DESIGNER GENES
SAMPLE TOURNAMENT

PART ONE- GENETICS PROBLEMS

In dogs, the inheritance of hair color involves a gene **(B) for black hair** and a gene **(b) for brown hair**. A **dominant (C)** is also involved. It must be present for the color to be synthesized (made). If this gene is NOT present, a **blond** condition results.

Genotype	Color Deposition gene	Phenotype
BB or Bb	**CC or Cc**	
bb	**CC or Cc**	
BB or Bb	**cc**	
bb	**cc**	

For the **two** given **genotypes**, **list** the **phenotype**. Be sure to list them in the **same order.**

1. **bbCC** **Bbcc**
2. **BBcc** **BbCC**
3. **BbCC** **BBCc**
4. **Bbcc** **bbCc**
5. **BBCC** **bbcc**

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I In dogs, the inheritance of hair color involves a gene **(B) for black hair** and a gene **(b) for brown hair**. A **dominant (C)** is also involved. It must be present for the color to be synthesized (made). If this gene is NOT present, a **blond** condition results.

Genotype	Color Deposition gene	Phenotype
BB or Bb	**CC or Cc**	
bb	**CC or Cc**	
BB or Bb	**cc**	
bb	**cc**	

For the **two** given **genotypes**, **list** the **phenotype**. Be sure to list them in the **same order.**

1.	**bbCC**	**Bbcc**	**brown**	**blond**
2.	**BBcc**	**BbCC**	**blond**	**black**
3.	**BbCC**	**BBCc**	**black**	**black**
4.	**Bbcc**	**bbCc**	**blond**	**brown**
5.	**BBCC**	**bbcc**	**black**	**blond**

Examine the **TRIHYBRID PUNNETT SQUARE.**

Use the Gene Symbols from the **Trihybrid Punnett Square** when answering the questions.

triple-het x triple-het cross

SsYyAa x SsYyAa

	SYA	SYa	SyA	Sya	sYA	sYa	syA	sya
SYA	SSYYAA	SSYYAa	SSYyAA	SSYyAa	SsYYAA	SsYYAa	SsYyAA	SsYyAa
SYa	SSYYaA	SSYYaa	SSYyaA	SSYyaa	SsYYaA	SsYYaa	SsYyAa	SsYyaa
SyA	SSyYAA	SSyYAa	SSyyAA	SSyyAa	SsyYAA	SsyYAa	SsyyAA	SsyyAa
Sya	SSyYaA	SSyYaa	SSyyaA	SSyyaa	SsyYaA	SsyYaa	SsyyaA	Ssyyaa
sYA	sSYYAA	sSYYAa	sSYyAA	sSYyAa	ssYYAA	ssYYAa	ssYyAA	ssYyAa
sYa	sSYYaA	sSYYaa	sSYyaA	sSYyaa	ssYYaA	ssYYaa	ssYyaA	ssYyaa
syA	sSyYAA	sSyYAa	sSyyAA	sSyyAa	ssyYAA	ssyYAa	ssyyAA	ssyyAa
sya	sSyYaA	sSyYaa	sSyyaA	sSyyaa	ssyYaA	ssyYaa	ssyyaA	ssyyaa

Phenotypes:
Out of 64 births.

- normal
- albinos
- anerythristic
- striped
- snow
- striped-albino
- striped-anery
- striped-snow

6. How many animals have **normal** color? What genes must be present for it to be **normal**?

7. How many animals have **stripped** color? What genes must be present for it to be **stripped**?

8. How many animals are **snow**? What genes must be present for it to be **snow**?

9. How many animals are **stripped snow**? What genes must be present for it to be **stripped snow**?

10. What is the phenotype ratio for this trihybrid cross?

Examine the **TRIHYBRID PUNNETT SQUARE.**

Use the Gene Symbols from the **Trihybrid Punnett Square** when answering the questions.

triple-het x triple-het cross

SsYyAa x SsYyAa

	SYA	SYa	SyA	Sya	sYA	sYa	syA	sya
SYA	SSYYAA	SSYYAa	SSYyAA	SSYyAa	SsYYAA	SsYYAa	SsYyAA	SsYyAa
SYa	SSYYaA	SSYYaa	SSYyaA	SSYyaa	SsYYaA	SsYYaa	SsYyAa	SsYyaa
SyA	SSyYAA	SSyYAa	SSyyAA	SSyyAa	SsyYAA	SsyYAa	SsyyAA	SsyyAa
Sya	SSyYaA	SSyYaa	SSyyaA	SSyyaa	SsyYaA	SsyYaa	SsyyaA	Ssyyaa
sYA	sSYYAA	sSYYAa	sSYyAA	sSYyAa	ssYYAA	ssYYAa	ssYyAA	ssYyAa
sYa	sSYYaA	sSYYaa	sSYyaA	sSYyaa	ssYYaA	ssYYaa	ssYyaA	ssYyaa
syA	sSyYAA	sSyYAa	sSyyAA	sSyyAa	ssyYAA	ssyYAa	ssyyAA	ssyyAa
sya	sSyYaA	sSyYaa	sSyyaA	sSyyaa	ssyYaA	ssyYaa	ssyyaA	ssyyaa

Phenotypes:
Out of 64 births.

- normal
- albinos
- anerythristic
- striped
- snow
- striped-albino
- striped-anery
- striped-snow

6. How many animals have **normal** color? What genes must be present for it to be **normal**? **27** **SYA**

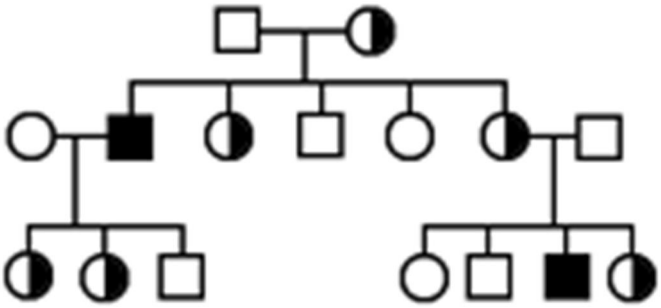
7. How many animals have **stripped** color? What genes must be present for it to be **stripped**? **9** **ssYA**

8. How many animals are **snow**? What genes must be present for it to be **snow**? **3** **Syyaa**

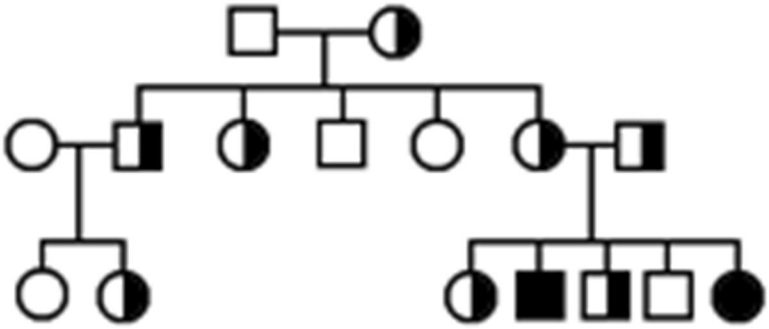
9. How many animals are **stripped snow**? What genes must be present for it to be **stripped snow**? **1** **ssyyaa**

10. What is the phenotype ratio for this trihybrid cross? **27:9:9:9:3:3:3:1**

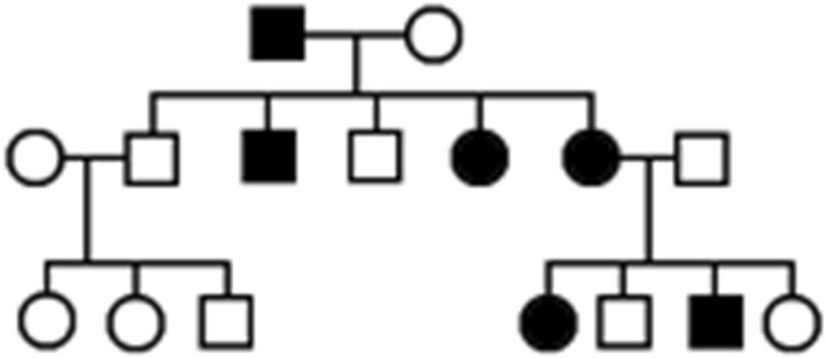
PEDIGREE 1



PEDIGREE 2



PEDIGREE 3



Examine **PEDIGREES 1-3** and answer the following questions

The shaded symbol represents the affected individuals. Half shaded are carriers

Assume that all couples are legally married. Use **D** for the dominant gene and **d** for the recessive gene. If the trait involves sex-linkage also use the **X** and **Y** chromosome symbols.

11. Which pedigree represents a trait that is **autosomal recessive**?

12. Which pedigree represents a trait that is **autosomal dominant**?

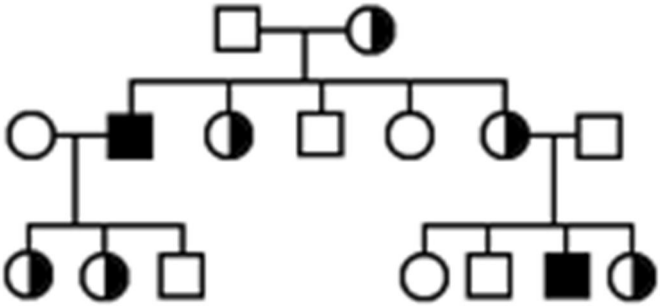
13. Which pedigree represents a trait that is **sex-linked recessive**?

14. What would be the genotype for a **carrier** of an **autosomal dominant** trait?

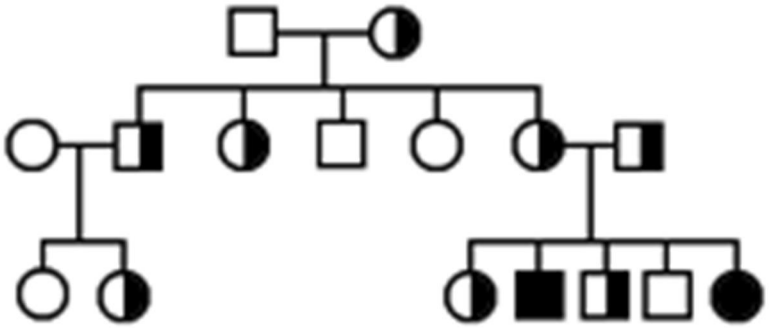
15. What would be the genotype of a **carrier** of an **autosomal recessive** trait?

What would be the phenotype of this individual? (**dominant or recessive**)

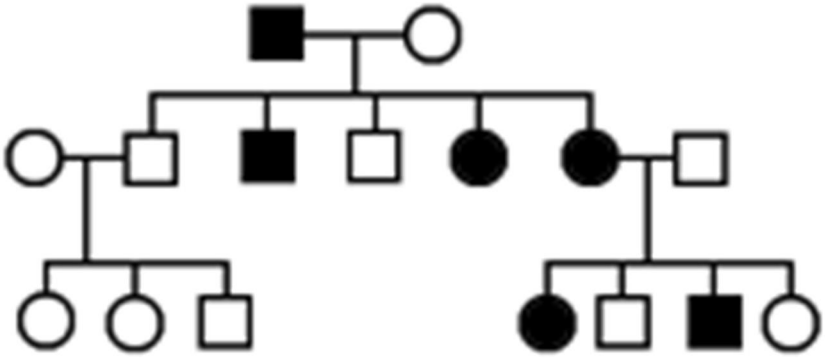
PEDIGREE 1



PEDIGREE 2



PEDIGREE 3



Examine **PEDIGREES 1-3** and answer the following questions

The shaded symbol represents the affected individuals. Half shaded are carriers

Assume that all couples are legally married. Use **D** for the dominant gene and **d** for the recessive gene. If the trait involves sex-linkage also use the **X** and **Y** chromosome symbols.

11. Which pedigree represents a trait that is **autosomal recessive**? **Pedigree 2**

12. Which pedigree represents a trait that is **autosomal dominant**? **Pedigree 3**

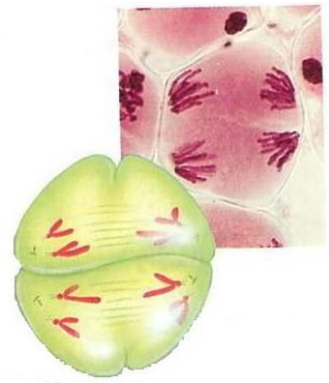
13. Which pedigree represents a trait that is **sex-linked recessive**? **Pedigree 1**

14. What would be the genotype for a **carrier** of an **autosomal dominant** trait? **There are none**

15. What would be the genotype of a **carrier** of an **autosomal recessive** trait? **Dd**

What would be the phenotype of this individual? (**dominant or recessive**)

PART TWO - MITOSIS AND MEIOSIS



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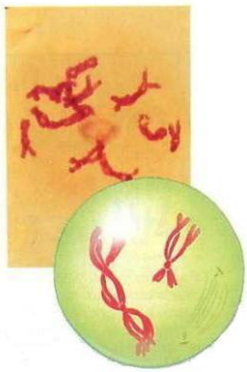

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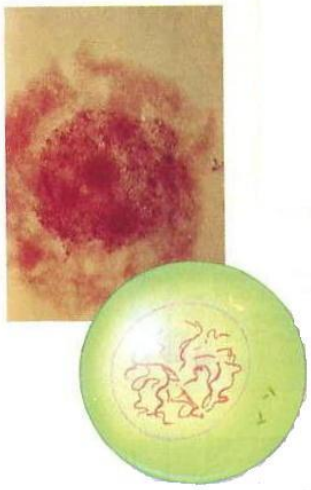

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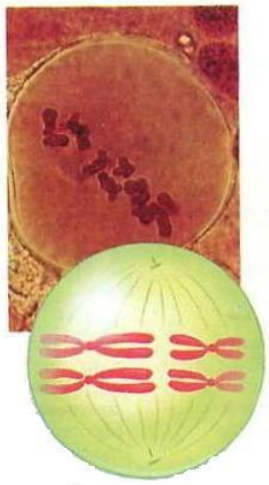

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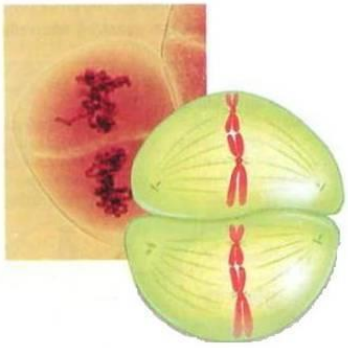
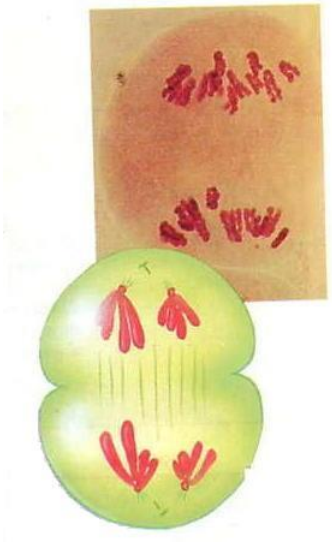


F.

PART TWO - MITOSIS AND MEIOSIS



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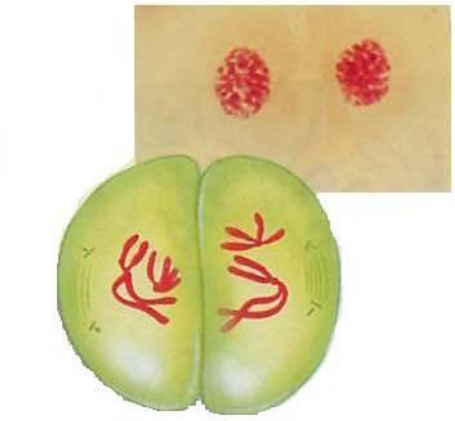
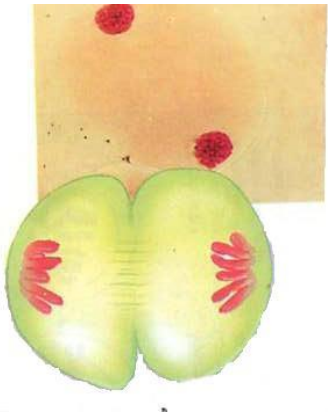
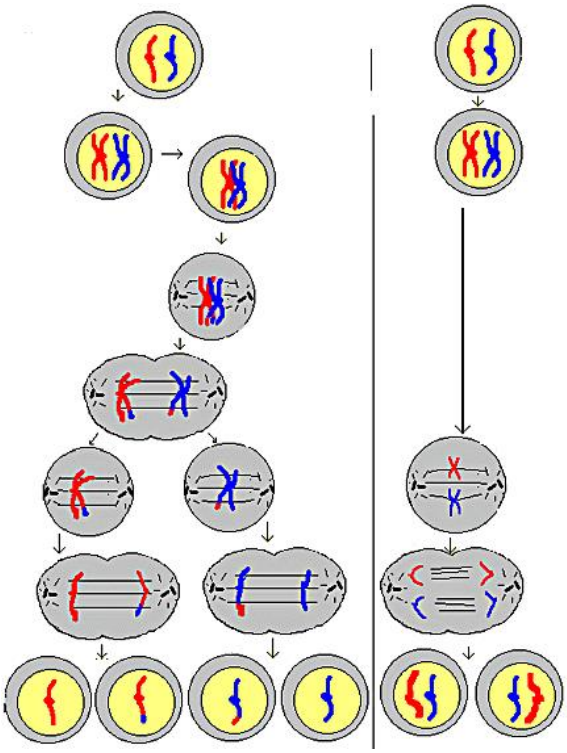


H.



I.



J.

PART TWO- MITOSIS AND MEIOSIS

Examine Diagrams A-J and use them when answering the questions.

1. Examine Diagram J. What processes are illustrated here?

2. How many divisions are present in the entire diagram?

3. What is Diagram A?

4. What is Diagram B?

5. What is Diagram C?

6. What is Diagram D?

7. What is Diagram E?

8. What is Diagram F?

9. What is Diagram G?

10. What is Diagram H?

11. What is Diagram I?

12. What process is being shown in Diagrams (A-I)

13. In which Diagram (A-I) would the four chromatids from a pair of chromosomes twist together to form a group of four?

14. Which phase is this?

15. What is the process called that causes the four chromosomes to twist together?

16. What is the group of 4 called?

17. In Diagram D, what is the process called that is splitting the cytoplasm to form the 4 cells?

18. At the end of what phase does this occur?

19-20. Examine Diagram J. Notice that there are pieces of the blue and red chromatids that have switched chromatids. What is this called and during what phase did it occur?

PART TWO- MITOSIS AND MEIOSIS

Examine Diagrams A-J and use them when answering the questions.

1. Examine Diagram J. What processes are illustrated here?
Mitosis and Meiosis

2. How many divisions are present in the entire diagram? **3 (1 mitosis and 2 meiosis)**

3. What is Diagram A? **anaphase II**

4. What is Diagram B? **prophase I**

5. What is Diagram C? **interphase I**

6. What is Diagram D? **telophase II**

7. What is Diagram E? **metaphase I**

8. What is Diagram F? **metaphase II**

9. What is Diagram G? **anaphase I**

10. What is Diagram H? **prophase II**

11. What is Diagram I? **telophase I**

12. What process is being shown in Diagrams (A-I) **meiosis**

13. In which Diagram (A-I) would the four chromatids from a pair of chromosomes twist together to form a group of four? **B**

14. Which phase is this? **prophase I**

15. What is the process called that causes the four chromosomes to twist together?

16. What is the group of 4 called? **synapsis** **tetrad**

17. In Diagram D, what is the process called that is splitting the cytoplasm to form the 4 cells?
Cytokinesis

18. At the end of what phase does this occur?
telophase

19-20. Examine Diagram J. Notice that there are pieces of the blue and red chromatids that have switched chromatids. What is this called and during what phase did it occur?
Crossing over **Prophase I**

PART 3-MOLECULAR GENETICS

DNA and RNA

List the three differences between DNA and RNA (1-3)

1.

2.

3.

M-RNA modification

4. What is the difference between exons and introns?

5. What happens to the M-RNA before it leaves the nucleus?

Types of RNA

6. What is the function of m-RNA?

7. What is the function of t-RNA?

8. What is the function of the r-RNA?

9. Name the two processes that make up gene expression?

10. Describe the difference between transcription and translation?

PART 3-MOLECULAR GENETICS

DNA and RNA

List the three differences between DNA and RNA (1-3)

1.. DNA is double strand and RNA is single strand (# 1-3 in any order)

2. DNA has deoxyribose as its sugar while RNA has ribose

3. DNA has thymine and RNA has Uracil

M-RNA modification

4. What is the difference between exons and introns?
Exons are coding template for M RNA and non coding Interons sections between the exons

5. What happens to the M-RNA before it leaves the nucleus?
It is modified by removing the introns, adding a cap to 5' end and a poly A tail to the 3' end

Types of RNA

6. What is the function of m-RNA?

Carries blueprint into the cytoplasm and serves as the template for protein synthesis

7. What is the function of t-RNA?
Transfers amino acids and attaches to mRNA template at correct position to attach amino acid

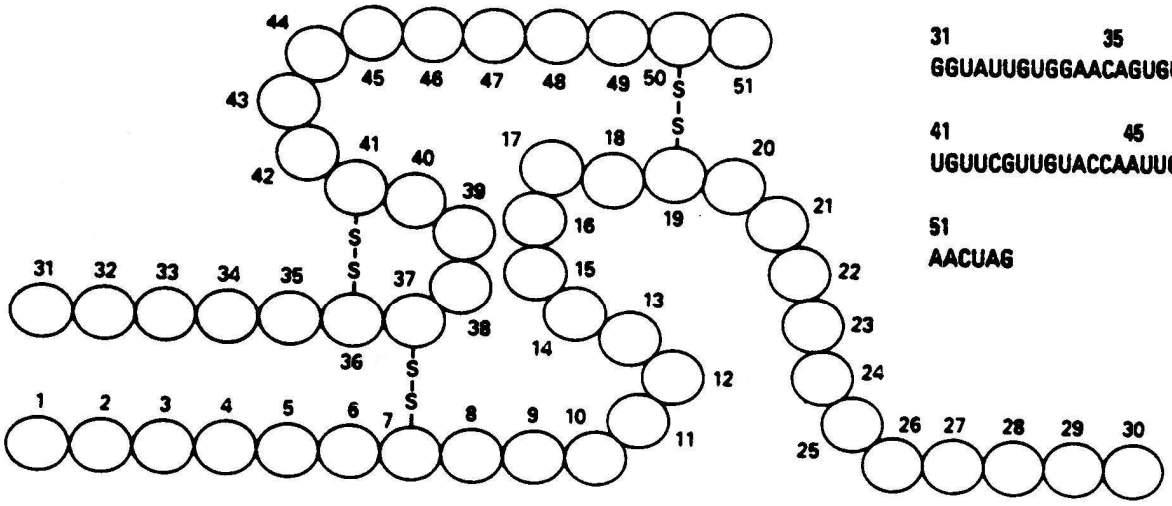
8. What is the function of the r-RNA?
Major component of ribosome which allows mRNA and tRNA to connect so amino acids can connect.

9. Name the two processes that make up gene expression?
Transcription and Translation

10. Describe the difference between transcription and translation?

Transcription produces RNA and Translation builds peptides for proteins (protein synthesis)

Examine the diagram and use the universal code in answering the following questions.



```
1                5                10
UUUGUCAAUCAGCAUCUGUGUGGGAGUCAC

11               15               20
CUAGUCCAGGCCCUAUAUUUGGUUUGCGGC

21               25               30
GAGAGAGGGUUCUUUUACUACCCCAAAGCA

31               35               40
GGUAUUGUGGAACAGUGUUGUCGUUCUGUU

41               45               50
UGUUCGUUGUACCAAUUGGAGAAUUAUUGU

51
AACUAG
```

11. How many nucleotides are in this section of M-RNA?

12. How many codon are present along this section of M-RNA?

13. Which codon should precede codon number 1 as the start codon ?

14. Which amino acid is # 40 ?

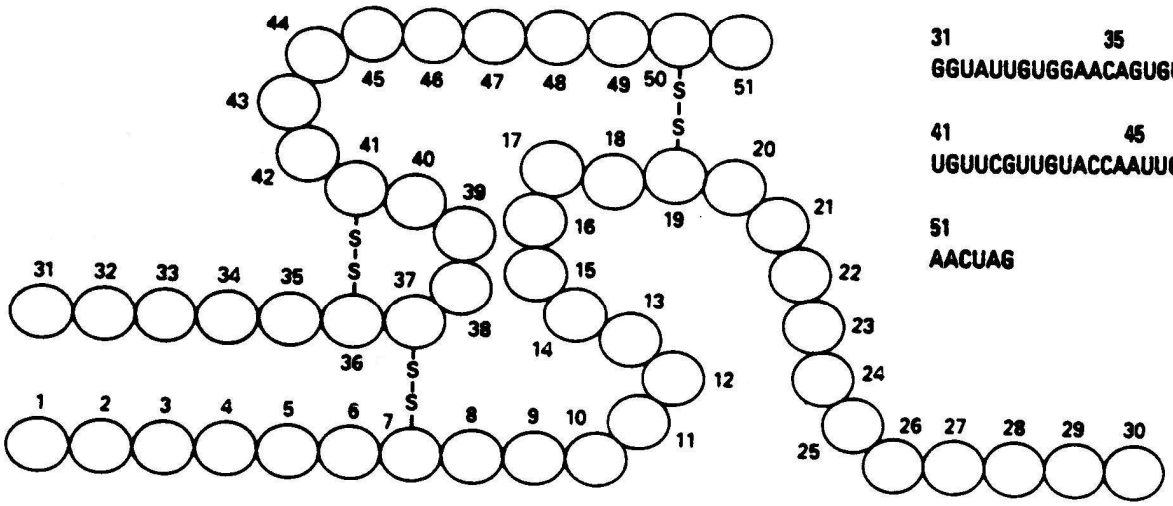
15. Why is there no amino acid for the last codon?

First position (5' end)	U	C	A	G	Third position (3' end)
U	UUC, UUA, UUG: Phe / Leu	UCC, UCA, UCG: Ser	UAC: Tyr; UAA, UAG: Stop	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	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

Amino acid names:

Ala = alanine	Gln = glutamine	Leu = leucine	Ser = serine
Arg = arginine	Glu = glutamate	Lys = lysine	Thr = threonine
Asn = asparagine	Gly = glycine	Met = methionine	Trp = tryptophan
Asp = aspartate	His = histidine	Phe = phenylalanine	Tyr = Tyrosine
Cys = cysteine	Ile = Isolevcine	Pro = proline	Val = valine

Examine the diagram and use the universal code in answering the following questions.



```
1                5                10
UUUGUCAAUCAGCAUCUGUGUGGGAGUCAC

11               15               20
CUAGUCCAGGCCCUAUAUUUGGUUUGCGGC

21               25               30
GAGAGAGGGUUCUUUUACUACCCCAAAGCA

31               35               40
GGUAUUGUGGAACAGUGUUGUCGUUCUGUU

41               45               50
UGUUCGUUGUACCAAUUGGAGAAUUAUUGU

51
AACUAG
```

11. How many nucleotides are in this section of M-RNA?

156

12. How many codon are present along this section of M-RNA?

52

13. Which codon should precede codon number 1 as the start codon ?

AUG (start codon)

14. Which amino acid is # 40 ?

Valine (from GUU)

15. Why is there no amino acid for the last codon?

UAG is a stop codon – it does not code for an amino acid but signals the end of the peptide

First position (5' end)	U	C	A	G	Third position (3' end)
U	UUU Phe UUC UUA Leu UUG	UCU UCC UCA Ser UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU CUC CUA Leu CUG	CCU CCC CCA Pro CCG	CAU His CAC CAA Gln CAG	CGU CGC CGA Arg CGG	U C A G
A	AUU AUC Ile AUA AUG	ACU ACC ACA Thr ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G
G	GUU GUC GUA Val GUG	GCU GCC GCA Ala GCG	GAU Asp GAC GAA Glu GAG	GGU GGC GGA Gly GGG	U C A G

Amino acid names:

Ala = alanine	Gln = glutamine	Leu = leucine	Ser = serine
Arg = arginine	Glu = glutamate	Lys = lysine	Thr = threonine
Asn = asparagine	Gly = glycine	Met = methionine	Trp = tryptophan
Asp = aspartate	His = histidine	Phe = phenylalanine	Tyr = Tyrosine
Cys = cysteine	Ile = Isolevcine	Pro = proline	Val = valine

REPLICATION, TRANSCRIPTION AND TRANSLATION

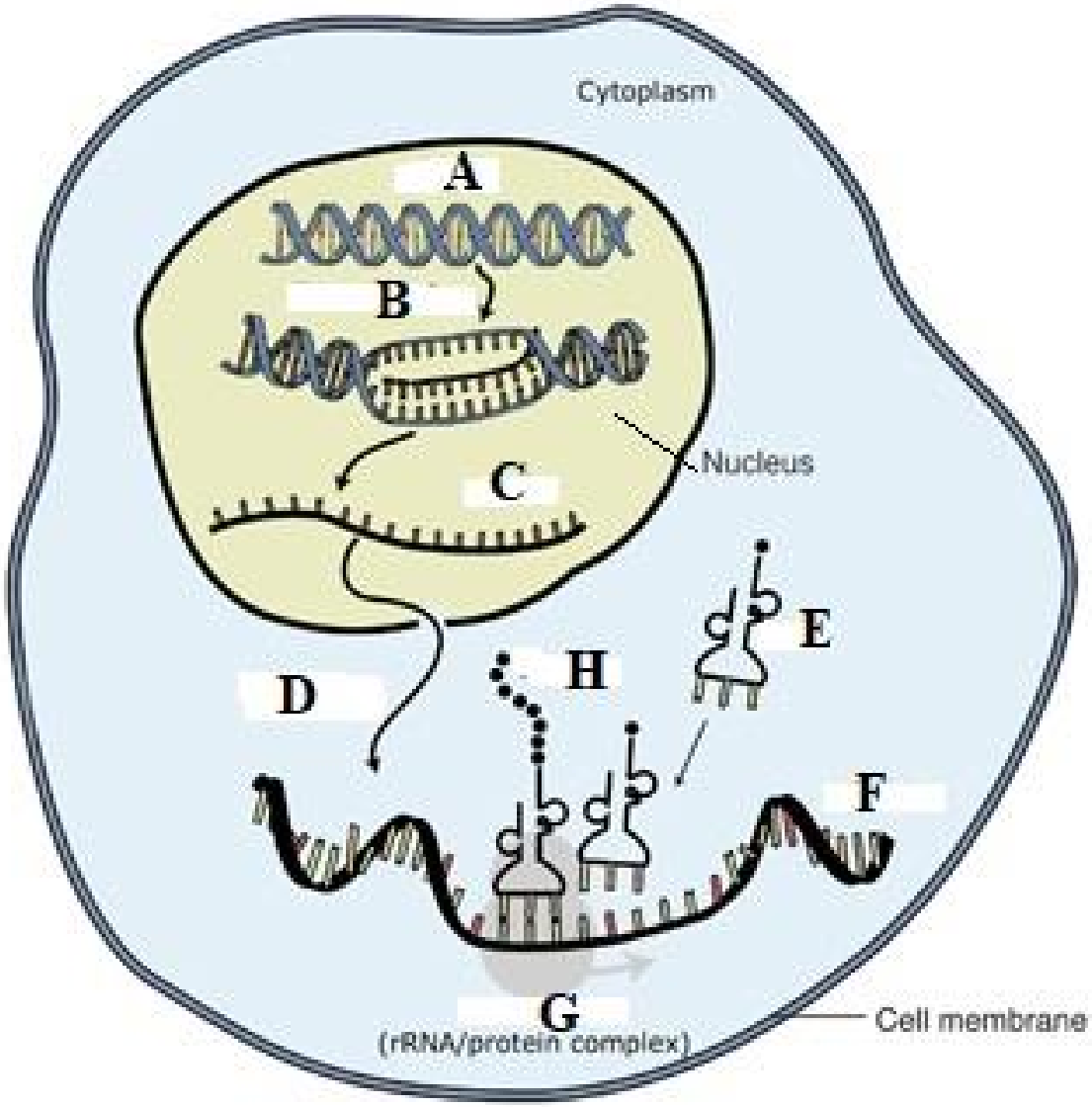


DIAGRAM 1

REPLICATION, TRANSCRIPTION AND TRANSLATION

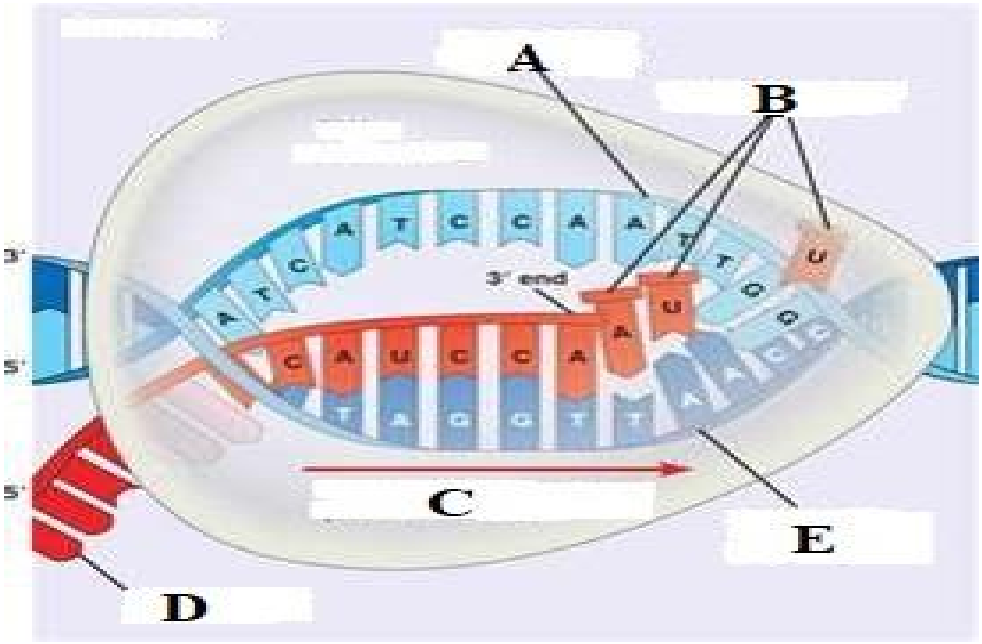


DIAGRAM 2

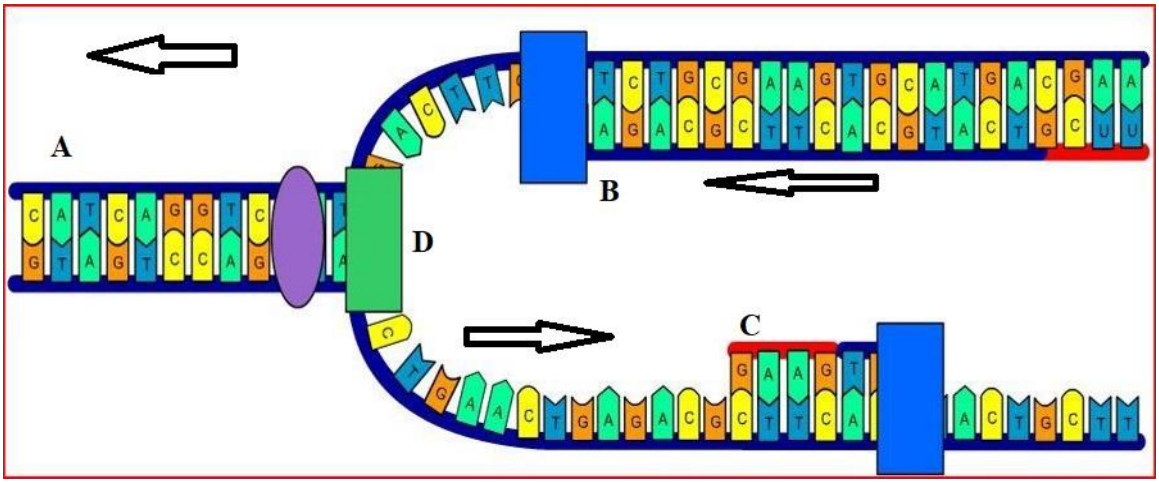


DIAGRAM 3

Use DIAGRAMS 1, 2, AND 3 for the following questions

16. Which Diagram (1, 2, or 3) shows only DNA REPLICATION?

17. How is Replication different in prokaryotic and eukaryotic cells?

18. What letter on the diagrams represents the original DNA?

19. What letter on the diagram represents the leading strand?

20. What letter on the diagram represents the lagging strand with Okazaki fragments?

21. How is the DNA read (5ĉto 3ôor 3ôto 5ô) and how are the DNA nucleotide added to each strand (5ĉto 3ôor 3ôto 5ô)?

22. Which Diagram (1, 2, or 3) shows only TRANSCRIPTION?

23. How is TRANSCRIPTION different in Prokaryotic cells than in Eukaryotic cells

24. Which letter on the Transcription Diagrams represents the Non-template strand of DNA?

25. Which letter on the Transcription Diagrams represents the Template strand of DNA?

26. Which letter on the Transcription Diagrams represents the newly formed RNA strand?

27. The remaining diagram represent all three processes. Translation takes place where in the Eukaryotic cell**?**

28. Which letter on the diagram represents the mRNA serving as the template for translation?

29. Which letter on the diagram represents the tRNA with an amino acid attached?

30. Which letter on the diagram represents the ribosome that is moving along the template mRNA?

Use DIAGRAMS 1, 2, AND 3 for the following questions

16. Which Diagram (1, 2, or **3**) shows only DNA REPLICATION?

17. How is Replication different in prokaryotic and eukaryotic cells?
Prokaryotes have circular DNA and replication is continuous in cytoplasm ï one replication bubble, Eukaryotes have linear DNA and replication takes place in nucleus as part of cell cycle with many replication bubbles.

18. What letter on the diagrams represents the original DNA? **A**

19. What letter on the diagram represents the leading strand? **B**

20. What letter on the diagram represents the lagging strand with Okazaki fragments? **C**

21. How is the DNA read (5ĉto 3ôor **3' to 5'**) and how are the DNA nucleotide added to each strand (**5'to 3'** or 3ôto 5ô)?

22. Which Diagram (1, **2**, or 3) shows only TRANSCRIPTION?

23. How is TRANSCRIPTION different in Prokaryotic cells than in Eukaryotic cells.
mRNA in Eukaryotes has introns so it must be modified to remove them plus a cap and tail are added. Eukaryotes have monocistronic mRNA while prokaryotes have polycistronic mRNA and are controlled by operons.

24. Which letter on the Transcription Diagrams represents the Non-template strand of DNA? **A**

25. Which letter on the Transcription Diagrams represents the Template strand of DNA? **E**

26. Which letter on the Transcription Diagrams represents the newly formed RNA strand? **D**

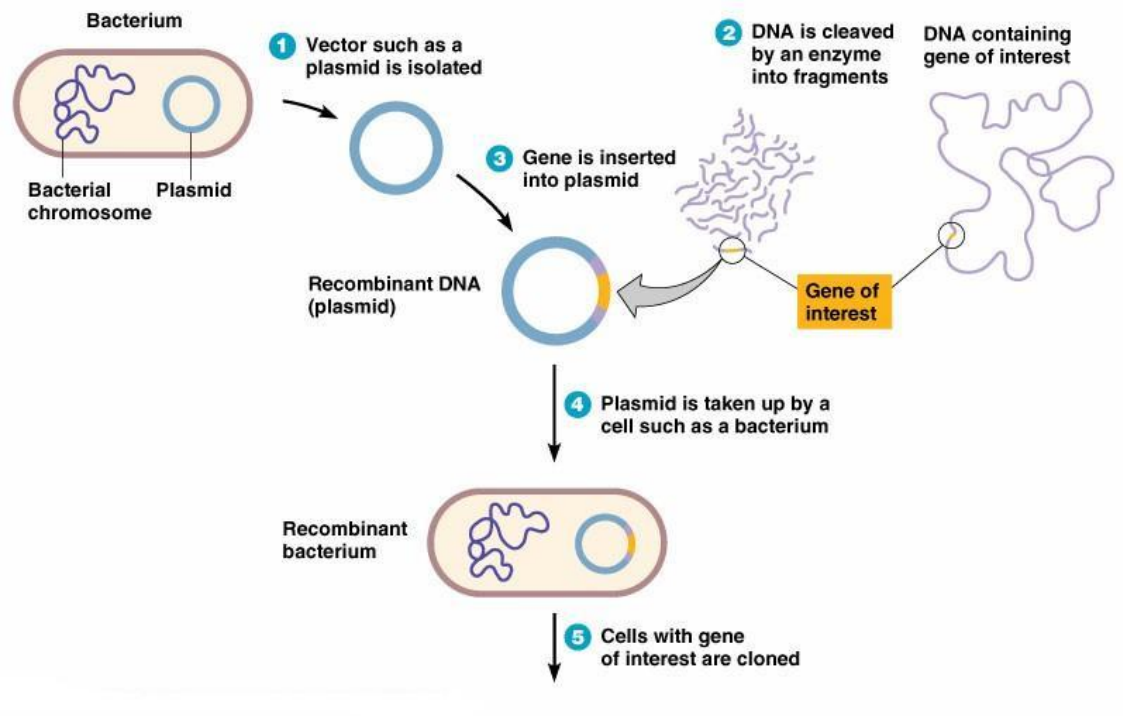
27. The remaining diagram represent all three processes. Translation takes place where in the Eukaryotic cell**?** **cytoplasm at the ribosome**

28. Which letter on the diagram represents the mRNA serving as the template for translation? **F**

29. Which letter on the diagram represents the tRNA with an amino acid attached? **E**

30. Which letter on the diagram represents the ribosome that is moving along the template mRNA? **G**

PART FOUR – BIOTECHNOLOGY



1-9. Put the numbers of the following activities in the proper order

1. Cloning desired DNA and Vectors
2. Analyzing DNA by cutting fragments and separating by Electrophoresis
3. Cutting DNA with Restriction Enzymes
4. Inserting DNA into Vector as Plasmid
5. Identifying desired DNA
6. Inserting Vector into Host Cell as bacterium
7. Storing clones in DNA Libraries
8. Connecting DNA pieces with Ligase
9. Identifying cloned genes with Radioactive Probes

10. Why are plasmids used as vectors?

11. What is the role of restriction enzymes?

12. What is hybridization?

13. What enzyme facilitates the reattachment of pieces of DNA?

14. What is the role of Restriction Maps?

15. What are transgenic organisms?

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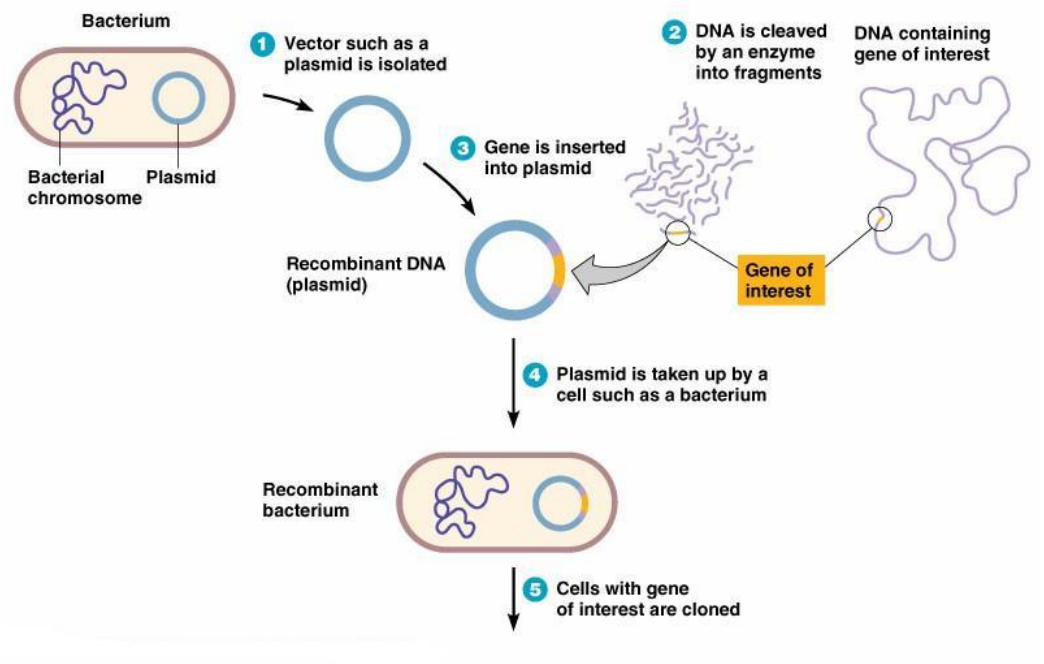

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9. Identifying cloned genes with Radioactive

Correct Order is 5 3 4 8 6 1 7 9 8

10. Why are plasmids used as vectors? **They are circular DNA from bacteria easily replicated and not part of the bacterium genome.**

11. What is the role of restriction enzymes? **enzymes used to cut DNA at a particular spot – there are many kinds which allow specific cutting – originate from bacteria and used as defense against viruses.**

12. What is hybridization? **the process of putting different pieces of DNA together**

13. What enzyme facilitates the reattachment of pieces of DNA? **DNA ligase**

14. What is the role of Restriction Maps? **used in determining the location of genes on a chromosome and making a map of restriction sites**

15. What are transgenic organisms? **organism that have DNA from another organism**

For each of the following types of test, choose the best technique to accomplish the task.

16. cut pieces of DNA into fragments

17. separate fragments of DNA or Protein using electric current

18. clone a very small sample of DNA

19. transfer DNA from gel to paper or membrane

20. identify a DNA section from a DNA Library

A. RFLP

B. PCR

C. Electrophoresis

D. Radioactive Probe

E. Southern Blot

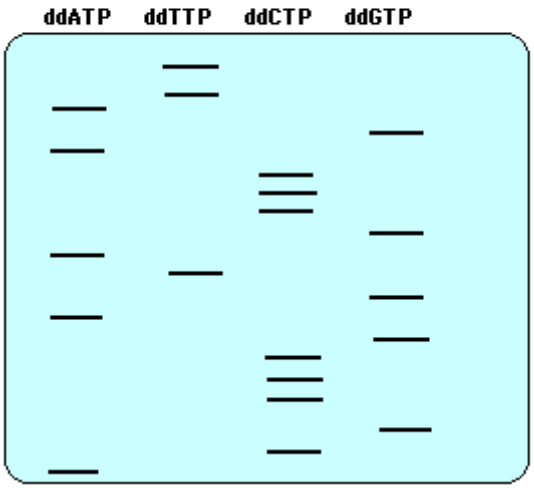
F. Restriction enzymes

21. Construct a restriction map of a linear fragment of DNA, using the following data. Your map should indicate the relative positions of the restriction sites along with distances from the ends of the molecule to the restriction sites and between restriction sites

DNA	**Sizes of Fragments (bp)**
uncut DNA	10,000
DNA cut with EcoRI	8000, 2000
DNA cut with BamHI	5000, 5000
DNA cut with EcoRI + BamHI	5000, 3000, 2000

Restriction Map:

The following gel was produced by the Sanger method of DNA sequencing.



22._____ Give the DNA Sequence from the gel

23._____ Deduce the sequence of the complementary strand.

For each of the following types of test, choose the best technique to accomplish the task.

16. cut pieces of DNA into fragments **F**

17. separate fragments of DNA or Protein using electric current **C**

18. clone a very small sample of DNA **B**

19. transfer DNA from gel to paper or membrane **E**

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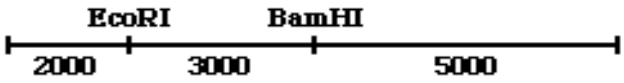

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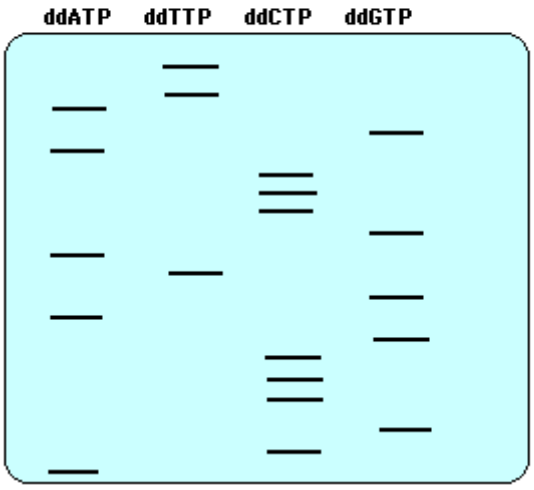


22._____ Give the DNA Sequence from the gel

TTAGACCCGATGAGCCCGCA

23._____ Deduce the sequence of the complementary strand.

AATCTGGGCTACTCGGGCGT

For question 24, in humans, 1 in 10,000 females have a rare sex-linked recessive genetic disorder.

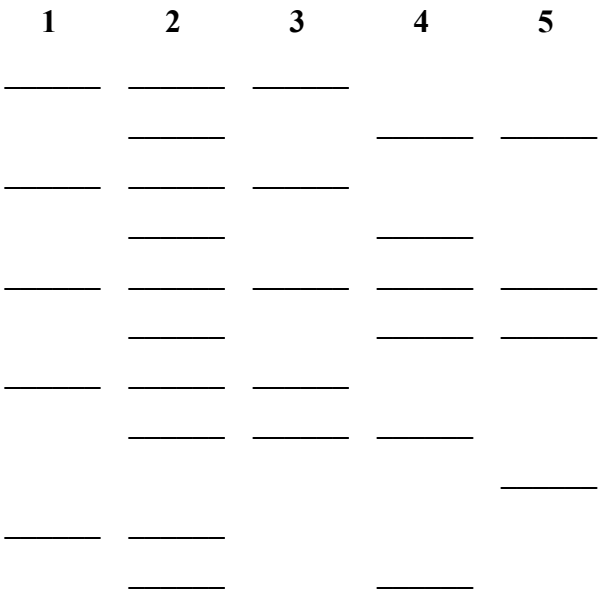
24. _____What is the frequency of the affected males?

25._____ If the frequency of the recessive allele is 0.2, what is the frequency of the heterozygous individuals in the population.

Examine the information concerning the paternal case. Use the evidence from the blood samples and DNA analysis to answer the questions.

PARENTAL CASE		
Blood Analysis		DNA ANALYSIS KEY
Mother	I^A i	#1-Sample from mother's blood
Child	i i	#2-Sample from child's blood
Possible Father #1	I^A I^B	#3-Sample from possible father #1
Possible Father #2	I^A i	#4-Sample from possible father #2
Possible Father #3	I^B i	#5-Sample from possible father #3

DNA ANALYSIS



26. _____ What is the blood type of the child? What is its genotype?

27. _____ What is the blood type of the mother? What is her genotype?

28. _____ What are the blood types of the possible fathers?

29. _____ Based upon the blood types, which of the possible fathers **could be** the biological father of the child?

30. _____ Based upon all of the evidence, which of the possible fathers is most likely the father of this child?

For question 24, in humans, 1 in 10,000 females have a rare sex-linked recessive genetic disorder.

24. _____What is the frequency of the affected males? **1/100 (1/100 X 1/100 = 1/10,000)**

25._____ If the frequency of the recessive allele is 0.2, what is the frequency of the heterozygous individuals in the population.

1 - .2 = .8 so 2 pq = (2x 0.8X0.2) = .32

Examine the information concerning the paternal case. Use the evidence from the blood samples and DNA analysis to answer the questions.

PARENTAL CASE		
Blood Analysis		DNA ANALYSIS KEY
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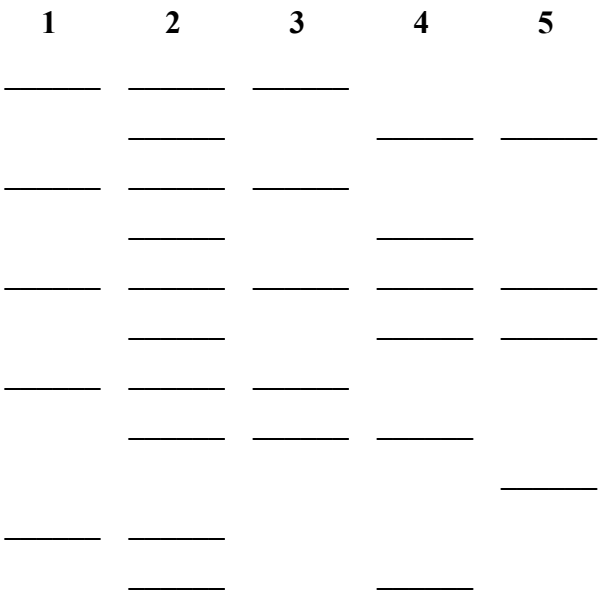
Possible Father #3	I^B i	#5-Sample from possible father #3

DNA ANALYSIS



26. _ **type O ii** ____ What is the blood type of the child? What is its genotype?

27. __ **type A I^Ai** _ What is the blood type of the mother? What is her genotype?

28. _ **types AB, A, B** _What are the blood types of the possible fathers?

29. father's 2 & 3 ___ Based upon the blood types, which of the possible fathers **could be** the biological father of the child?

30. _ **father 2** ___ Based upon all of the evidence, which of the possible fathers is most likely the father of this child?