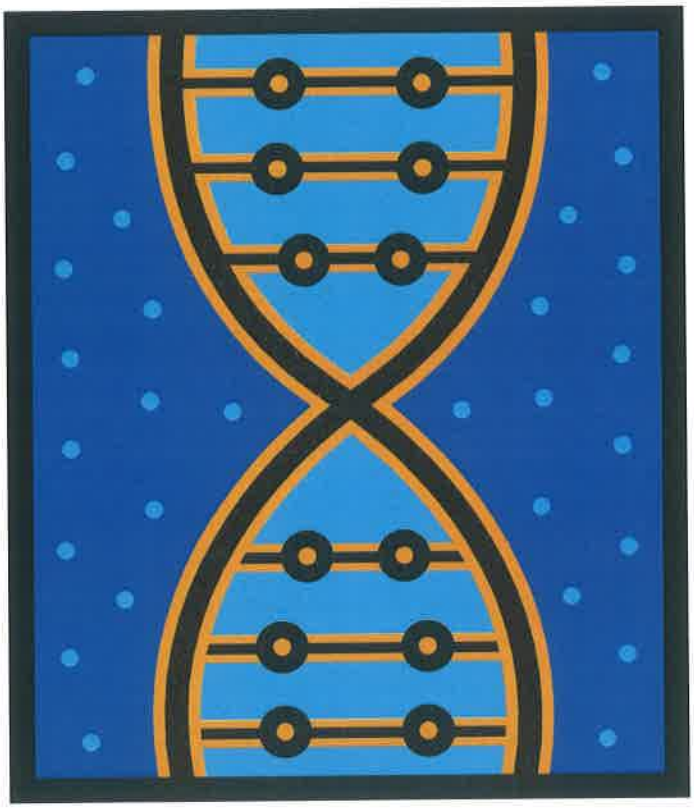
Unit Six:



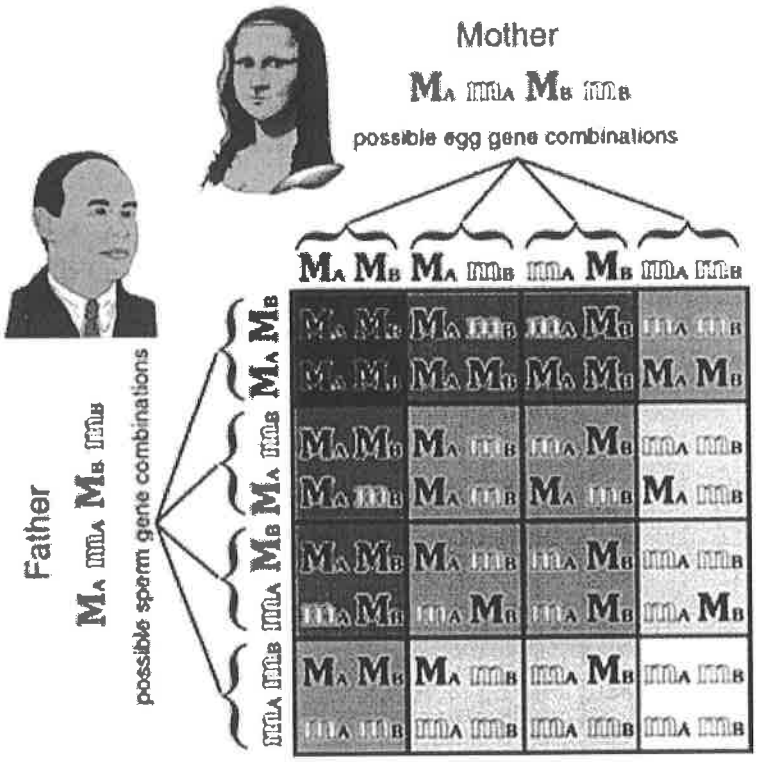
Genetics

Name:

MONOHYBRID CROSSES AND PUNNETT SQUARES
A STUDY OF INHERITANCE

INTRODUCTION:

Scientists use a grid like tool (Punnett Square) to make predictions about various genetic problems. The Punnett Square shows only the probability of what might occur and not the actual results. Probability is the chance of something occurring. If one wants to flip a coin 100 times, since there are 2 sides to the coin, he would expect 50 heads and 50 tails. If he flips the coin 100 times, he may actually get 60 heads and 40 tails. Prediction is one thing, and actually getting the predicted results is another. The punnett square only shows the chances of what might occur each time the event is under taken. In this investigation you will use a punnett square to predict possible genotypes and phenotypes and their ratios from a monohybrid cross.



MATERIALS:

- Yellow beads
- Green beads
- Small Paper Bag

PROCEDURE:

1. Each group of 2 students will pick up two paper bags filled with 15 green (G) beads and 15 yellow (g) beads. This represents 2 heterozygous parents Gg x Gg.
2. One student in the group will be in charge of the male bag and the other will be in charge of the female bag, together they will each record data.
3. At the same time, each student controlling the bag of gametes, will reach into the bag and pull out one of the beads. The only possibilities that can be made from the selection are: GG, Gg, or gg. What do each of these mean? Record this information in your lab notebook.
    a. GG: _____
    b. Gg: _____
    c. gg : _____
4. Record the results on the data sheet on the next page.
5. Return the beads back into the bag and conduct the same process 29 more times.

DATA TABLE:

Trial	Offspring's Genotype	Offspring's Phenotype
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
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21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

ANALYSIS QUESTIONS:

1. What of the beads represents the dominant trait?
2. How do you know the above trait selected is the dominant trait?
3. Which of the beads represents the recessive trait?
4. What are the genotypes of the parents used in this experiment?
5. What is the phenotype of the parents?
6. Fill in the punnett square below using the parents given in the procedure.

   Male_____ X Female_____

7. What is the genotypic ratio of the cross?
8. What is the phenotypic ratio of the cross?

INVESTIGATING INHERITED TRAITS

Introduction

Heredity is the passing on of traits or characteristics from parents to offspring. The units of heredity are called genes. These genes are found on the chromosomes in a cell. The combinations of genes for each trait occur by chance.

When one gene in a pair is expressed, the traits of the other gene is masked, or hidden. The expressed gene is dominant and the masked gene is recessive. Dominant genes are written as capital letters, and recessive genes are written as lowercase letters. If both genes in a pair are the same, the trait is *homozygous*, or pure. If the genes are not similar, the trait is *heterozygous*, or hybrid. Sometimes genes are neither dominant nor recessive. The result is a blending of traits.

The genetic makeup of an individual is known as its genotype. The observable physical characteristics of an individual that are the result of its genotype are known as its phenotype. In humans, the sex of an individual is determined by the particular combination of the two sex chromosomes. Individuals that have two X chromosomes (XX) are females, whereas those with an X and a Y chromosome (XY) are males.

In this investigation, you will observe how the results of different gene combinations produce certain traits.

Problem
How are traits inherited?

Materials (per pair of students) 2 coins

Pre-lab Discussion Questions

1. What does a single side of a double-sided coin or disk represent in this activity? What is the probability (in percent) that a single coin toss will result in heads/tails?
2. Why is a coin toss a good way to represent gene combinations that occur in nature?
3. What is the difference between heterozygous and homozygous?

Procedure

1. Determine which partner will toss for the female and which will toss for the male. Remember that there are two genes per trait.

2. Have the partner who is representing the male flip a coin to determine the sex of the offspring. If the coin lands heads up, the offspring is female. If the coin lands tails up, the offspring is a male. Record the sex of the offspring.

3. For all the coin tosses you will now make, heads will represent the dominant gene and tails will represent the recessive gene.

4. You and your partner should now flip your coins at the same time to determine the phenotype of the first trait, the shape of the face. Note: *the coins should be flipped only once for each trait.*

5. Continue to flip the coins for each trait listed in the table in Figure 1. After each flip, record the trait of your offspring by placing a check in the appropriate box in the table.

6. Using the recorded traits, draw the facial features for your offspring.

Analysis Questions

1. What are all of the possible combinations of parent genotypes of a child who has wavy (Hh) hair?
2. If a woman who is homozygous for almond-shaped eyes (AA) marries a man who is heterozygous for almond-shaped eyes (Aa), what are the possible genotypes and phenotypes of their children? Show a your work (a Punnet square)
3. How is it possible for a child to express a trait if neither parent does?
4. Use your knowledge of genetics to explain why it is a wrong move for a king to divorce his queen because she only produced daughters though he wanted a son.
5. Would you expect the other pairs of students in your class to have an offspring similar to yours? Why or why not?

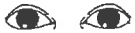
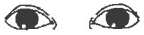
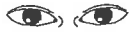
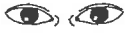
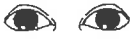
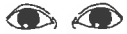
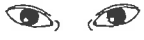
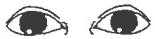
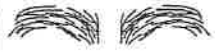
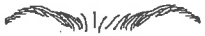
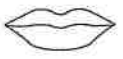
Traits	Dominant (both heads)	Hybrid (one head, one tail)	Recessive (both tails)
Shape of face	 round *RR*	 round *Rr*	 Square *rr*
Cleft in chin	 present *CC*	 present *Cc*	 absent *cc*
Texture of hair	 curly *HH*	 wavy *Hh*	 straight *hh*
Widow's peak	 present *WW*	 present *Ww*	 absent *ww*
Spacing of eyes	 close together *EE*	 medium distance *Ee*	 far apart *ee*
Shape of eyes	 almond *AA*	 almond *Aa*	 round *aa*
Position of eyes	 straight *SS*	 straight *Ss*	 slant upward *ss*
Size of eyes	 large *LL*	 medium *Ll*	 small *ll*

Figure 1

Traits	Dominant (both heads)	Hybrid (one head, one tail)	Recessive (both tails)
Length of eyelashes	 long *LL*	 long *Ll*	 short *ll*
Shape of eyebrows	 bushy *BB*	 bushy *Bb*	 fine *bb*
Position of eyebrows	 not connected *NN*	 not connected *Nn*	 connected *nn*
Size of nose	 large *LL*	 medium *Ll*	 small *ll*
Shape of lips	 thick *TT*	 medium *Tt*	 thin *tt*
Size of ears	 large *LL*	medium *Ll*	small *ll*
Size of mouth	large *LL*	medium *Ll*	small *ll*
Freckles	present *FF*	present *Ff*	absent *ff*
Dimples	present *DD*	present *Dd*	absent *dd*

Lab # _____ DRAGON GENETICS
Principles of Mendelian Genetics

BACKGROUND

Students will work in pairs in the lab to produce a dragon from the random mixing of genetic traits. Each student will be a surrogate dragon parent. They will pick up a complete set of dragon chromosomes. Surrogate dragon parent partners must be of the opposite sex, therefore one parent must pick up the double X chromosomes while the other must pick up the X/Y chromosomes. The homologous chromosomes will be separated according to Mendel's law of Independent Assortment. The genetic codes that are passed on to the baby will be recorded on the following pages. The surrogate parents must then decode the genes inherited by their *bundle of joy* to determine the phenotype traits of their baby. Using the pictures at the end of the handout, they will cut out these traits and paste them together to have a picture of their baby.

PROCEDURE.

1. Each partner must pick up five Popsicle sticks -- one of each color of autosome, and one sex chromosome stick. Each side of a stick represents a chromosome, and the two sides together represent a pair of homologous chromosomes.
2. For each color autosome and then for the sex chromosomes, each parent will randomly drop his or her stick on the table. The side of the stick that is up represents the chromosome that is passed on to the baby.
3. The alleles from each pair of homologous chromosomes will be recorded in the data chart on pages 3-4.
4. The decoding chart on page 2 indicates the phenotypic effect of each gene. The trait produced by each pair of alleles should be recorded in the data chart. Remember that a CAPITAL letter is dominant over a small letter [recessive] unless the decoding chart indicates those traits are codominant, sex-influenced, or sex-limited.
5. Cut out the traits for your baby. Fit them together and produce a picture of the baby. Students may trace the traits to produce their baby's picture or just glue them to the page.
6. The baby's colors will be added to the picture, if possible; otherwise indicate the baby's colors below the picture

Genotypes		Alleles in		GREEN AUTOSOMES
Mom	Dad	Egg	Sperm	TRAIT ---- Phenotype of Baby

Genotypes		Alleles in		RED AUTOSOMES
Mom	Dad	Egg	Sperm	TRAIT ---- Phenotype of Baby

Genotypes		Alleles in		ORANGE AUTOSOMES
Mom	Dad	Egg	Sperm	TRAIT ---- Phenotype of Baby

Genotypes		Alleles in		YELLOW AUTOSOMES
Mom	Dad	Egg	Sperm	TRAIT ---- Phenotype of Baby

Genotypes		Alleles in		SEX CHROMOSOMES
Mom	Dad	Egg	Sperm	TRAIT ---- Phenotype of Baby

**COPY the charts above into your lab notebook and complete.

ANALYSIS:

1) How does dropping the stick on the table and transcribing the letters on the sides facing up follow Mendel's Law of Segregation? (First state the law)
2) Explain how dropping the green, orange, and red sticks illustrates Mendel's Law of Independent Assortment? (First state the law)
3) What is the gender of your baby?
4) What is a sex-linked trait? What traits are sex-linked for the dragons?
5) Which traits are more likely to be found in males?
6) How might the traits you mentioned in question 5 be an advantage to males? (Be creative)
7) Which traits are more likely to be found in females?
8) How might the traits you mentioned in question 7 be an advantage to females? (Be creative)

DRAGON GENOME
DECODING OF THE GENES

Chromosome	Dominant genes	Recessive genes
Green Autosome	A. no chin spike	a. chin spike
	B. nose spike	b. no nose spike
	C. three head flaps	c. four head flaps
	D. no visible ear hole	d. visible ear hole
	E. [see below]	
Red Autosome	F. long neck	f. short neck
	G. no back hump	g. back hump
	H. no back spikes	h. back spikes
	I. long tail	i. short tail
	J. flat feet	j. arched feet
Orange Autosome	K. red eyes	k. yellow eyes
	L. spots on neck	l. no spots on neck
	M. [see below]	
	N. no fang	n. fang
	O. spots on back	o. no spots on back
Yellow Autosome	P. no spots on thigh	p. spots on thigh
	Q. green body	q. purple body
	R small comb on head [see below]	r. large comb on head
	S. [See below]	
	T. [See below]	
Sex Chromosomes	U. regular thigh	u. pointed thigh
	V. four toes	v. three toes
	W. no chest plate	w. chest plate
X Chromosome Only	X. no. tail spike	x. tail spike
	Z. long arms	z. short arms
	+ non-fire breather	- fire breather
Y chromosome only	Y. male sex	

Codominant traits

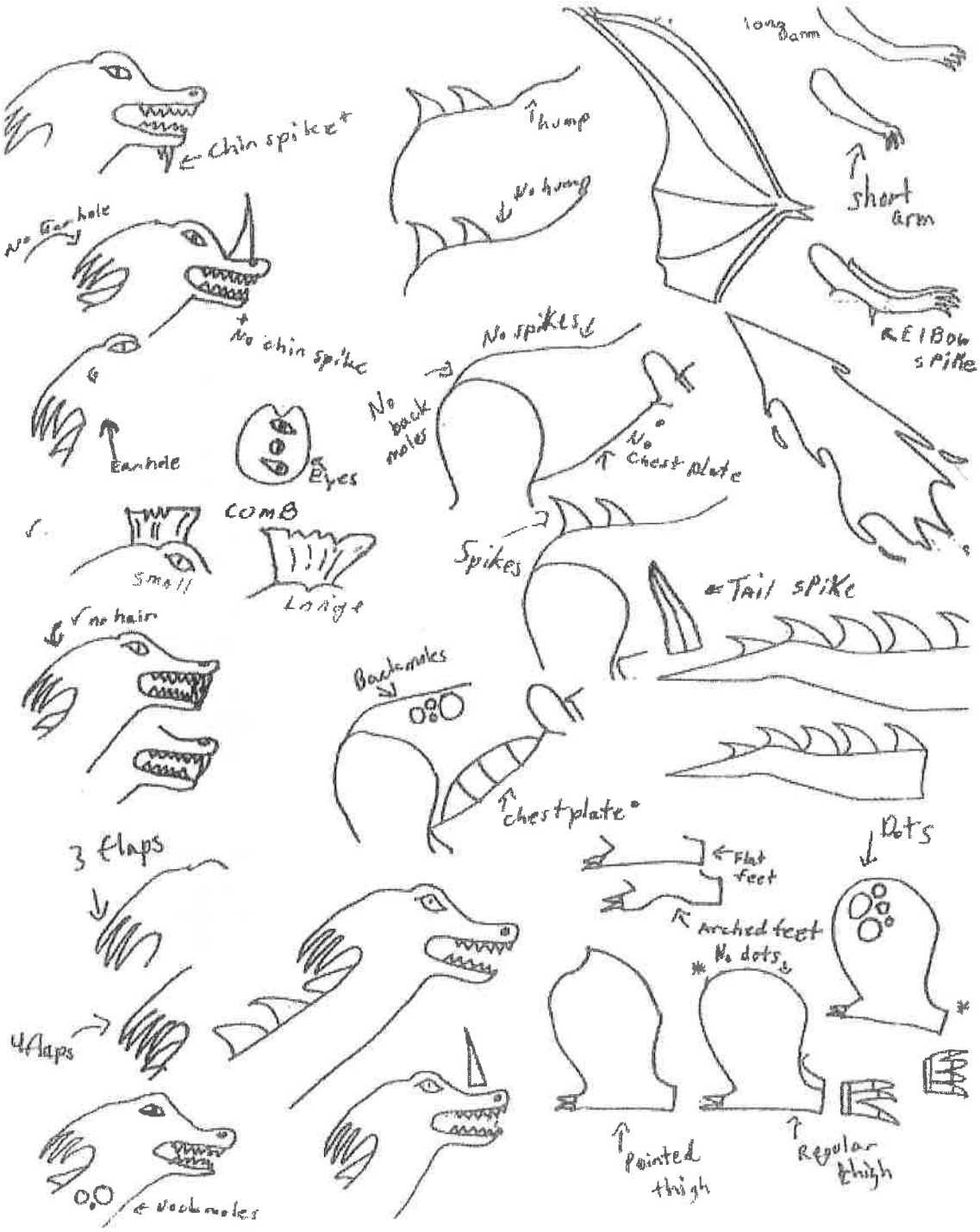
E. eye pointed at each end	e. round eye	Ee. eye round at front only
S. Red spots	s. yellow spots	Ss. orange spots

Sex-influenced traits

M. wings	m. no wings [dominant in presence of male hormone]
T. no elbow spike	t. elbow spike [dominant in presence of male hormone]

Sex-limited traits

R or r Only males have the comb on the head


Chin spike*
No Ear hole
No chin spike
Earhole
Eyes
comb
small
Large
no hair
3 flaps
4 flaps
0.0
* Back moles
Thump
No thump
long arm
short arm
ELBOW spike
No spikes
No back moles
No Chest plate
Spikes
Tail spike
Back moles
chest plate*
Flat feet
Arched feet
No dots
Dots
Pointed thigh
Regular thigh

Name: _____ Date: _____

Lab # ____

Investigating a Human Karyotype

Background:

A *karyotype* is an arrangement of a photograph of condensed chromosomes in a cell arranged in a way for each pair to be easily identified. Karyotypes are made by cutting out the chromosomes taken from a photograph of a dividing cell and arranging them by homologous pair, in size order. Karyotyping can be used to identify abnormal conditions caused by extra or missing chromosomes. Normal males have one "X" and one "Y" chromosome. Normal females have two "X" chromosomes and no "Y" chromosomes. A female missing an "X" chromosome can be diagnosed as having Turner Syndrome. A male with an extra "X" chromosome can be diagnosed as having Klinefelter's Syndrome. A person with an extra chromosome number 21 can be diagnosed as having Down's Syndrome (Trisomy-21). In this laboratory you will prepare a human karyotype and determine the genetic characteristics of that person.

Objectives:

1. Prepare a karyotype from an illustration of the chromosomes found in a human cell.
2. Diagnose the specific condition of your assigned subject by examining his or her karyotype.

Materials:

1. Samples of normal male and female karyotypes
2. Scissors
3. Tape or glue

Procedure:

1. You will receive an assigned set of chromosomes (set A, B, or C) each containing scattered human chromosomes that must be paired and identified.
2. Write the letter of your assigned karyotype set in the bottom right hand corner of your blank karyotyping sheet. (Set A, B, or C)
3. Examine the illustrations of each chromosome. Look at their banding patterns, shapes, and sizes. Each chromosome pair should be numbered from the largest pairs to the smallest pairs with the "X" and "Y" chromosomes appearing last in the karyotype.
4. Carefully cut out each chromosome from your assigned karyotype set. (Be very careful when cutting them out, some of the chromosomes are very small and if you lose one your diagnosis will be incorrect!)
5. Pair each chromosome with its corresponding homolog (match).

6. Identify the chromosome number of each pair by placing the pairs in size order from largest to smallest. (Chromosome numbers range from 1 to 22)
7. Any "X" or "Y" chromosomes will be placed after chromosome pair 22.
8. Use the sample karyotypes of a normal male and female provided to help you perform steps 5 - 7.
9. After you have determined the correct matching and order of each chromosome pair, then tape or glue chromosomes to your blank karyotyping sheet.
10. Fill in the information at the bottom of your karyotyping sheet indicating the total number of chromosomes, sex, and diagnosis of the subject.
11. Answer the analysis questions.

Analysis Questions:

1. Is the karyotype you constructed normal or abnormal? Explain how you know.

2. What 2 pieces of information could be gained if a karyotype was performed with chromosomes from a cell sample of a child that is not yet born?

3. List 3 factors that can be used to identify homologous chromosomes.

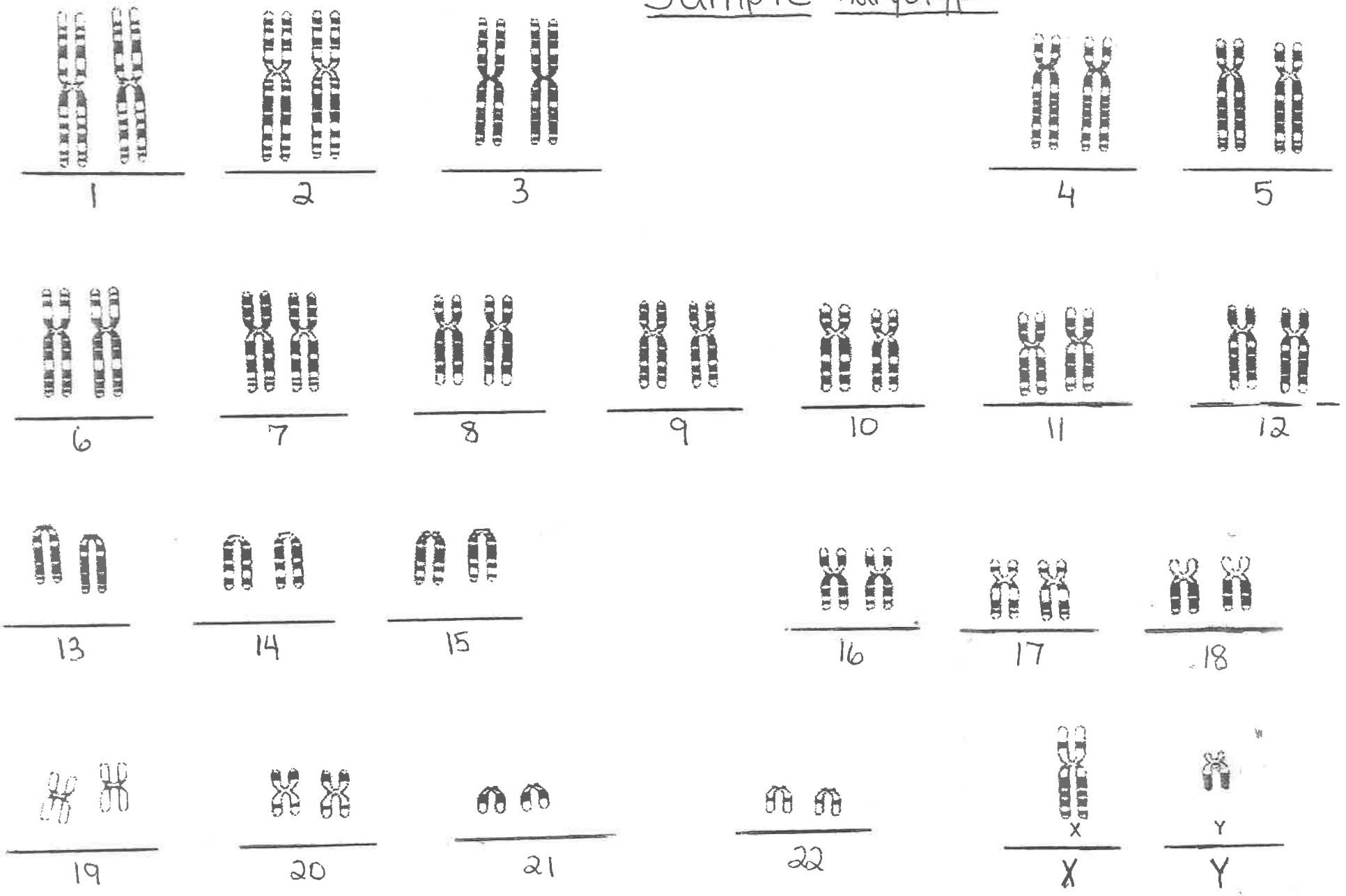
4. Define each of the following:

   karyotype –

   sex chromosome –

   autosomes –

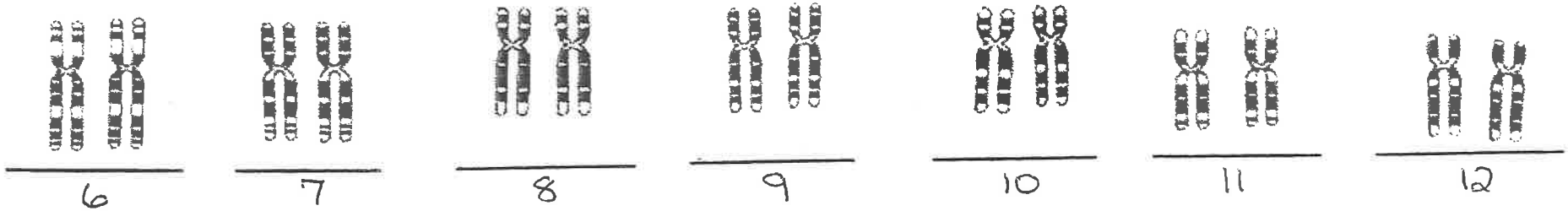
Sample Karyotype

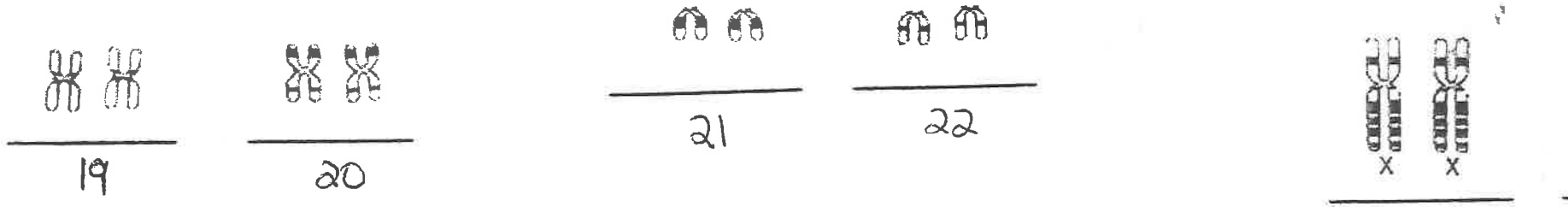


Total Number of Chromosomes 46 Sex of Subject XY

Diagnosis Normal Male

Sample Karyotype



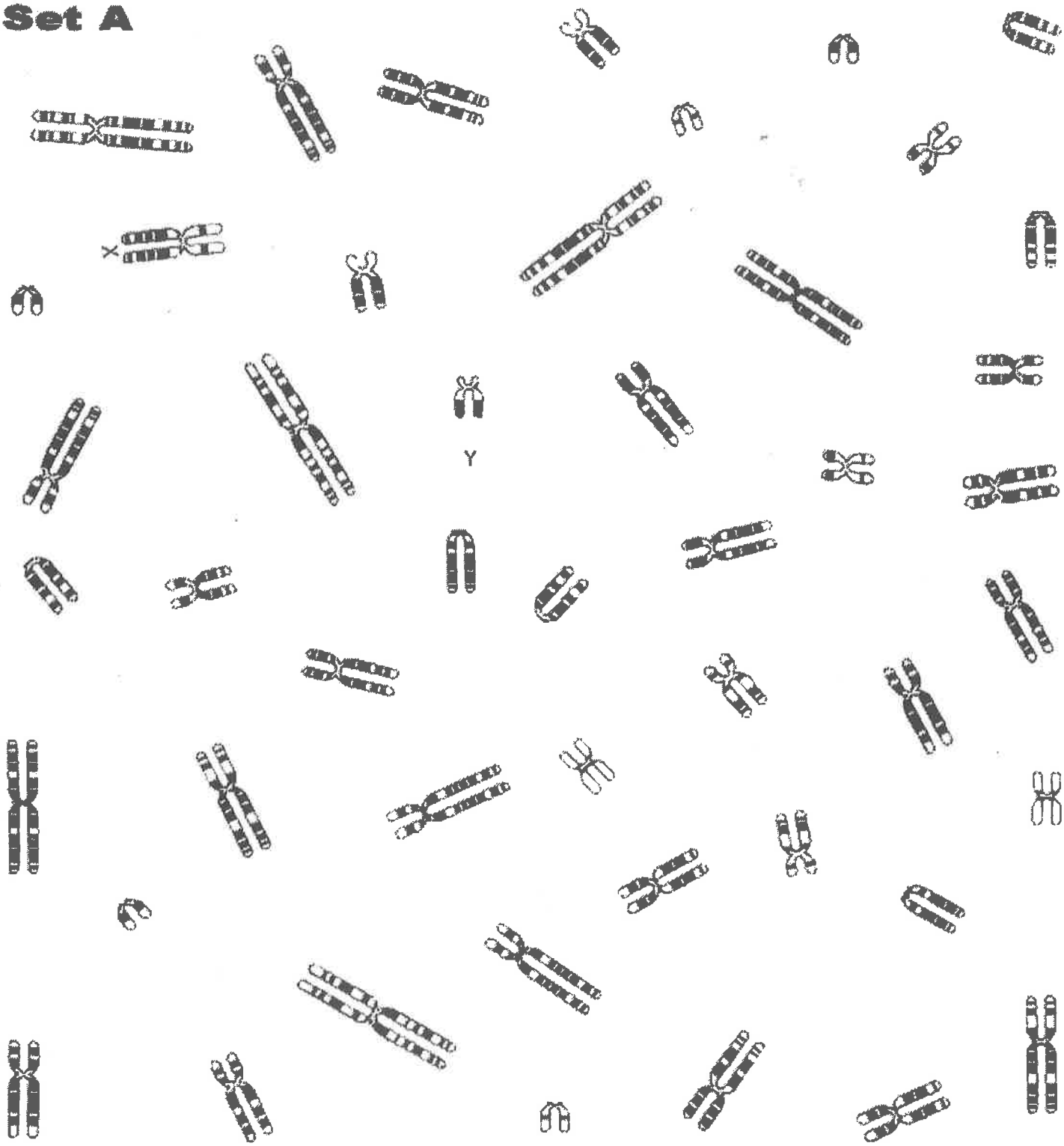


Total Number of Chromosomes 46

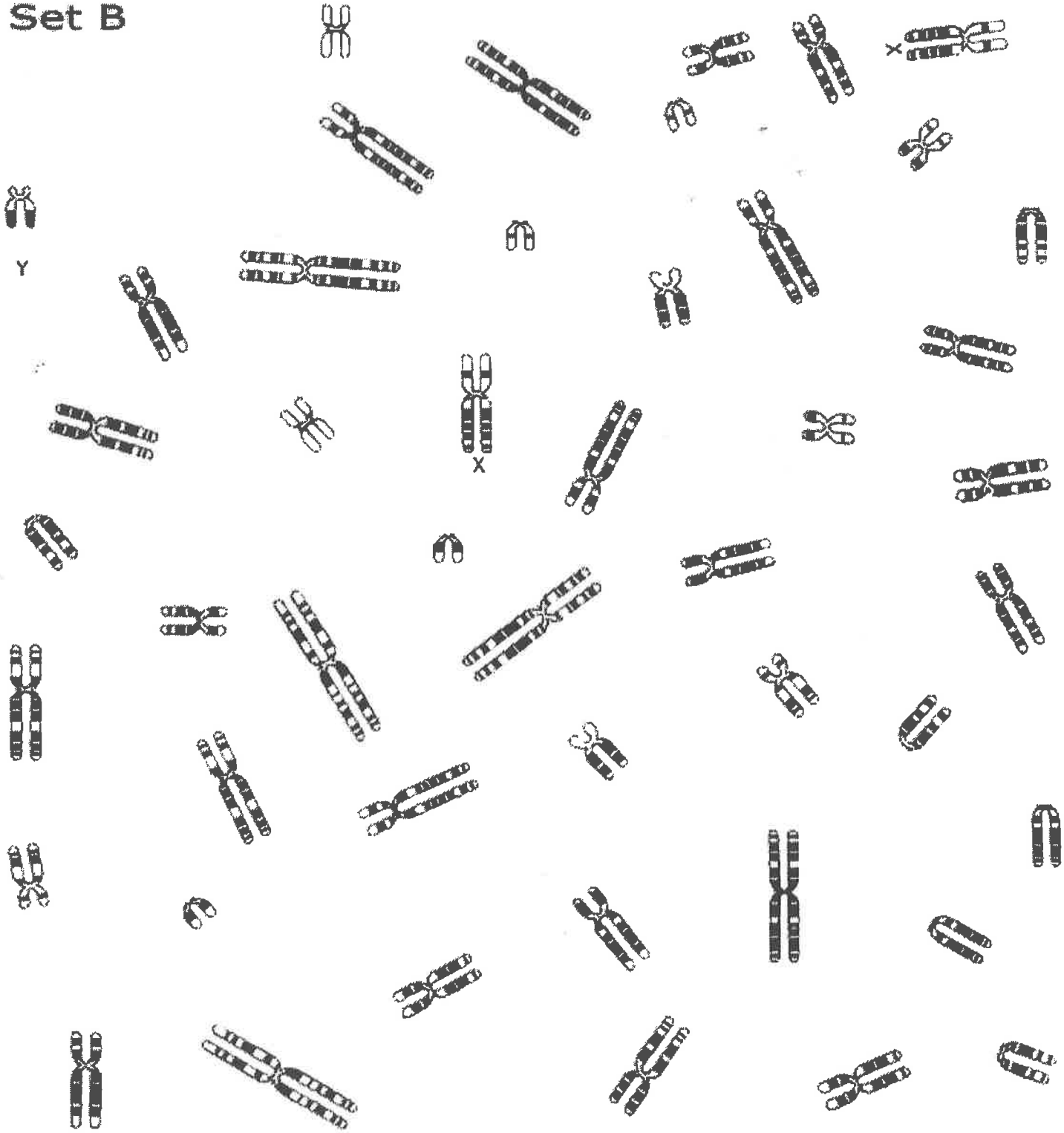
Sex of Subject XX

Diagnosis Normal Female

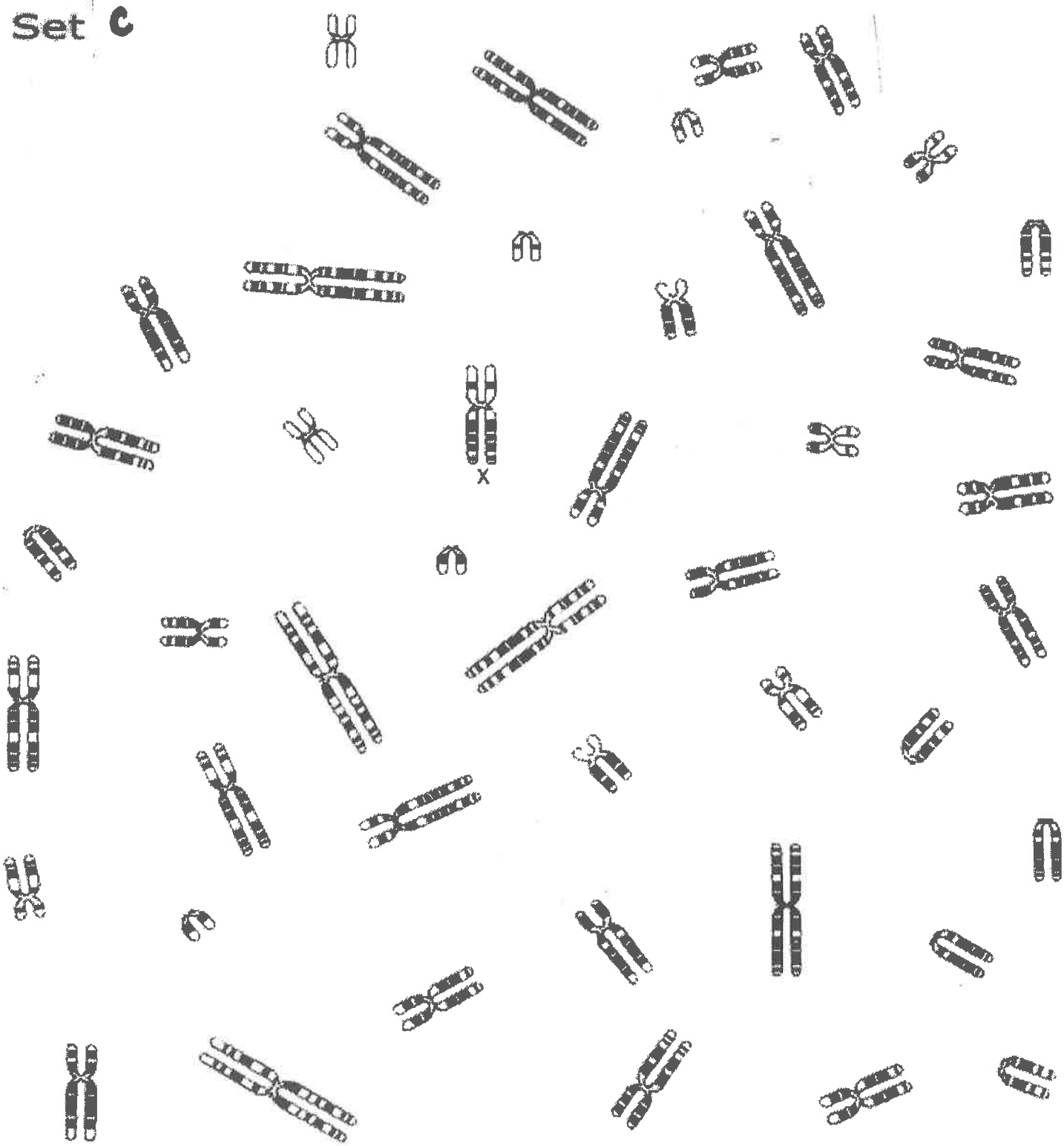
Set A



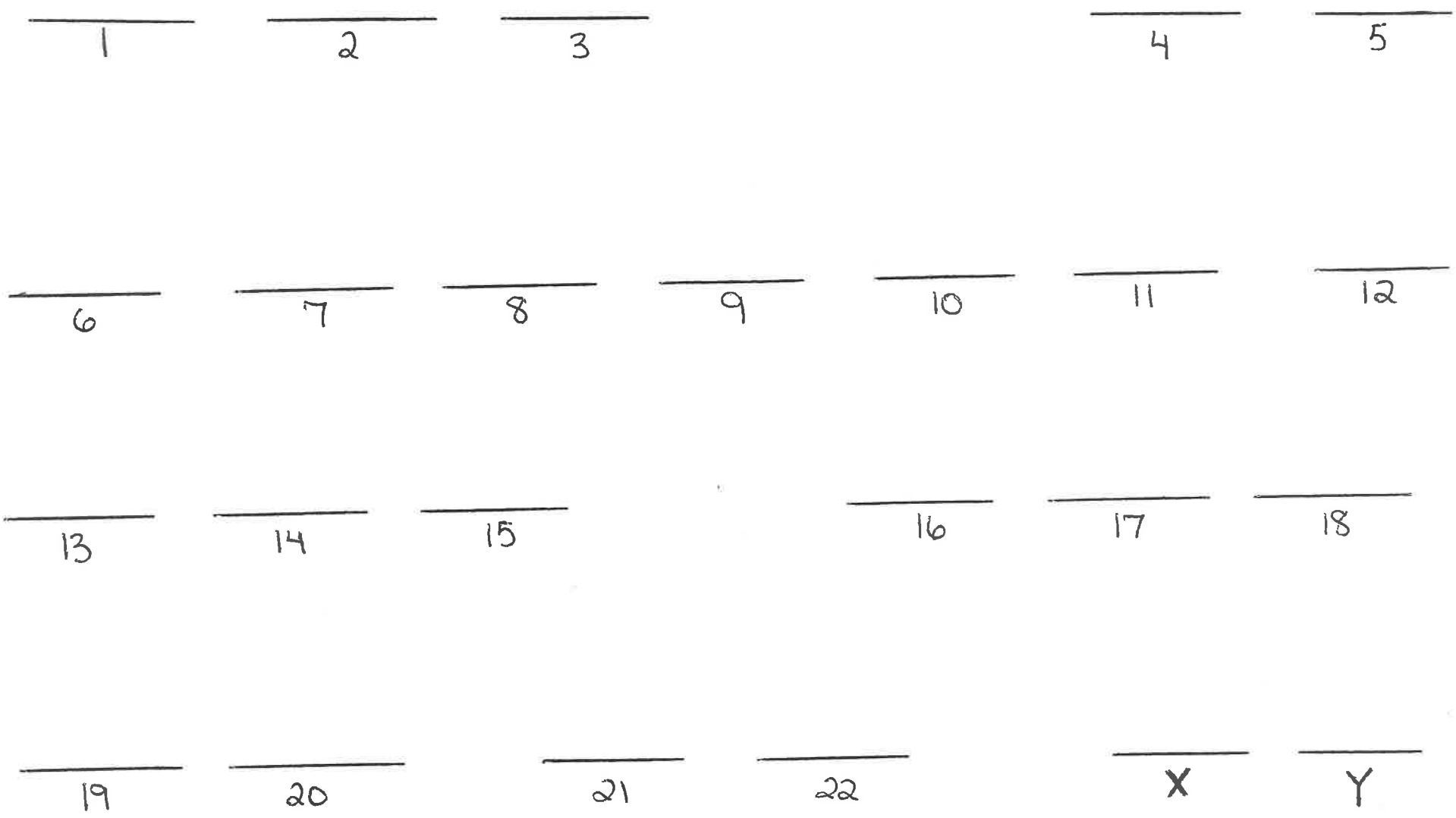
Set B



Set C



Name: _____ Karyotyping Sheet



Total Number of Chromosomes ____ Sex of Subject ____

Diagnosis _____

Set Letter ____

Name _____ Date _____

Constructing a Paper Helix Lab

Background

DNA is called the blueprint of life. It got this name because it contains the instructions for making every protein in your body. Why are proteins important? Because they are what your muscles and tissues are made of; they synthesize the pigments that color your skin, hair, and eyes; they digest your food; they make (and sometimes are) the hormones that regulate your growth; they defend you from infection. In short, proteins determine your body's form and carry out its function. DNA determines what all of these proteins will be.

The DNA molecule is a double helix. Think of it as a ladder that has been twisted into a spiral. The outside of the ladder is made up of alternating sugar and phosphate groups. The sugar is called *deoxyribose*. The rungs of the ladder are made up of nitrogen containing bases. There are four different nitrogen containing bases in DNA: *adenine*, *guanine*, *cytosine*, and *thymine*. These four bases are of two types: purines and pyrimidines. Purines are large double-ring structures. Adenine and guanine are purines. Pyrimidines are smaller ring structures. Cytosine and thymine are pyrimidines.

Inside the DNA ladder, two bases pair up to make a "rung." One base sticks out from each sugar-phosphate chain toward the inside of the ladder. It forms a pair with a base sticking out from the opposite sugar-phosphate chain. Only three rings can fit between the two sugar-phosphate chains, so a pyrimidine (one ring) and a purine (two rings) form a pair. Because of the chemical structures of the bases adenine always pairs with thymine, and cytosine always pairs with guanine.

Objectives:

In this activity you will:

1. work with a partner to construct a paper model of the DNA molecule
2. Investigate the pairing of bases in a DNA molecule

Materials:

Obtain:

- 1 sheet of 4 deoxyribose sugars
- 4 phosphate molecules
- Any 2 base pairs (4 bases)
- Scissors
- Glue / tape / stapler

Procedures:

1. 'Gather your materials and assemble a portion of a DNA molecule using the teacher's model as an example
2. Make sure your segment of DNA is lined up correctly by matching stars to stars and circles to circles
3. Tape or glue your DNA segment together
4. Complete the analysis questions on the reverse side of this page

Questions

1 What base does adenine pair with?

2 What base does guanine pair with?

3 What is the smallest unit of DNA called?

4. What is the shape of a DNA molecule?

5. Which bases are purines?

6. Which bases are pyrimidines?

7. Why must a purine pair with a pyrimidine?

8. What is the name of the sugar in the DNA backbone?

9 Suppose you know that the sequence of bases on one DNA strand is AGCTCAG What is the sequence of bases on the opposite strand?

10. Assume that a 100-base-pair DNA double helix contains 45 cytosines. How many adenines are there?

Name: _____

Lab # _____

DNA at Work: Protein Synthesis

Objective: This activity will simulate how DNA codes for the proteins an organism will produce.

Materials: 20 DNA template cards
64 tRNA anticodon cards
Paper to write on
Pen/pencil

Procedures:

1. DNA template cards will be kept on the teacher's desk at all times. After all, DNA cannot leave the nucleus.

2. Each student will be assigned a DNA sequence number. You will travel to the nucleus and copy your DNA strand sequence onto your paper.

3. You will then transcribe the DNA sequence on your paper into mRNA.

4. Then, you will return to your desk with the mRNA sequence and write out the tRNA anticodon sequence.
   Example: DNA = TAA, mRNA = AUU, tRNA = UAA

5. Next, you will walk around the room and search out the tRNA card with the correct anticodon and flip the card over revealing the word it translates to.

6. You will write down all the words in the sequence as they occur.

7. After completing the sentence, show your sentence to your teacher to find out if your DNA was coded for correctly.

8. Any mistake in translating the code could be the fault of the student but in nature is most probably the result of a mutation (mistake) in the DNA itself.

9. You will repeat this process to code for another sentence.

10. Set up your paper with the following information for each of the 3 sentences you will be assigned.

DNA card # _____
DNA Sequence: _____
mRNA Sequence: _____
tRNA Sequence: _____
Sentence it codes for: _____

ANALYSIS QUESTIONS

1. Describe the role of DNA and it's location in a cell.

2. What would happen to the protein being synthesized if one of the DNA bases were wrong? What is this event called and why is it a problem?

3. Describe the roles of mRNA and tRNA

4. Explain why protein synthesis is essential for all living things.

5. In this activity, what did the words in the sentence represent and what did the entire sentence represent?

6. Explain the process of protein synthesis. Make sure to include the following terms in your explanation: DNA, nucleus, mRNA, transcription, ribosome, codon, tRNA, anticodon, amino acid, protein, translation.

Name:

BREAKING THE CODE

A Study of Transcription and Translation

INTRODUCTION

Molecules of DNA carry genetic instructions for protein formation. Converting the DNA instructions into proteins requires a series of coordinated steps in transcription and translation. The purpose of this lab is to differentiate between transcription and translation. If codes can be determined within the DNA strand then protein molecules can be identified.

PROCEDURE:

Use the data chart below and fill in the columns based on the information provided in the upper columns.

- Convert the DNA Sequence into an mRNA codon. Use the base pairing rule for the creating of RNA A,U,G, C.
- Indicate which process is responsible for the conversion of DNA to mRNA.
- Convert the Codon into an anticodon
- Indicate the process responsible for joining the mRNA with the tRNA to create an amino acid chain.
- Utilizing the Universal Genetic Code Chart provided on the following page, determine the amino acid that is coded by each base sequence. *Remember use the mRNA codon to determine the amino acid.*

DNA Base Sequence	Process	mRNA Codon	Process	tRNA Anticodon	Amino Acid
AAT					
GGG					
ATA					
AAA					
ACA					
GCC					
GAC					
CAA					
AAA					

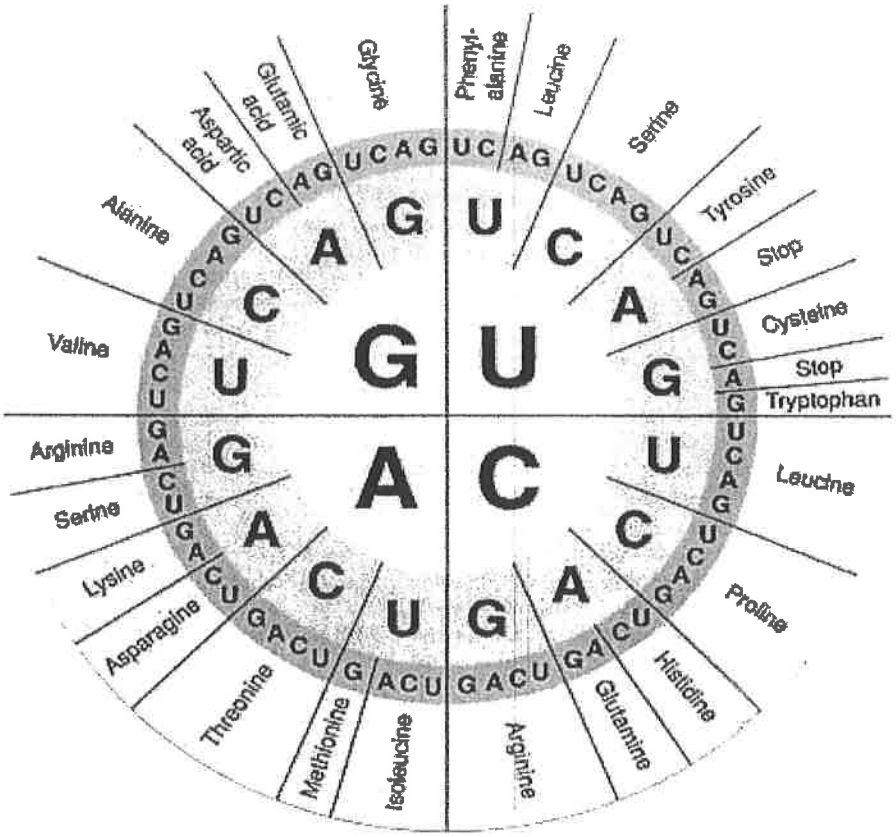
ANALYSIS QUESTIONS

1. Where is DNA located within the cell?
2. Where does transcription occur?
3. Where does translation occur?
4. What is the function of mRNA and tRNA?
5. Explain why specific base pairing rules are essential to the processes of transcription and translation?
6. What would happen if the DNA sequence AACATACCAAGGACA was changed to ATACATACCAAGGACA?
7. What is the function the mRNA sequence AUG?
8. What is the function of the mRNA sequence UGA?

The Genetic Code

(Based on Messenger RNA Codons)

First Base	Second Base U	Second Base C	Second Base A	Second Base G	Third Base
U	Phenylalanine	Serine	Tyrosine	Cysteine	U
	Phenylalanine	Serine	Tyrosine	Cysteine	C
	Leucine	Serine	Stop	Stop	A
	Leucine	Serine	Stop	Tryptophan	G
C	Leucine	Proline	Histidine	Arginine	U
	Leucine	Proline	Histidine	Arginine	C
	Leucine	Proline	Glutamine	Arginine	A
	Leucine	Proline	Glutamine	Arginine	G
A	Isoleucine	Threonine	Asparagine	Serine	U
	Isoleucine	Threonine	Asparagine	Serine	C
	Isoleucine	Threonine	Lysine	Arginine	A
	start Methionine	Threonine	Lysine	Arginine	G
G	Valine	Alanine	Aspartic acid	Glycine	U
	Valine	Alanine	Aspartic acid	Glycine	C
	Valine	Alanine	Glutamic acid	Glycine	A
	Valine	Alanine	Glutamic acid	Glycine	G



28–1 How Does DNA Make Protein?

DNA directs your cells to make certain proteins. How does DNA make proteins? DNA is a model for making a molecule called messenger RNA (mRNA). Messenger RNA is much like DNA. RNA is made of substances, called nitrogen bases, that must match up with the nitrogen bases in DNA. These nitrogen bases will only match up in certain ways. The production of mRNA occurs in the nucleus.

After it is formed, mRNA leaves the nucleus and attaches to a ribosome in the cytoplasm of the cell. Other RNA molecules, called transfer RNA (tRNA), bring protein parts to the mRNA on the ribosome. The two types of RNA molecules match up, join protein parts together, and make a protein. Figure 1 shows the steps involved in making a protein. DNA determines what proteins are produced.

INTERPRETATION

OBJECTIVES

In this exercise, you will:

a. use models to show how DNA makes mRNA.
b. use models to show how mRNA leaves the nucleus and causes tRNA to make proteins.

MATERIALS

scissors
colored pencils: red, blue and green

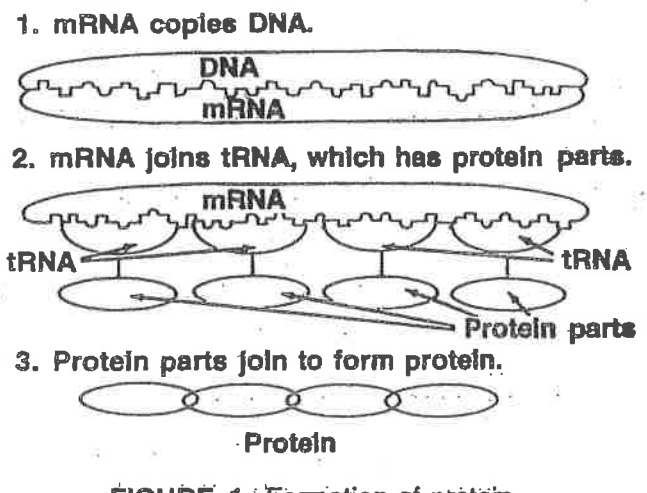


FIGURE 1. Formation of protein

PROCEDURE

1. Examine Figure 2, a model of a DNA molecule. DNA has two main sides. These sides are often compared with the upright sides of a ladder. The squares in the model represent sugar molecules. The nitrogen bases A, C, G, and T join to connect the two sides.
2. Cut out the two sides of the DNA model in Figure 2.
3. Color the two sides red.
4. Put the two sides together so that they fit together like the pieces of a puzzle. Note that nitrogen base A only binds with T and base G only with C.
5. Examine Figure 5, a model of a cell. The nucleus is in the upper left corner. Place the model of DNA in the nucleus. DNA carries the code for making cell proteins. That code is the order in which the nitrogen bases appear.
6. Cut out the model of the mRNA molecule in Figure 3. This molecule has only one side.
7. Color this model blue. Observe that the sugar in the mRNA molecule is different from the sugar in DNA. Also, the nitrogen base U is present instead of T.
8. Open the two sides of the DNA model.
9. Place the mRNA molecule along one side of the DNA model. Note that its bases will fit only one side of the DNA. In an actual cell, the mRNA is assembled from small molecules to fit exactly along one side of the DNA. The nitrogen bases can only fit certain other bases because of their shape. mRNA copies the code of DNA.

10. Move the mRNA molecule out of the nucleus to the cytoplasm by following the dotted line as a path. This shows that mRNA carries the code of the DNA to the ribosomes.
11. Move the mRNA to the cell part called the ribosome. Place it on the dashed lines at the ribosome.
12. Put the DNA model sides back together.
13. Cut out the three tRNA molecules shown in Figure 4. Using a green pencil, color only the lower parts (that contain the letters A, U, C, and G). This type of RNA is different from mRNA in two ways. First, each tRNA molecule has only three nitrogen bases and second, a certain protein part is attached to it. Transfer RNA is found in the cytoplasm of the cell. The top of each tRNA has a specific protein part attached to it.
14. Fit the tRNA molecules to the mRNA molecule again, so the bases fit together tightly. Observe which bases of tRNA bind with which bases of mRNA (A with U, G with C).
15. With the tRNA molecules in place on the mRNA molecule, the protein parts can now join with each other. The linked protein parts carried by the tRNA make a chain. This chain separates from the tRNA molecules and leaves the ribosome to become a protein. The code of the DNA molecule directs certain steps in a cell for the process of forming a certain protein.

QUESTIONS

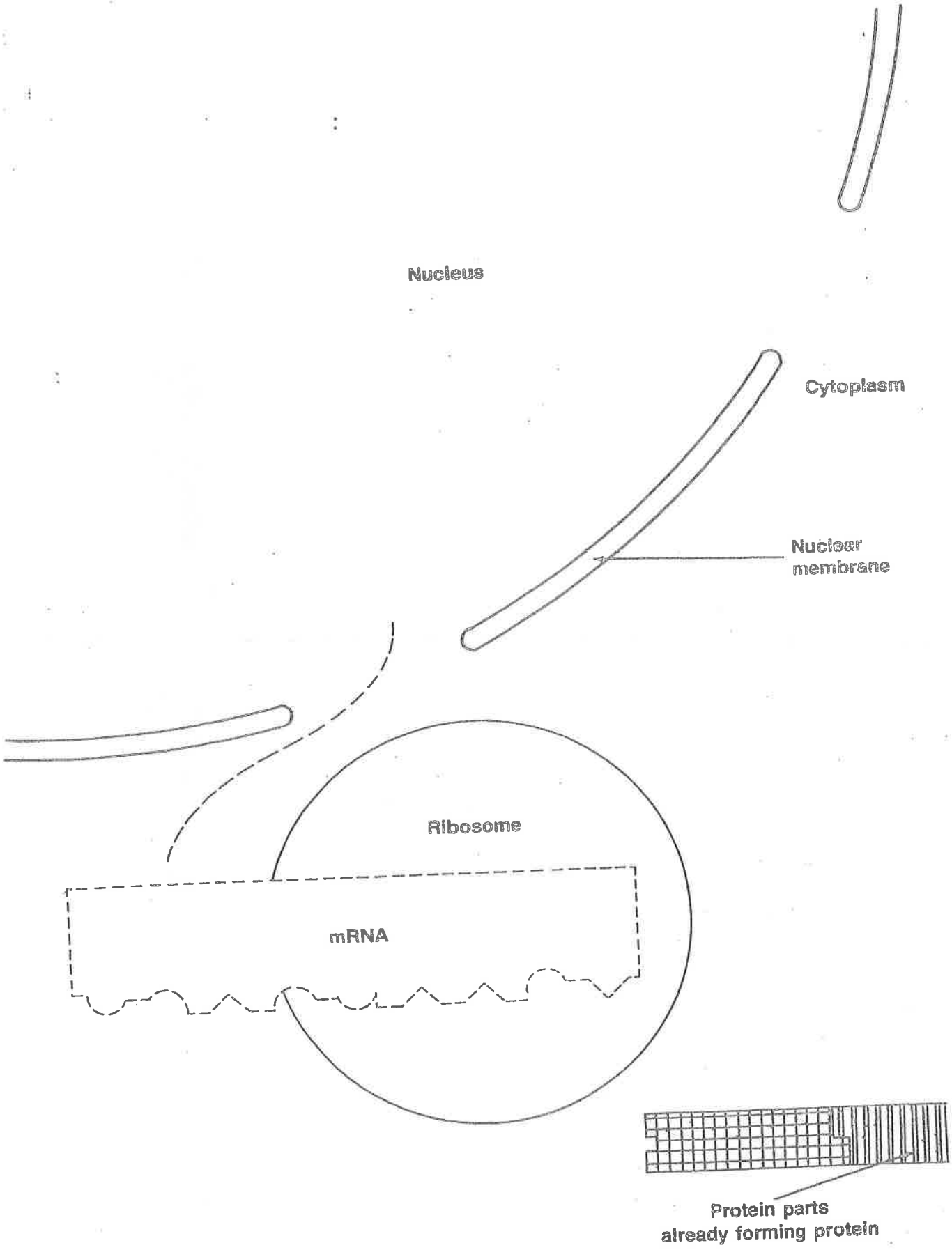
1. What do the letters DNA stand for?_____
2. In DNA, what nitrogen base always binds with A? _____ G? _____
3. How is mRNA different from DNA?_____

   _____
4. In mRNA, what nitrogen base binds with the DNA base

   A? _____ G? _____ T? _____
5. Where in the cell is mRNA made?_____
6. To what cell part does mRNA attach?_____
7. What carries the protein parts to the ribosome and the mRNA?_____
8. How are mRNA and tRNA alike?_____

   _____
9. What does tRNA have that mRNA does not have?_____
10. Where in the cell are proteins made?_____
11. What determines which proteins are produced?_____

FIGURE 5. Model of a cell



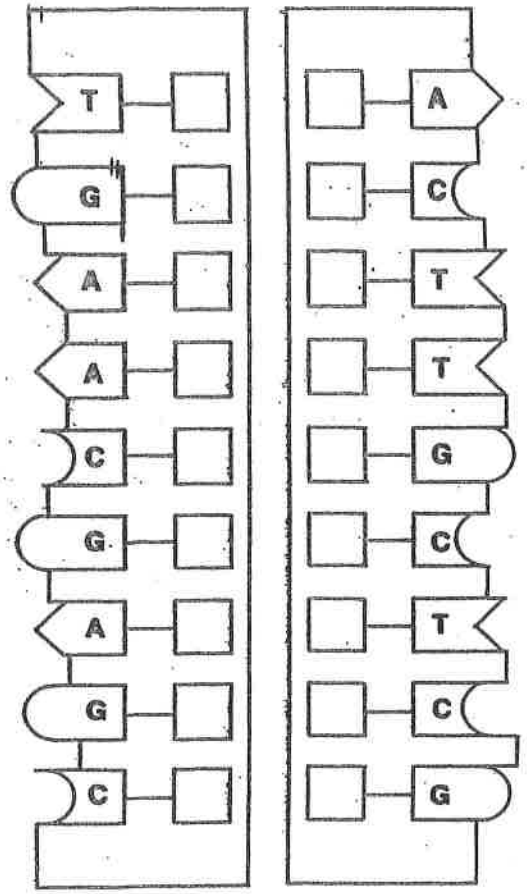


FIGURE 2. DNA molecule

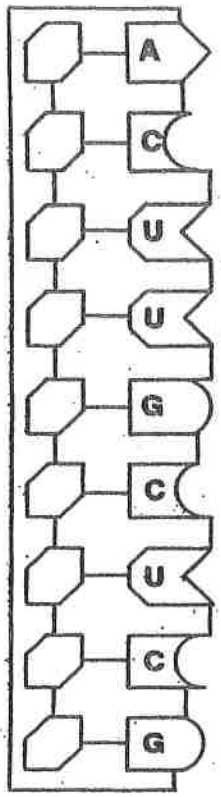


FIGURE 3. Messenger RNA

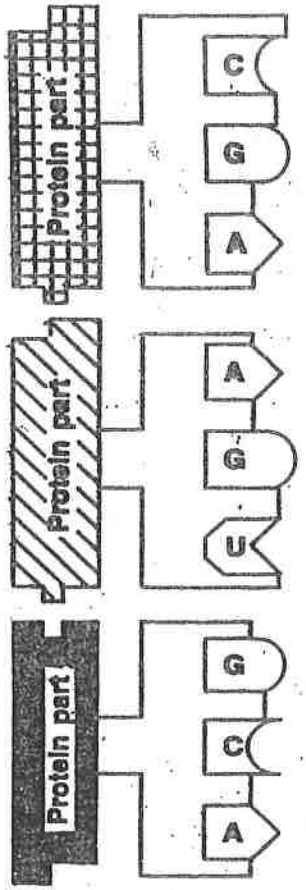


FIGURE 4. Transfer RNA

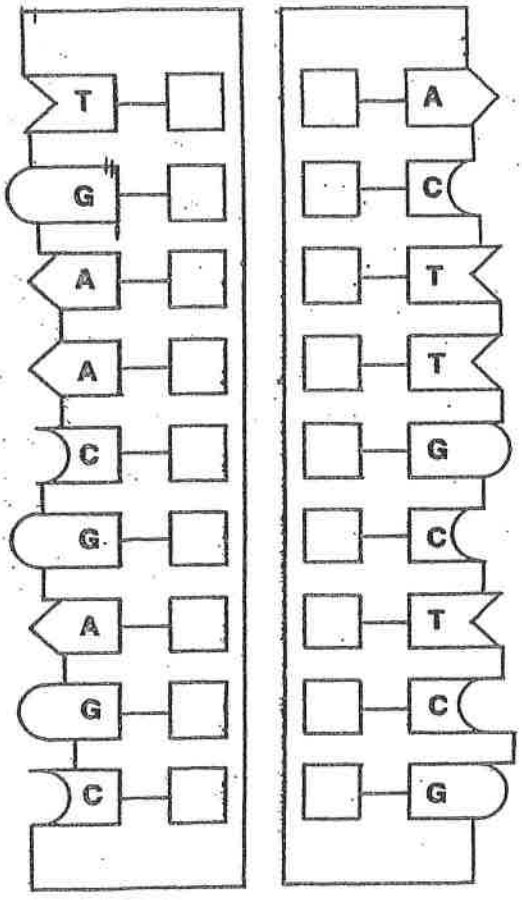


FIGURE 2. DNA molecule

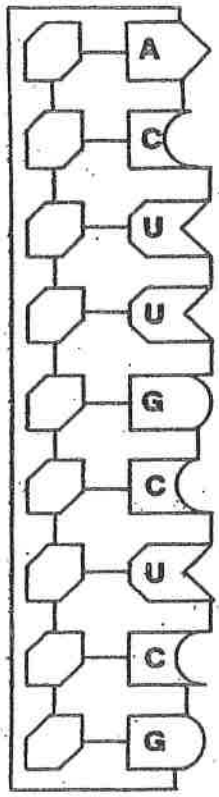


FIGURE 3. Messenger RNA

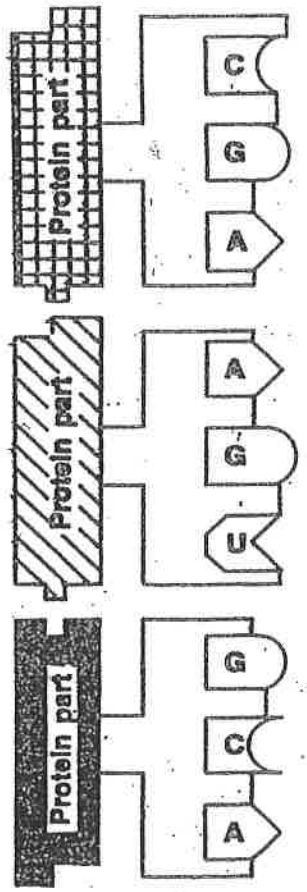


FIGURE 4. Transfer RNA

Name:

RECOMBINANT DNA

A STUDY OF BIOTECHNOLOGY

INTRODUCTION:

Deoxyribonucleic acid, or DNA, is the blueprint for life. Inside every cell in your body, DNA contains the code that determines who you are and what traits you have. Recombinant DNA is DNA from two different sources that has been combined in vitro (outside living organisms). There are three main reasons for creating recombinant DNA: (i) to create a protein product, (ii) to create multiple copies of genes, and (iii) to insert foreign genes into other organisms to give those organisms a new trait.

Recombinant DNA is used widely today to create large amounts of protein for treating certain illnesses. In 1982, insulin became the first recombinant DNA drug to hit the market (NHGRI, 2003). A person with diabetes does not produce adequate insulin. Insulin, a protein, can now be produced in large quantities by bacteria that have been given the human insulin gene (Hormones, n.d.; Stanford University, 2002; G. Stein & J. Stein, 2002). Another example of a protein that is made by bacteria for medical use is human growth hormone (Hanna, 2004; G. Stein & J. Stein, 2002).

The creation of multiple copies of a gene is valuable for genetic research. The availability of multiple copies of a gene has many advantages including the determination of the nucleotide sequence of a gene.

Inserting genes that originated in one organism into another organism is proving indispensable in agriculture and other fields. In agriculture, adding genes to plants to make them draught or insect resistant is already common practice. Another use is the creation of bacteria that will help clean up toxic waste. A bacteria has been created using recombinant technology that can digest oil from an oil spill.

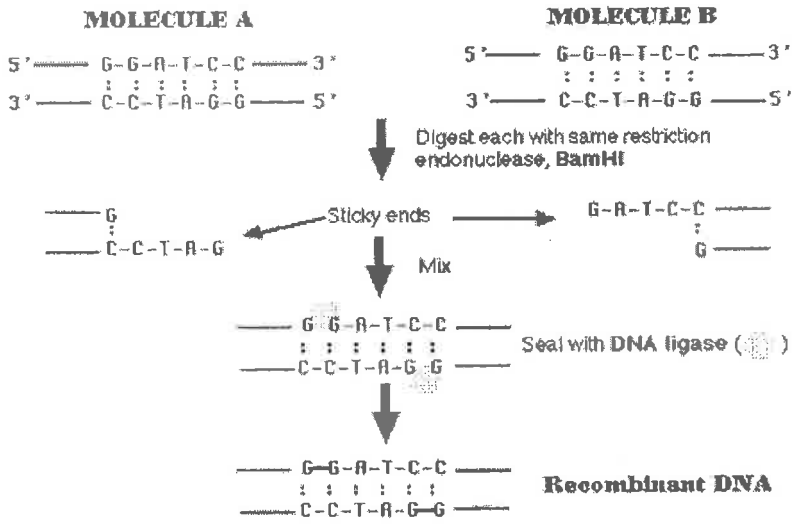
Here is an overview of how a gene from an organism can be inserted into a bacterium. First, the gene of interest must be identified. For example, the insulin gene would have to be localized in the human genome. Then a plasmid has to be isolated from bacteria cells. A plasmid is a circular, double-stranded DNA sequence that replicates in bacteria and is separate from the bacterial chromosome. The gene is inserted into the plasmid, and the plasmid is taken up by a bacterium. The bacteria reproduce, and start creating the desired protein (Campbell & Reece, 2002).

Restriction enzymes, discovered in 1968, are important parts of this process (NHGRI, 2003). In nature, restriction enzymes are a bacterium's self-defense. A restriction enzyme cuts in between a certain sequence of nucleotides, called the restriction sight, which is 4-8 nucleotides long. Every time that sequence occurs in the bacterium's own DNA, methyl groups (-CH3) are added to adenines or cytosines which prevent the restriction enzyme from working. Any time foreign DNA, such as a phage (a bacterial virus), enters the bacterium, the bacterium's restriction enzyme would cut the phage's DNA into pieces. Although not all bacteria have restriction enzymes, there are wide varieties of restriction enzymes that have been discovered and continue to be discovered (Campbell & Reece, 2002).

Restriction enzymes are used to cut open a plasmid and the same enzyme is used to cut the desired gene out of the chromosome. This makes two matching cuts, and when the gene and plasmid are combined, they form a temporary bond. Another enzyme, DNA ligase, is used to create a permanent seal (Campbell & Reece, 2002).

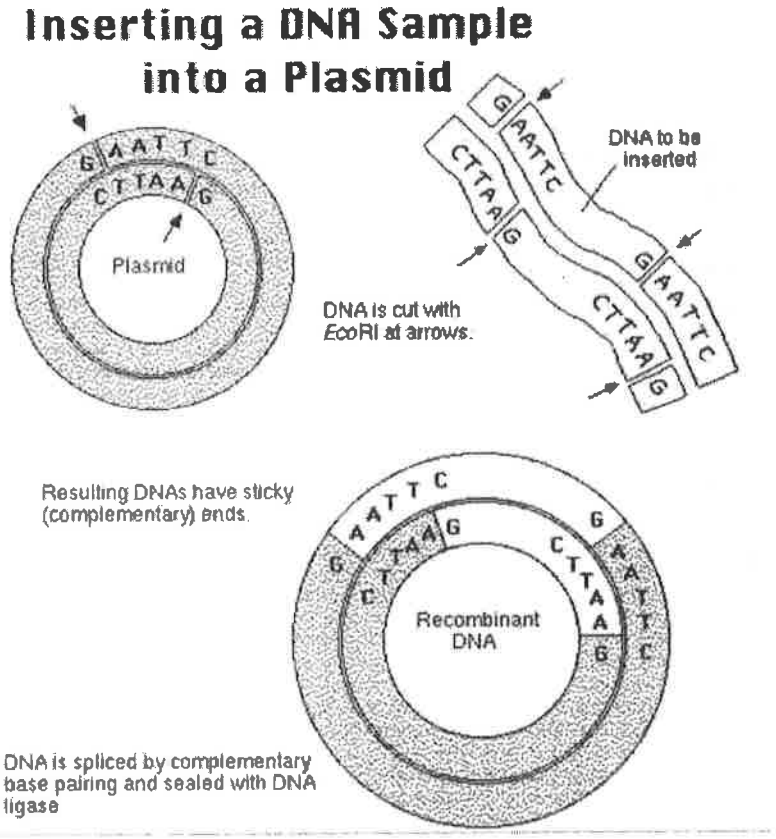
PROCEDURE

1. Using the diagrams on the following page, cut out the bacterial plasmid and the gene for human insulin.
2. Find the base Sequence AATT. Cut out the strand of DNA at the base sequence AATT. This represents the sticky ends for gene splicing.
3. Find the base sequence TTAA in the bacterial plasmid and cut out the complimentary AATT strand.
4. Combine the gene for Human Insulin with the bacterial plasmid.
5. Do not lose your recombinant DNA strand! You will have to staple your recombinant DNA to the back page of your lab report!



ANALYSIS QUESTIONS

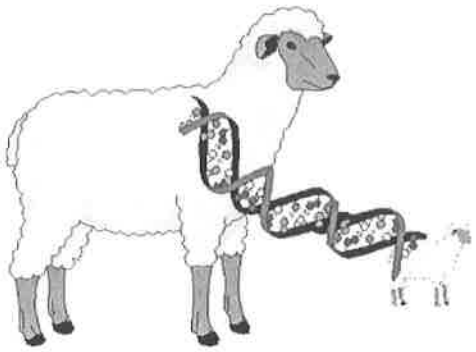
1. What is recombinant DNA?
2. What is recombinant DNA technology used for?
3. What kind of molecule is responsible for cutting the DNA to join the two organisms DNA together?
4. How does this molecule work? Your answer must include a discussion of restriction sites, bacterial DNA and Human DNA?
5. Why is bacteria used to produce the human gene?



Name: _____

Lab # _____

Web Lesson: Cloning in Focus
Genetic Science Learning Center



Directions: Go to the website http://gslc.genetics.utah.edu
- scroll down to the bottom to click on the cloning link
- from this cloning home page you will find links to all of the subheadings on this lab

On the cloning home page, click the link called **What is Cloning?**

Read all of the information on the page and answer the questions in your own words.

1. Describe the process of Somatic Cell Nuclear Transfer (SCNT).
2. How does SCNT differ from the natural way of making an embryo?

On the cloning home page, click the link called **Click and Clone**

3. List all the components needed to clone a mouse.

4. List the following steps in the correct sequential order.

   Stimulate cell division
   Deliver baby
   Remove and discard the nucleus from the egg cell
   Isolate donor cells from egg donor and germ cell donor
   Transfer the somatic cell nucleus into the egg cell
   Implant embryo into a surrogate mother

5. What do the 2 time gaps represent?

6. In this cloning process, what color would the cloned mouse be and why?

On the cloning home page, click on the link called **Why Clone?**

7. Describe 3 ways how cloning can be used for medical purposes

On the cloning home page, click on the link called **Cloning Myths**

8. Describe the 2 main misconceptions regarding cloning.

On the cloning home page, click on the link called **What Are the Risks of Cloning?**

9. What are a few reasons why cloning animals has such a high failure rate?

10. What is a telomere and how does it affect cloned animals? (look at the right margin of this page)

On the cloning home page, click on the link called **What Are Some Issues in Cloning?**

11. Share your comments on some of the "questions to ponder" that are listed.