HEREDITY PRACTICE ACTIVITIES

Background: Phenotype is the observable trait an individual possesses while **genotype** is gene combinations an individual has which result in the trait being expressed.

Directions: Complete each of the following genetics problems. Use Punnett squares where necessary to assist you.

1. In guinea pigs, short hair (S) is dominant over long hair (s). Two heterozygous dominant guinea pigs are crossed (Ss X Ss).

   _____What will be the genotype ratio of their offspring?
   _____What will be the phenotype ratio of their ratio?

2. In mice, black eyes (B) is dominant over red eyes (b). A heterozygous dominant mouse is crossed with a homozygous recessive mouse (Bb X bb).

   _____What will be the genotype ratio of their offspring?

   _____What will be the phenotype ratio of their ratio?

3. Four o'clock flowers exhibit incomplete dominance. Red flowers are RR and white flowers are WW. When a RW flower is present, it will be pink. A pink flower is crossed with a red flower.

   _____What will be the genotype ratio of their offspring?
   _____What will be the phenotype ratio of their ratio?

4. A man who is blood type AB marries a women who is blood type O.

   _____What blood types might be present in their children?

5. A man who is a hemophiliac marries a woman who is a carrier for the hemophilia gene.

   _____What percent of their sons can be expected to be hemophiliacs?
   _____What percent of their daughters can be expected to be hemophiliacs?

6. In race horses, black hair (B) is dominant over chestnut hair (b) and a trotting gait (T) is dominant over a pacing gait (t). Two heterozygous black trotters are mated (BbTt X BbTt).

   _____What will be the genotype ratio of their offspring?
   _____What will be the phenotype ratio of their ratio?

7. A baby is born with blood type O. The baby's mother has blood type B.

   _____What blood type could the biological father <u>not</u> have?

HEREDITY PRACTICE ACTIVITIES

Background: **Phenotype** is the observable trait an individual possesses whereas **genotype** is the gene combination an individual has which results in the trait being expressed.

Directions: Complete each of the following genetics problems. Use Punnett squares where necessary to assist you.

1. In guinea pigs, short hair (S) is dominant over long hair (s). Two heterozygous dominant guinea pigs are crossed (Ss X Ss).
   1SS:2Ss:2ss What will be the genotype ratio of their offspring?
   3 short:1 tall What will be the phenotype ratio of their ratio?

2. In mice, black eyes (B) is dominant over red eyes (b). A heterozygous dominant mouse is crossed with a homozygous recessive mouse (Bb X bb).
   2Bb : 2bb What will be the genotype ratio of their offspring?
   2 black ¦ 2 red What will be the phenotype ratio of their ratio?

3. Four o'clock flowers exhibit incomplete dominance. Red flowers are RR and white flowers are WW. When a RW flower is present, it will be pink. A pink flower is crossed with a red flower.
   2RR : 2RW What will be the genotype ratio of their offspring?
   2 red : 2 pink What will be the phenotype ratio of their ratio?

4. A man who is blood type AB marries a women who is blood type O.
   A or B What blood types might be present in their children?

5. A man who is a hemophiliac marries a woman who is a carrier for the hemophilia gene.
   50% What percent of their sons can be expected to be hemophiliacs?
   50% What percent of their daughters can be expected to be hemophiliacs?

6. In race horses, black hair (B) is dominant over chestnut hair (b) and a trotting gait (T) is dominant over a pacing gait (t). Two heterozygous black trotters are mated (BbTt X BbTt).
   1:2:1:2:4:2:1:2:1 What will be the genotype ratio of their offspring?
   9:3:3:1 What will be the phenotype ratio of their ratio?

Genotype:	***Phenotype:***
1 BBTT : 2 BbTT : 1 bbTT 2 BBTt : 4 BbTt : 2 bbTt 1 BBtt : 2 Bbtt : 1 bbtt	9 black trotters : 3 black pacers: 3 chestnut trotters : 1 chestnut pacer

7. A baby is born with blood type O. The baby's mother has blood type B.
   AB What blood type could the biological father **not** have?

PUNNETT SQUARES for Genetics Practice Problems

1.

SS	Ss
Ss	ss

2

Bb	bb
Bb	bb

3

RR	RW
RR	RW

4

I^Ai	I^Bi
I^Ai	I^Bi

5

XX^h	X^hX^h
Xy	X^hy

6

BBTT	BBTt	BbTT	BbTt
BBTt	BBtt	BbTt	Bbtt
BbTT	BbTt	bbTT	bbTt
BbTt	Bbtt	bbTt	bbtt

GENOTYPES AND PHENOTYPE FREQUENCIES



A



B

1. The traits expressed in the hybrid corn are (see diagram B). Count the number of each kernel type in the enlarged photo of diagram A, record the number next to the kernel type name below.
   A. purple smooth -
   B. purple sunken -
   C. white smooth -
   D. white sunken -

2. Based upon your count of the expressed traits and using the letter "P" for purple gene and "W" for the smooth gene, give the genotype for each type of kernel.
   (A) purple and smooth -
   (B) purple and sunken -
   (C) white and smooth -
   (D) white and sunken -

3. What are the four types of alleles possible for the following cross PpWw x PpWw

4. Complete the following Punnett Square for the cross listed in # 3 :

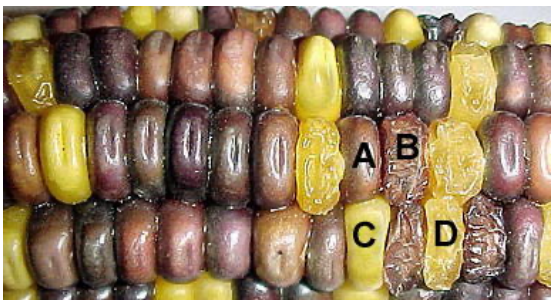
Gametes				

5. What is the expressed phenotype ratio for the hybrid ear of corn?

GENOTYPES AND PHENOTYPE FREQUENCIES



A



B

1. The traits expressed in the hybrid corn are (see diagram B). Count the number of each kernel type in the enlarged photo of diagram A, record the number next to the kernel type name below.
   A. purple smooth -
   B. purple sunken -
   C. white smooth -
   D. white sunken -

2. Based upon your count of the expressed traits and using the letter "P" for purple gene and "W" for the white gene, give the genotype for each type of kernel.
   (A) purple and smooth - **PPWW, PPWw, PpWW or PpWw**
   (B) purple and sunken - **PPww or Ppww**
   (C) white and smooth – **ppWW or ppWw**
   (D) white and sunken - **ppww**

3. What are the four types of alleles possible for the following cross PpWw x PpWs
   PW Pw pW pw

4. Complete the following Punnett Square for the cross listed in # 3 :

Gametes	PW	Pw	pW	pw
PW	PPWW	PPWw	PpWW	PpWw
Pw	PPWw	PPww	PpWw	Ppww
pW	PpWW	PpWw	ppWW	ppWw
pw	PpWw	Ppww	ppWw	ppww

5. What is the expressed phenotype ratio for the hybrid ear of corn?
   9:3:3:1

KARYOTYPE ANALYSIS

Background Information: **Chromosomes** come in pairs.

A **karyotype** is print of human chromosomes and is an arrangement of chromosomes with the autosomes arranged longest to shortest and the sex chromosomes listed last. Karyotypes are used to identify persons with extra or missing chromosomes. An extra chromosome is termed trisomy and a missing chromosome is monosomy.

The numbered chromosome pairs termed **autosomes** are arranged longest to shortest.

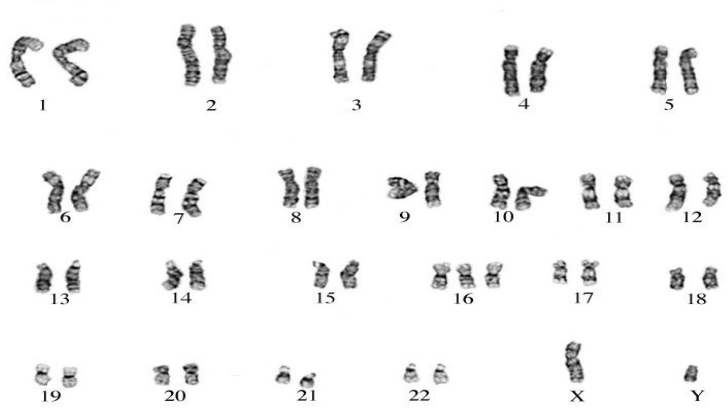
The **sex (X & Y) chromosomes** are placed last with normal females having XX and normal males having XY.
If only X chromosomes are present, it will be female.
If X and Y chromosomes are present, it will be male.

Bent chromosomes are not abnormal. It is just the way they were photographed.

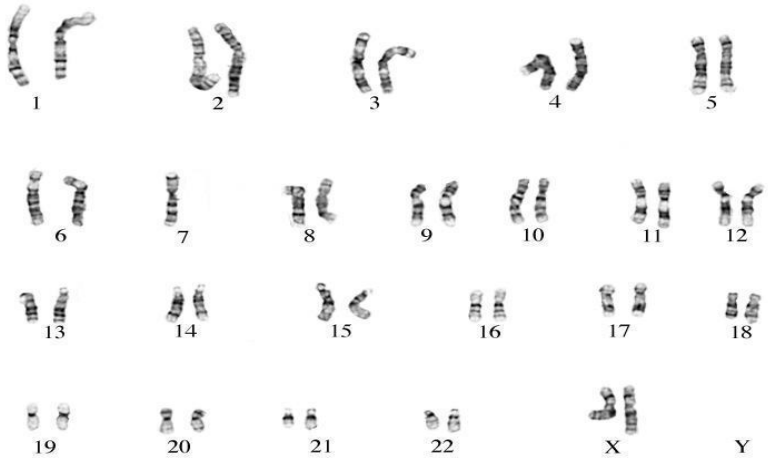
If an individual has an extra chromosome, it is termed **trisomy** and if a chromosome is missing, it is termed **monosomy**.

Examine the karyotype listed below and answer the questions

Karyotype for Individual A



Karyotype for Individual B


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
X
Y

Use the **Background Information** and the **Karyotypes for Individuals A, , and B** to answer the following questions.

1. Which individual(s) are **female**?

2. Which individual(s) are **male**?

3. How many **pairs chromosomes** are present in a normal human?

4. How many **pairs of autosomes** are present in a normal human?

5. Which individual(s), if any, are **monosomy**?

6. Which pair of chromosomes is affected for these individuals?

7. Which individual(s), if any, are **trisomy**?

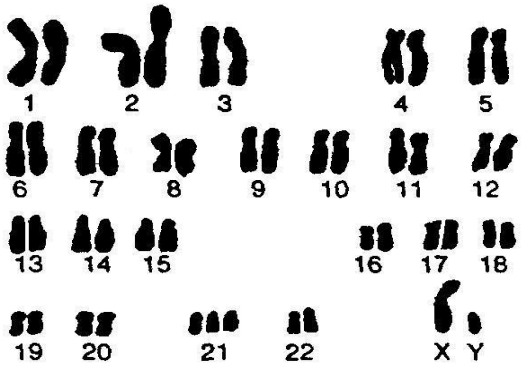
8. Which pair of chromosomes is affected for these individuals?

9. For an individual who is **monosomy**, how many chromosomes are present in their karyotype?

10. For an individual who is **trisomy**, how many chromosomes are present in their karyotype?

Examine Individual C and answer the following questions:

Individual C



_____ Is this individual a male or female?
_____ Is there any evidence of monosomy? If so, which pair of chromosomes is affected?
_____ Is there any evidence of trisomy? Is so, which pair of chromosomes is affected?
_____ How many chromosomes are present in a somatic cell of a normal human?
_____ How many chromosomes are present in a somatic cell of this human?

Use the **Background Information** and the **Karyotypes for Individuals A and B** to answer the following questions.

1. Which individual(s) are **female**?
   B

2. Which individual(s) are **male**?
   A

3. How many **pairs chromosomes** are present in a normal human?
   23 pr.

4. How many **pairs of autosomes** are present in a normal human?
   22 pr.

5. Which individual(s), if any, are **monosomy**?
   B

6. Which pair of chromosomes is affected for these individuals?
   Pair 7 (This is a female with Monosomy 7)

7. Which individual(s), if any, are **trisomy**?
   A

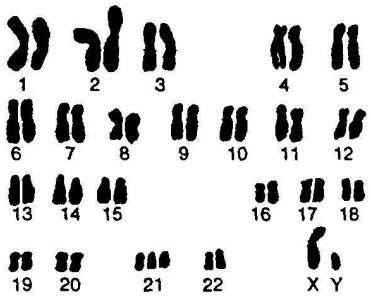
8. Which pair of chromosomes is affected for these individuals?
   Pair 16 (This is a male with Trisomy 16)

9. For an individual who is **monosomy**, how many chromosomes are present in their karyotype?
   45 chromosomes

10. For an individual who is **trisomy**, how many chromosomes are present in their karyotype? **47 chromosomes**

Examine Individual C and answer the following questions:

Individual C



male Is this individual a male or female? Both X and Y
No Is there any evidence of monosomy? If so, which pair of chromosomes is affected?
Yes - 21st Is there any evidence of trisomy? Is so, which pair of chromosomes is affected? ***Trisomy 21 = Down's Syndrome***
46 How many chromosomes are present in a somatic cell of a normal human?
47 How many chromosomes are present in a somatic cell of this human?

PEDIGREE ANALYSIS

Background Information:

Remember that capital letters represent dominant genes and lower case letters represent recessive genes. Use **D** for the dominant gene and **d** as the recessive gene for this problem.

Phenotype is the appearance of the trait and **genotype** is the two gene combination that causes the trait.

A **karyotype** is print of human chromosomes. The numbered chromosome pairs termed **autosomes** are arranged longest to shortest.

The **sex (X & Y) chromosomes** are placed last with normal females having XX and normal males having XY.

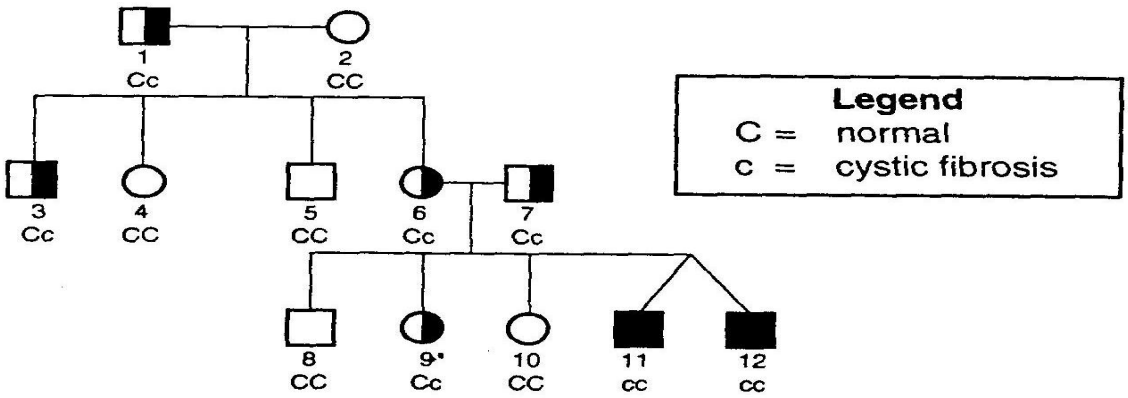
If only X chromosomes are present, it will be female. If X and Y chromosomes are present, it will be male.

Bent chromosomes are not abnormal. It is just the way they were photographed.

If an individual has an extra chromosome, it is termed **trisomy** and if a chromosome is missing, it is termed **monosomy**.

A **pedigree** is a family tree. Males are represented by squares females are represented by c

Examine the pedigree provided and answer the questions. It represents a family with the recessive autosomal gene for cystic fibrosis. Shaded individuals have cystic fibrosis, half shaded are carrier, and not shaded do not have the gene for cystic fibrosis.



_____ What is the relationship of individuals one and four?
_____ What is the genotype of individual seven?
_____ How many generations are represented on this pedigree?
_____ Which individuals might be identical twins?
_____ What phenotype will individual two express?

PEDIGREE ANALYSIS

Background Information:

Remember that capital letters represent dominant genes and lower case letters represent recessive genes. Use **D** for the dominant gene and **d** as the recessive gene for this problem.

Phenotype is the appearance of the trait and **genotype** is the two gene combination that causes the trait.

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The **sex (X & Y) chromosomes** are placed last with normal females having XX and normal males having XY.

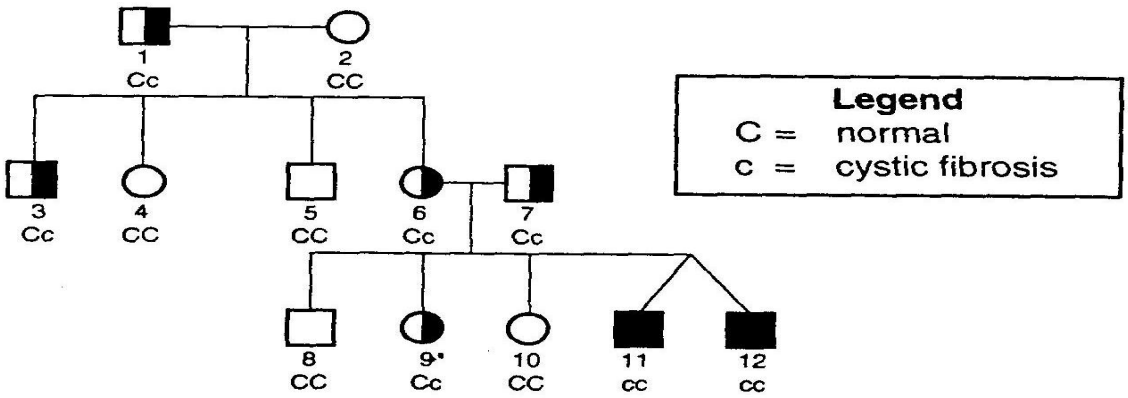
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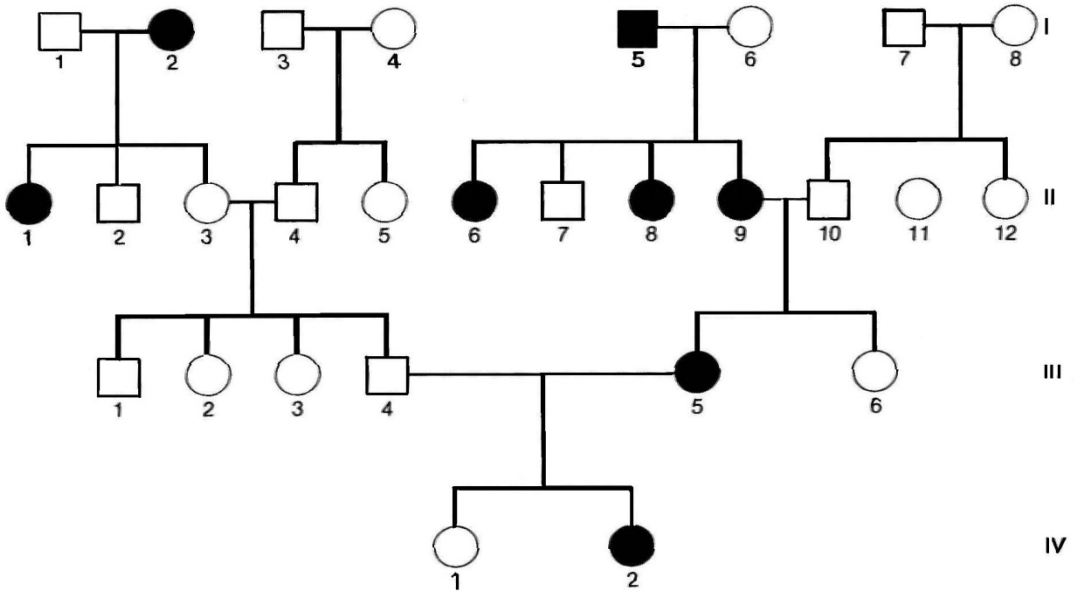
Examine the pedigree provided and answer the questions. It represents a family with the recessive autosomal gene for cystic fibrosis. Shaded individuals have cystic fibrosis, half shaded are carrier, and not shaded do not have the gene for cystic fibrosis.



Father & Daughter What is the relationship of individuals one and four?
Cc What is the genotype of individual seven?
three How many generations are represented on this pedigree?
11 & 12 Which individuals might be identical twins?
CC What phenotype will individual two express?

Pedigree for Families with Night Blindness

This type of night blindness is caused by an autosomal dominant gene.
The individuals in black display the trait.



PEDIGREE ANALYSIS QUESTIONS

When answering the questions, assume all couples are legally married.

1. How many generations are on this pedigree?

2. What is the relationship of **Individuals I-7 and II-9?**

3. What is the relationship of **Individuals I-1 and I-2**?

4. What is the relationship of **Individuals II-6 and II-11**?

5. What are the possible genotypes for a person who has night blindness?

6. What are the possible genotypes for a person who has normal night vision?

7. How many individuals have normal night vision?

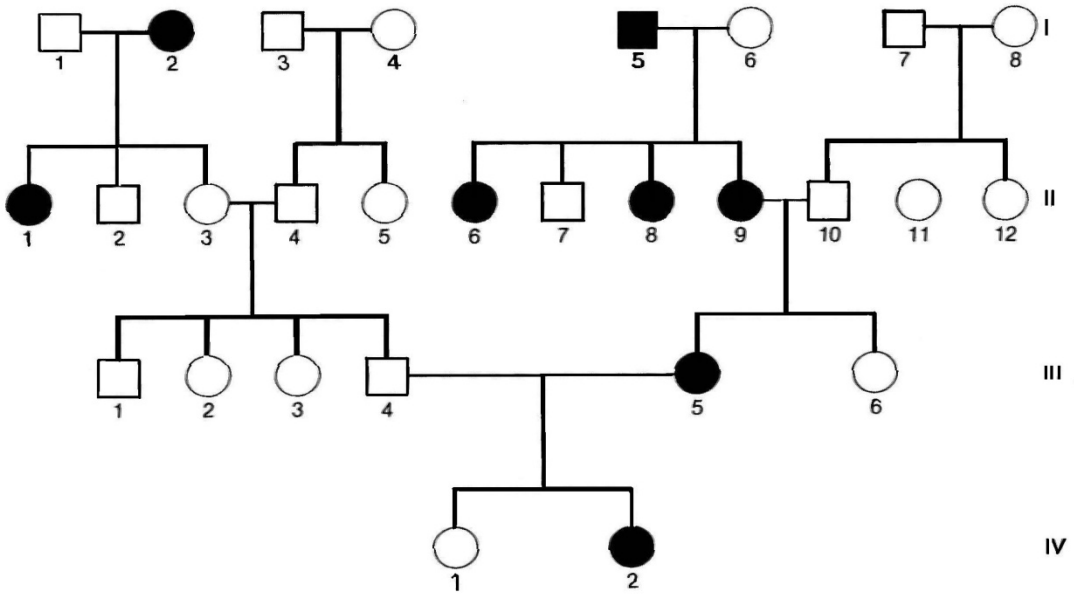
8. What is the genotype of Individual IV-2?

9. What is the genotype of Individual II-2?

10. Are there any individuals who have a homozygous dominant genotype on this pedigree? If so, who are they?

Pedigree for Families with Night Blindness

This type of night blindness is caused by an autosomal dominant gene.
The individuals in black display the trait.



PEDIGREE ANALYSIS QUESTIONS

When answering the questions, assume all couples are legally married.

1. How many generations are on this pedigree?
four (I – IV)

2. What is the relationship of **Individuals I-7 and II-9?**
Father-in-law and Daughter-in-law

3. What is the relationship of **Individuals I-1 and I-2**?
Husband and wife (assuming that all couples are legally married)

4. What is the relationship of **Individuals II-6 and II-11**?
Sisters-in-law

5. What are the possible genotypes for a person who has night blindness?
DD or Dd (D = dominant allele and d = recessive allele)

6. What are the possible genotypes for a person who has normal night vision?
dd

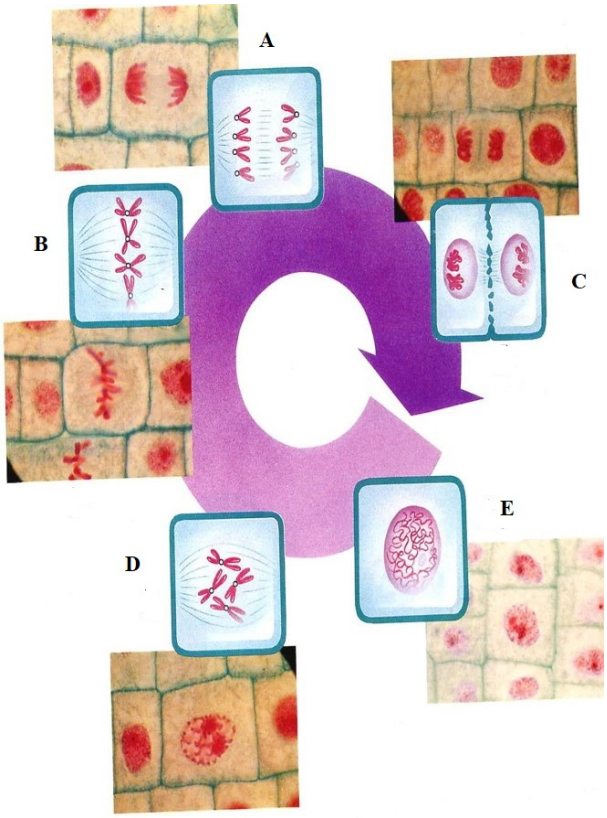
7. How many individuals have normal night vision?
20 individuals (count the symbols in white)

8. What is the genotype of Individual IV-2?
dd

9. What is the genotype of Individual II-2?
Dd because he is normal but mom has night blindness

10. Are there any individuals who have a homozygous dominant genotype on this pedigree? If so, who are they?
No – this is a dominant trait and each person with the trait has a parent with the recessive normal vision or children who have normal vision.

MITOSIS AND MEIOSIS – PART I



1. Mitosis involves how many divisions and produces how many new cells?

2. Meiosis involves how many divisions and produces how many new cells?

3. In the production of the egg, what is the name of the other three smaller cells?

4. What are the uses for mitosis?

Use the diagram provided to answer the questions 5-10.

5. Which process does this diagram represent – mitosis or meiosis? Are these cells plant cells or are they animal cells?

6. Which letter from the diagram shows chromatids moving away from the equator toward the poles? What phase is this?

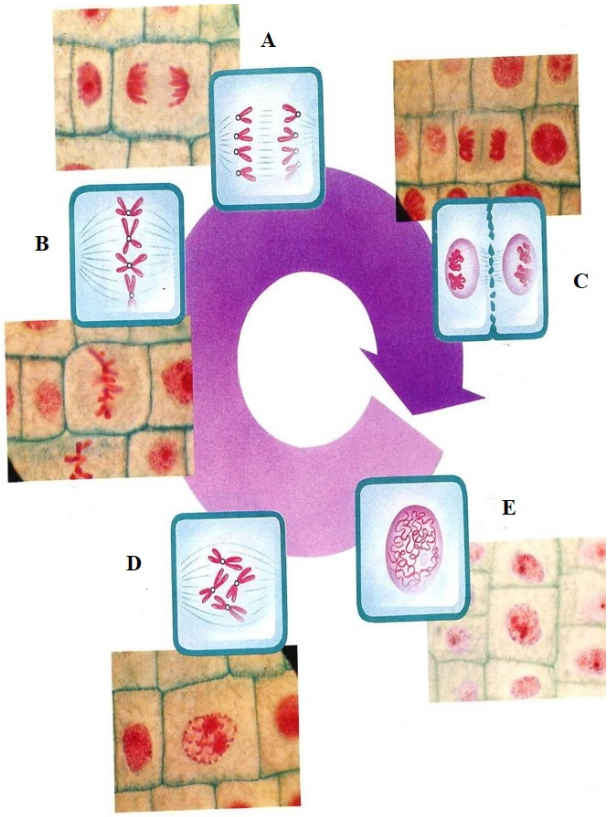
7. Which letter from the diagram shows chromatids moving toward the equator? What phase is this?

8. Which letter from the diagram shows chromatids lined up along the equator? What phase is this?

9. Which letter from the diagram shows uncoiled chromosomes that have replicated during this phase? What phase is this?

10. Which letter from the diagram shows chromatids uncoiling as the cytoplasm is being divided between the new cells? What phase is this?

MITOSIS AND MEIOSIS – PART 1



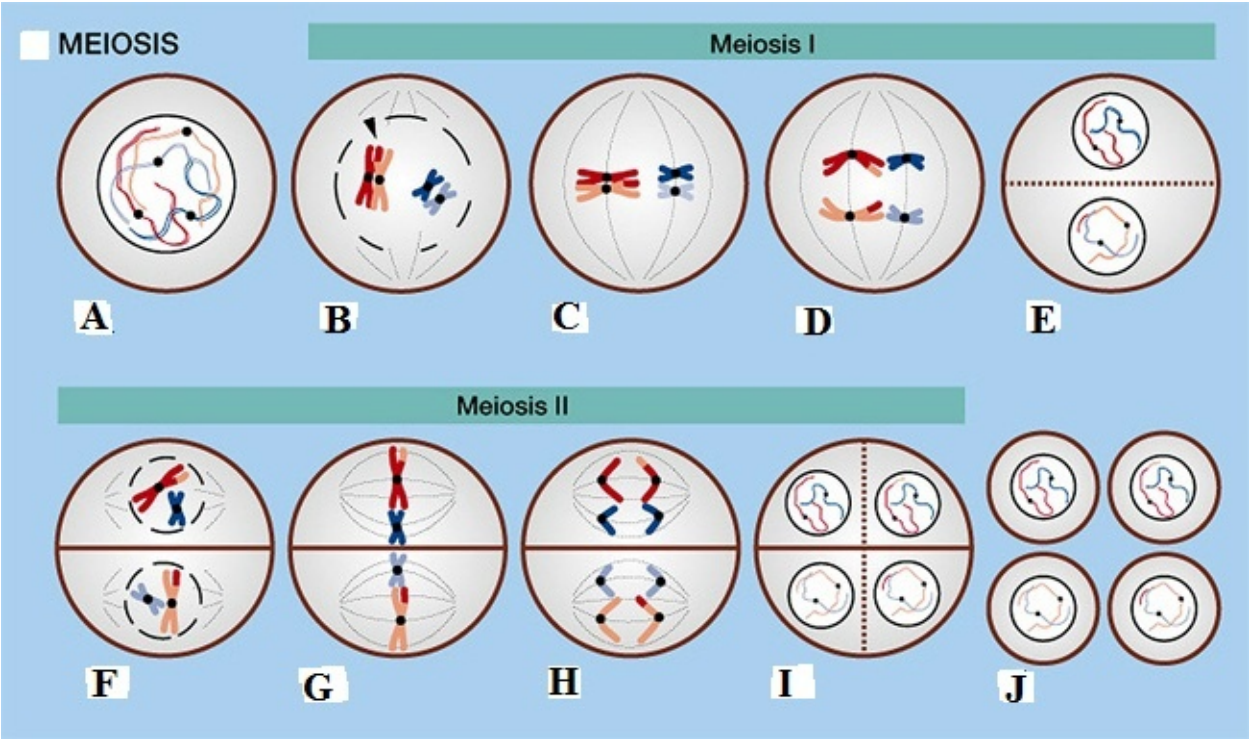
1. Mitosis involves how many divisions and produces how many new cells?
   1 division and 2 cells
2. Meiosis involves how many divisions and produces how many new cells?
   2 divisions and 4 cells

3. In the production of the egg, what is the name of the other three smaller cells?
   polar bodies
4. What are the uses for mitosis?
   growth, repair, cloning or reproduction of cells

Use the diagram provided to answer the questions 5-10.

5. Which process does this diagram represent – mitosis or meiosis? Are these cells plant cells or are they animal cells?
   mitosis – plant cells
6. Which letter from the diagram shows chromatids moving away from the equator toward the poles? What phase is this?
   A - anaphase
7. Which letter from the diagram shows chromatids moving toward the equator? What phase is this?
   D – prophase
8. Which letter from the diagram shows chromatids lined up along the equator? What phase is this?
   B – metaphase
9. Which letter from the diagram shows uncoiled chromosomes that have replicated during this phase? What phase is this?
   E – interphase
10. Which letter from the diagram shows chromatids uncoiling as the cytoplasm is being divided between the new cells? What phase is this?
    C – telophase

MITOSIS & MEIOSIS – PART 2 – MEIOSIS



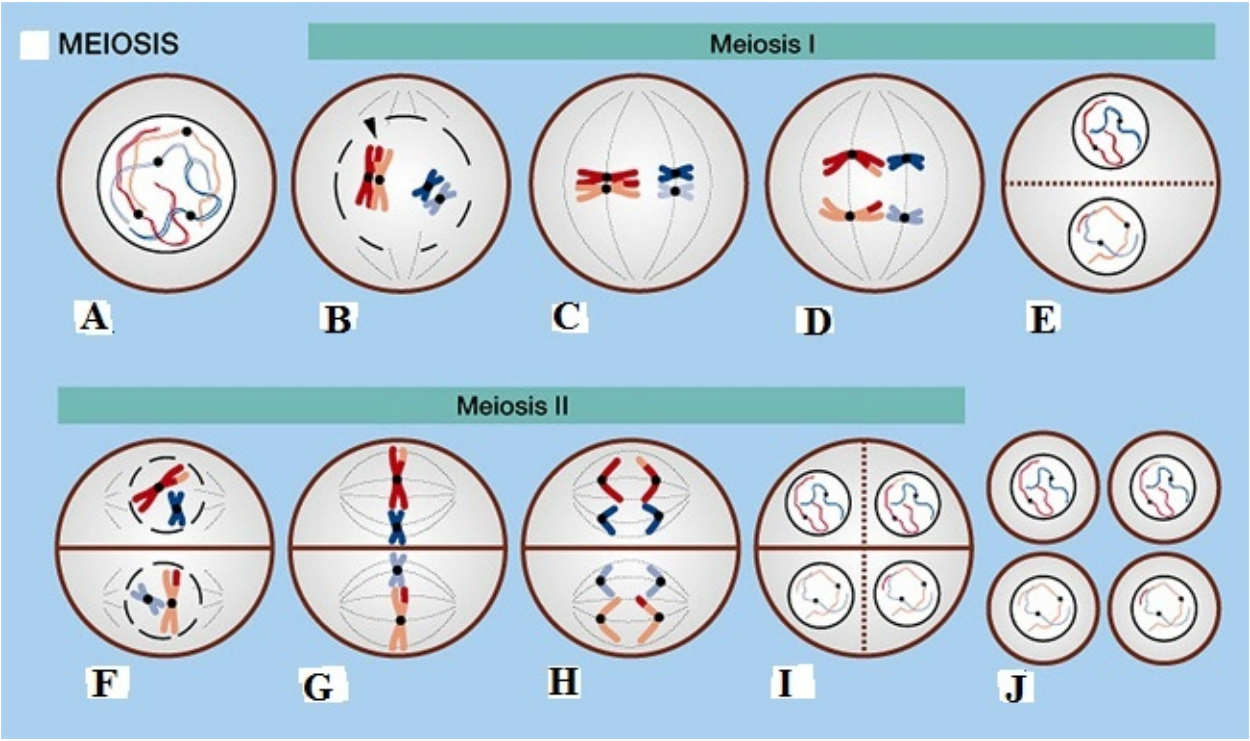
MEIOSIS ACTIVITIES

1. Cytokinesis occurs
2. Individual chromosomes move toward the poles
3. Synapsis occurs to form a tetrad
4. One chromatid pair per spindle fiber line up at the equator
5. Chromatid pairs move toward the poles
6. Nuclear membrane dissolves
7. Tetrads or 2 chromatid pairs line up at the equator
8. Cross over can occur
9. Nuclear membrane forms
10. Spindle fibers form
11. A Tetrad or 2 chromatid pairs attaches per the spindle fibers
12. Spindle fibers dissolve
13. Replication occurs
14. One chromatid pair attaches per spindle fiber
15. Four sperm cells result

For the MEIOSIS PHASE listed, ***first*** **list** the appropriate **LETTER** from **MEIOSIS DIAGRAM** for this phase ***then*** **list** the **NUMBERS** of **ALL** of the appropriate **MEIOSIS ACTIVITIES** that would be taking place during **this** phase. **NOTE:** Some **MEIOSIS ACTIVITIES** may occur in more than one phase

1. **METAPHASE I**
2. **ANAPHASE II**
3. **TELOPHASE II**
4. **ANAPHASE I**
5. **PROPHASE I**

MITOSIS & MEIOSIS – PART 2 – MEIOSIS



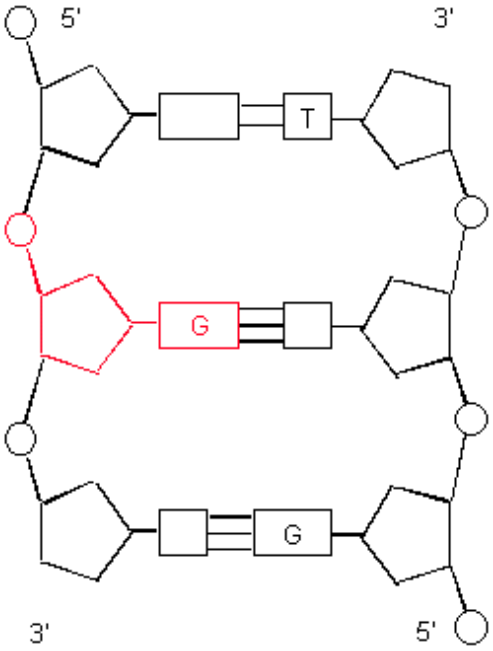
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1. **METAPHASE I** **C 7**
2. **ANAPHASE II** **H 2**
3. **TELOPHASE II** **I 1, 9, 12 (ANY ORDER)**
4. **ANAPHASE I** **D 5**
5. **PROPHASE I** **B 3 6 8 10 11 (ANY ORDER)**

DNA STRUCTURE



Examine the diagram provided and answer the following questions. Notice that the two 5' to 3' strands are anti-parallel or they run counter to each other.

1. The pentagon shaped symbol represents what chemical?

2. The circles along the side represent what chemical?

3. What type of chemical makes up the steps of the ladder?
(A, T, G, and C are abbreviations for the names of specific kinds of this chemical)

4. The red piece contains three chemicals? What is the name of this building block for DNA? How many kinds of these building blocks are needed to form DNA?

5. Which of the bases (A, T, C, or G) will bond to "T"?
Which of the bases (A, T, C, or G) will bond to "G"?

6. The process of DNA making new copies of itself is termed what?

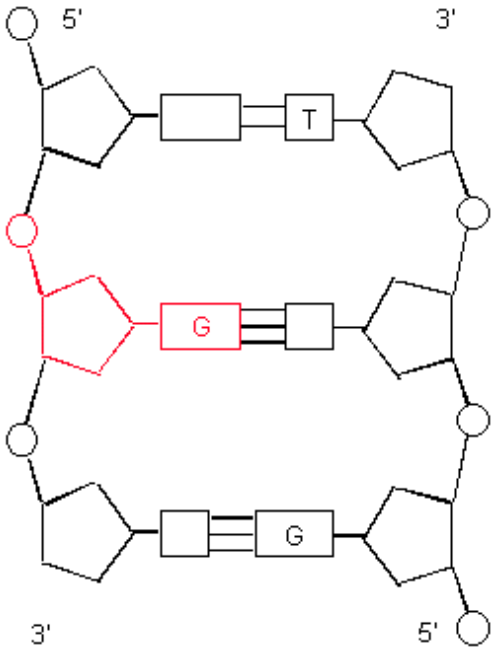
7. Which direction is DNA read - from 5' to 3' or from 3' to 5'?

8. If a DNA strand is 3' CGTAGT 5', what is the base sequence of its complementary strand?

9. Before DNA can copy itself, what must happen to the double helix?

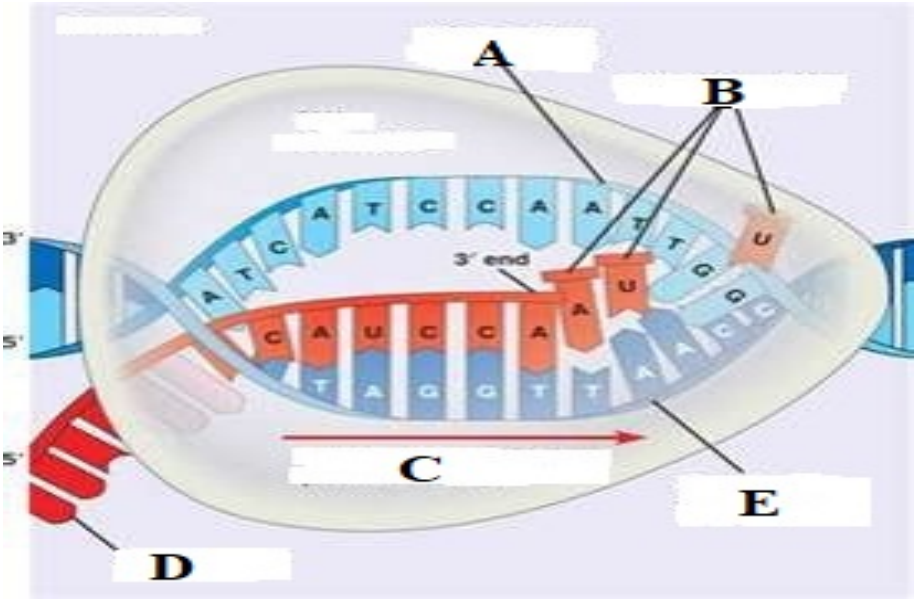
10. At the beginning of which 2 processes must DNA make new copies of itself?

DNA STRUCTURE

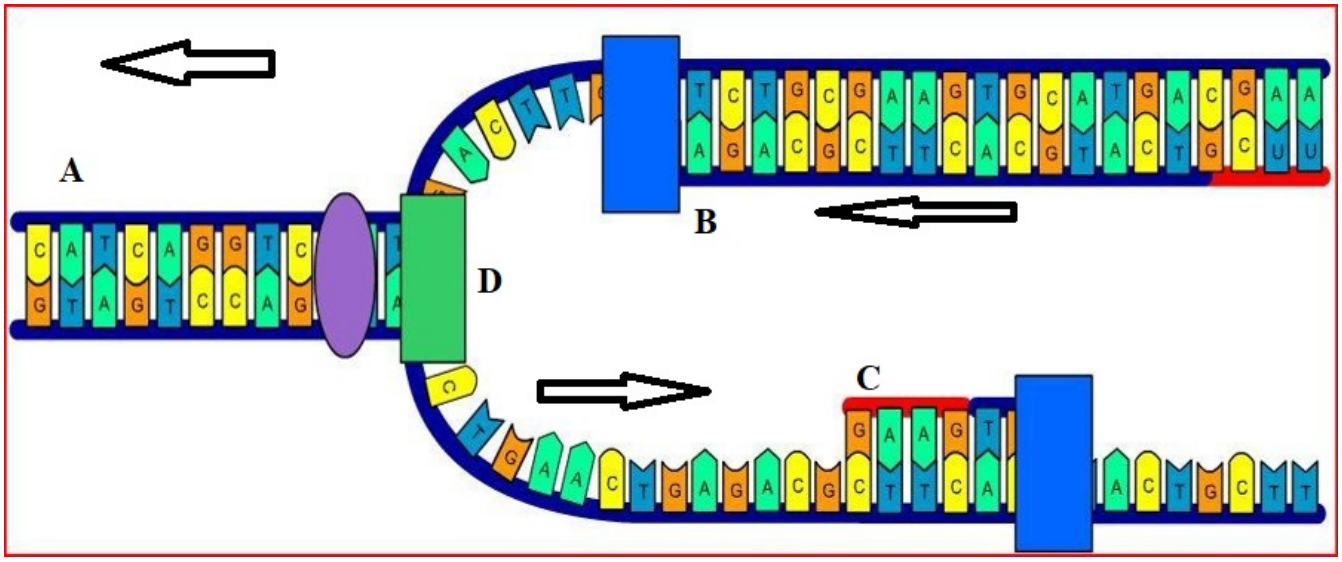


Examine the diagram provided and answer the following questions. Notice that the two 5' to 3' strands are anti-parallel or they run counter to each other.

1. The pentagon shaped symbol represents what chemical?
   sugar deoxyribose
2. The circles along the side represent what chemical?
   phosphate
3. What type of chemical makes up the steps of the ladder?
   (A, T, G, and C are abbreviations for the names of specific kinds of this chemical)
   nitrogen base
4. The red piece contains three chemicals? What is the name of this building block for DNA? How many kinds of these building blocks are needed to form DNA?
   nucleotide 4 kinds
5. Which of the bases (A, T, C, or G) will bond to "T"? **A**
   Which of the bases (A, T, C, or G) will bond to "G"? **C**
6. The process of DNA making new copies of itself is termed what?
   replication
7. Which direction is DNA read - from 5' to 3' or from 3' to 5'?
   3' to 5'
8. If a DNA strand is 3' CGTAGT 5', what is the base sequence of its complementary strand?
   5' GCATCA 3'
9. Before DNA can copy itself, what must happen to the double helix?
   uncoil
10. At the beginning of which 2 processes must DNA make new copies of itself?
    mitosis & meiosis



PROCESS 1



PROCESS 2

REPLICATION AND TRANSLATION

Use the **Diagram of Processes 1 and 2.**

1. Which process (1 or 2) represents Replication?

2. Which letter on the Replication Diagram represents the original DNA strand?

3. Which letter on the Replication Diagram represents the Replication Fork?

4. Which letter on the Replication Diagram represents the Leading Strand which form a continuous complimentary strand ?

5. Which letter on the Replication Diagram represents the Lagging Strands which produces Okazaki fragments which are later bonded together?

6. Which process (1 or 2) represents Transcription?

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

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

9. Which letter on the Transcription Diagrams represents the RNA nucleotides being added?

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

12. What direction is the DNA template being read? (3' to 5' or 5' to 3')

13. What direction is the RNA strand being formed? (3' to 5' or 5' to 3')

14.-15. Name the three kinds of RNA that are used in translation (protein synthesis and give their function),

REPLICATION AND TRANSLATION

Use the **Diagram of Processes 1 and 2.**

1. Which process (1 or 2) represents Replication? **2**

2. Which letter on the Replication Diagram represents the original DNA strand? **A**

3. Which letter on the Replication Diagram represents the Replication Fork? **D**

4. Which letter on the Replication Diagram represents the Leading Strand which form a continuous complimentary strand ? **B**

5. Which letter on the Replication Diagram represents the Lagging Strands which produces Okasaki fragments which are later bonded together? **C**

6. Which process (1 or 2) represents Transcription? **1**

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

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

9. Which letter on the Transcription Diagrams represents the RNA nucleotides being added? **B**

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

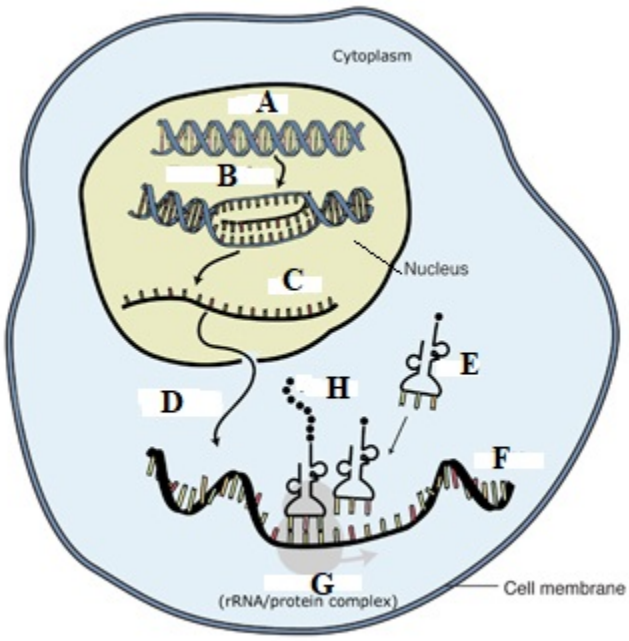
12. What direction is the DNA template being read? (3' to 5' or 5' to 3') **3' to 5'**

13. What direction is the RNA strand being formed? (3' to 5' or 5' to 3') **5' to 3'**

14.-15. Name the three kinds of RNA that are used in translation (protein synthesis and give their function),

mRNA – carries genetic code and serves as template
tRNA – transfers the amino acids to appropriate spot on the mRNA template
rRNA – makes up ribosome and allows tRNA to bond to mRNA

GENE EXPRESSION (TRANSCRIPTION & TRANSLATION)



1. Which letter on the diagram represents the original DNA molecule?

2. Which letter on the diagram represents the production of RNA from DNA by transcription?

3. Which letter on the diagram represents the production of a peptide chain by translation?

4. Which letter on the diagram represents the mRNA being modified?

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

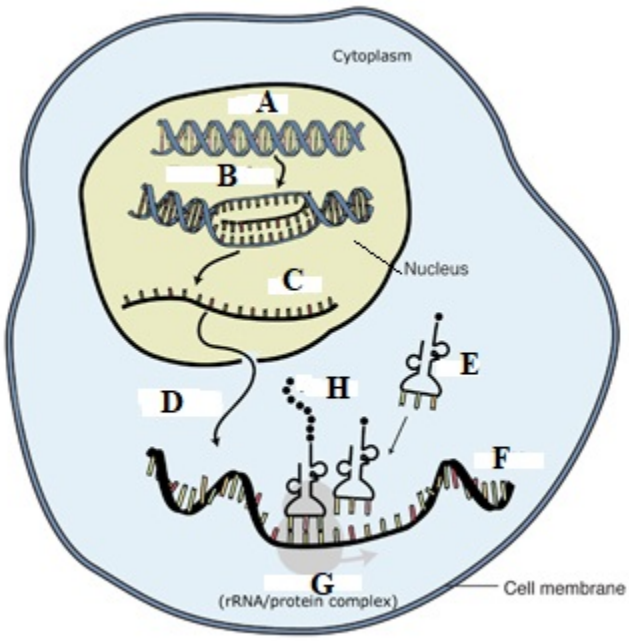
7. Which letter on the diagram represents the ribosome that is moving along the template mRNA?

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

9. Which letter on the diagram represents the newly formed peptide chain?

10. What makes up a protein?

GENE EXPRESSION (TRANSCRIPTION & TRANSLATION)



1. Which letter on the diagram represents the original DNA molecule? **A**
2. Which letter on the diagram represents the production of RNA from DNA by transcription? **B**
3. Which letter on the diagram represents the production of a peptide chain by translation? **D**
4. Which letter on the diagram represents the mRNA being modified? **C**
5. Which letter on the diagram represents the mRNA serving as the template for translation? **F**
7. Which letter on the diagram represents the ribosome that is moving along the template mRNA? **G**
8. Which letter on the diagram represents the tRNA with an amino acid attached? **E**
9. Which letter on the diagram represents the newly formed peptide chain? **H**
10. What makes up a protein? **PEPTIDES**