

academic Biology Final Study Guide

Directions: This packet contains an extensive study guide that will help you prepare for the upcoming Final Exam. Pace yourself and be prepared to work on part of it on your own time. This study guide covers the majority of the material that will appear on your Final.

Topics:

- Chapter 2 Chemistry
- Chapter 7 Cells (include notes on microscopes)
- Chapter 8 Photosynthesis
- Chapter 9 Cellular Respiration
- Chapter 10 Cell Growth and Division
- Chapter 11 Introduction to Genetics
- Chapter 12 DNA and RNA
- Chapter 13 Genetic Engineering

Study Suggestions:

- Create a concept map (or other graphic organizer) to summarize all of the important information in a chapter. Explain your concept maps to classmates or family members.
- Work in a small study group and assign different study tasks to different people then share all of the information.
- Write a summary of all of the important information in each Chapter.
- Write a summary of all of the important information in each section of class notes. Do not just recopy the notes, summarize the information into an easy to understand paragraph. Include important vocabulary.
- Write a short paragraph to summarize each handout or worksheet you received in class.
- Answer the questions on the chapter assessments at the end of each chapter.

Chapter 2 Chemistry

Vocab

atom
nucleus
electron
element
isotope
compound
chemical bond
ionic bond
ion
covalent bond
molecule
van der Waals forces

1. Draw and label the atomic structure. Include proton, neutron, nucleus and electrons.

2. What is atomic number? Mass number? What are the atomic number and mass number of Carbon? the number of protons in the nucleus of an atom, the total number of protons and neutrons in a nucleus. 6 and 12
3. If an atom has an atomic number of 15, how many protons does it have? Electrons? 15
4. If an atom has 8 protons in its nucleus, what is its atomic number? How many electrons does it have?
8, 8

5. If an atom has 8 protons and a mass number of 16, how many neutrons does it have? 8
6. What is an isotope? each of two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons
7. Carbon-12 and Carbon-14 are isotopes. Do they have the same number of neutrons? Protons?
No they differ in the number of neutrons, same number of protons
8. What is the definition of a chemical compound? a substance formed from two or more elements chemically united in fixed proportions
9. What is an element? pure substance of one type of atom
10. Sodium (Na) has one electron in its outer shell. What will its charge be when it becomes an ion? It will be positive
11. Oxygen (O) has six electrons in its outer shell. What will its charge be when it becomes an ion?
Negative
12. What is the difference between an ionic and a covalent bond? Ionic bond donates or gives up an electron to form the bond. Covalent bonding is characterized by the sharing of pairs of electrons between atoms and other covalent bonds.
13. What does it mean if 2 atoms are in the same group (column)?
The elements in each group have the same number of electrons
14. What is cohesion? Adhesion?
Cohesion is the mutual attraction between like molecules causing them to cling together. Adhesion is the mutual attraction between unlike molecules that causes them to cling to one another.
15. What does it mean that water is 'polar'? Water is a "polar" molecule, meaning that there is an uneven distribution of electron density. Water has a partial negative charge (δ⁻) near the oxygen atom due to the unshared pairs of electrons, and partial positive charges (δ⁺) near the hydrogen atoms
16. What is an organic compound? Organic compounds always contain carbon along with other elements that are needed for living organisms to function.
17. Where does the energy come from in carbohydrates? The breaking of the bonds between the carbon, hydrogen and oxygen
18. What polysaccharide do plants use to store excess sugar? What do animals use?
Plants use plant starch to store excess sugar. Animals store excess sugar in a polysaccharide called glycogen, or animal starch
19. What is the subunit of proteins?
Amino acids
20. What are the roles of proteins? Proteins are large, complex molecules that play many critical roles in the body. They do most of the work in cells and are required for the structure, function, and regulation of the body's tissues and organs. ... Enzymes carry out almost all of the thousands of chemical reactions that take place in cells.

21. Explain how enzymes work. Enzymes are highly selective catalysts, meaning that each enzyme only speeds up a specific reaction. ... The molecules that an enzyme works with are called substrates. The substrates bind to a region on the enzyme called the active site.
22. What are the roles of lipids? Lipids, also known as fats, play many important roles in your body, from providing energy to producing hormones. You wouldn't be able to digest and absorb food properly without lipids.
23. What are the 2 parts of lipids? The two main parts of a triglyceride lipid are glycerol and fatty acids.
24. What is the difference between saturated and unsaturated lipids? Saturated fatty acids are where all the carbon atoms have single bonds between them making the lipid saturated as no more hydrogens can be added. ... On the other hand, unsaturated fatty acids are where there is a double bond between one or more of the carbon atoms in the hydrocarbon chain.
25. What do nucleic acids do? The main role of nucleic acids is to store information that is used to make proteins. Nucleic acids come in two main forms: deoxyribonucleic acids, also known as DNA, and ribonucleic acids, also known as RNA. The main function of DNA is to store the genetic information that cells in the body need to function.
26. What are the 2 kinds of nucleic acids?
DNA and RNA

Chapter 7: Cells and Plasma Membrane

Vocabulary

cell
cell theory
nucleus
eukaryote
prokaryote

1. What is resolution?
Resolution is the ability to distinguish two points as separate structures rather a single fuzzy dot.
2. Compare and contrast how compound light microscopes and electron microscopes work.
Both are types of microscopes. Light- uses light and mirrors to magnify images up to 1,000x
Electron – TEM – transmission electron shoots a beam of electrons through the specimen
SEM – scanning electron – passes a beam of electrons over a specimen
3. What kind of image does a TEM produce? An SEM? TEM-2D SEM-3D

4. Describe the main difference and 2 similarities between prokaryotes and eukaryotes. (Hint: "They are both cells," or "they are both alive," are not acceptable answers.) They have vacuoles, vesicles and DNA. Pro- no nucleus Eu- nucleus

5. What do the terms 'prokaryote' and 'eukaryote' mean?

A eukaryote is an organism whose cells contain a nucleus within a membrane. ... The word eukaryote comes from the Greek eu, "well," and karyon, "nut or kernel," which is a common scientific word-forming element that's used to talk about the nuclei of cells. A prokaryote is a unicellular organism that lacks a membrane-bound nucleus, mitochondria, or any other membrane-bound organelle. The word prokaryote comes from the Greek πρό (pro) "before" and κάρυον (karyon) "nut or kernel". ...

6. What did each of the following scientists do to contribute to the Cell Theory? Leeuwenhoek, Schleiden, Schwann, Virchow, Hooke

Hooke- coined the term cells

Leeuwenhoek – first to see living things in a microscope

Schleiden- all plants are made of cells

Schwann- all animals are made of cells

Virchow- all living cells must come from pre-existing

7. Write the 3 parts of the cell theory. All known living things are made up of one or more cells. All living cells arise from pre-existing cells by division. The cell is the fundamental unit of structure and function in all living organisms.

8. What are 3 differences and 3 similarities between plant and animal cells? (Hint: "They are both cells," or "they are both alive," are not acceptable answers.)

Structurally, plant and animal cells are very similar because they are both eukaryotic cells. They both contain membrane-bound organelles such as the nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, and peroxisomes. Both also contain similar membranes, cytosol, and cytoskeletal elements. Differences plant cells have a cell wall, chloroplasts and animal cells have lysosomes

9. Write a short description of the function of each of the following organelles. Cell Membrane, Cell Wall, Nucleus, Nucleolus, Cytoplasm, Endoplasmic Reticulum (ER), Ribosome, Cytoskeleton, Mitochondria, Golgi Apparatus, Lysosome, Vacuole, Plastid, Chloroplast, Cilia, Flagella. Be able to identify the organelles in cell diagram.

10. What are the 5 levels of cell organization, in order?

Cell, tissue, organ, organ system, organism

11. What does it mean that cells in multicellular organisms are *specialized*? Why aren't the cells of unicellular organisms specialized? Specialized – certain cells have specific jobs (i.e.

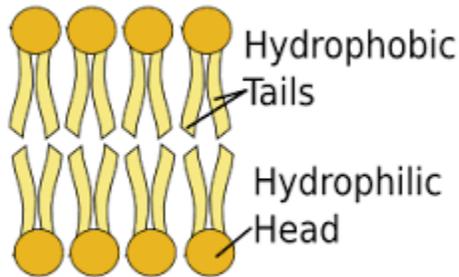
Unicellular – must do all jobs because it is only one cell

12. What is the Endosymbiotic Theory?

The endosymbiotic theory states that some of the organelles in today's eukaryotic cells were once prokaryotic microbes

13. Define homeostasis. the tendency toward a relatively stable equilibrium, maintaining a stable internal environment.
14. What 2 compounds make up the plasma membrane?
Lipid and protein
15. Draw a phospholipid. Label phosphate head and fatty acid tails. Which is hydrophilic and which is hydrophobic?

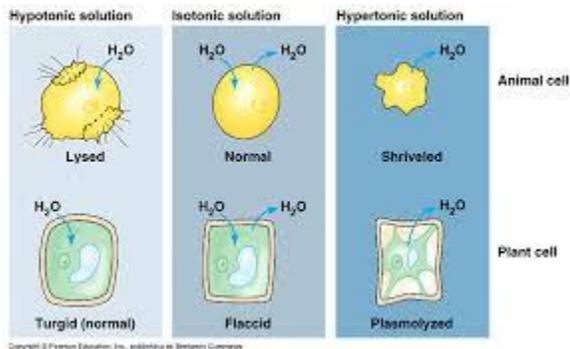
Extracellular Fluid



Intracellular Fluid

16. How does the presence of cholesterol affect the plasma membrane?
17. Without cholesterol, cell membranes would be too fluid, not firm enough, and too permeable to some molecules.
18. How does the presence of unsaturated phospholipids affect the plasma membrane
When we increase the amount of unsaturated fatty acids in our cell membrane, the fluidity also increases.
19. What is the Fluid Mosaic Model? Be sure to address both words, 'fluid' and 'mosaic'.
The cell membrane- Fluid – the phospholipid bilayer is viscous and individual phospholipids can move position
Mosaic – the phospholipid bilayer is embedded with proteins, resulting in a mosaic of components
20. Define diffusion. On what 2 concepts is diffusion based?
Diffusion is the net passive movement of particles (atoms, ions or molecules) from a region in which they are in higher concentration to regions of lower concentration. It continues until the concentration of substances is uniform throughout. Passive and active transport.
21. What is a concentration gradient? A gradual change in the concentration of solutes in a solution as a function of distance through a solution
22. What is dynamic equilibrium? a state of balance between processes.
23. What is a hypotonic solution? What happens to cells placed in it? A hypotonic solution is any solution that has a lower osmotic pressure than another solution, refers to a solution that has less solute and more water than another solution. Cell- explodes

24. What is a hypertonic solution? What happens to cells placed in it? A hypertonic solution is a particular type of solution that has a greater concentration of solutes on the outside of a cell when compared with the inside of a cell. Cell- shrinks
25. What is an isotonic solution? What happens to cells placed in it? An isotonic solution refers to two solutions having the same osmotic pressure across a semipermeable membrane. This state allows for movement of water across the membrane without changing the concentration of solutes on either side. Cell- water moving in and out at same rate
25. What is turgor pressure? In what kind of solution must a plant cell be placed to increase turgor pressure? The water pressure inside plant cells is called turgor pressure, and it is maintained by osmosis. Hypotonic
26. What organelle keeps a plant cell from bursting with too much water? Contractile vacuoles
27. How does being placed in a hypertonic solution affect a plant? It would cause the plant to shrink
28. What is plasmolysis? What does the inside of a plant cell look like that has undergone plasmolysis? Plasmolysis is when plant cells lose water after being placed in a solution that has a higher concentration of solutes than the cell does. A hypertonic solution causing the material in the plant cell to shrink away from the cell wall.
29. Which kind of transport requires a cell to expend energy, active or passive? Active
30. Channel and Carrier Proteins are both involved in which kind of transport, active or passive? Active
31. Define endocytosis and list two examples. Process of taking large molecules into the cell i.e. pinocytosis, phagocytosis
32. Define exocytosis. Is it an example of active or passive transport? Process of removing waste and large molecules from the cell. Active
33. Draw 3 beakers each containing a large cell floating in a hypertonic solution, a hypotonic solution and an isotonic solution. Include which direction the water would flow.



Chapter 8 Photosynthesis

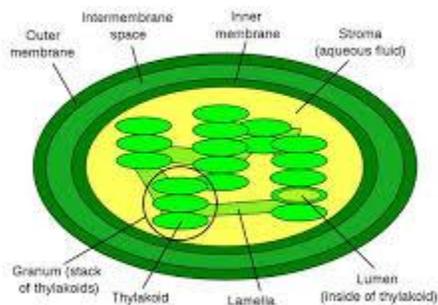
Vocabulary

autotroph

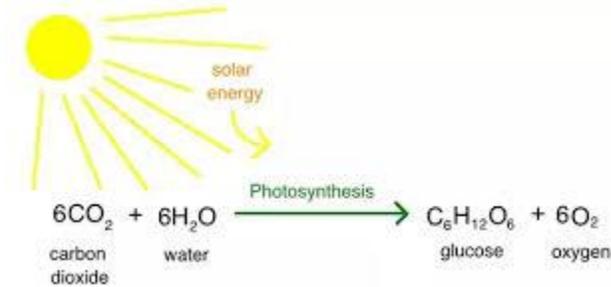
heterotroph

adenosine triphosphate (ATP)

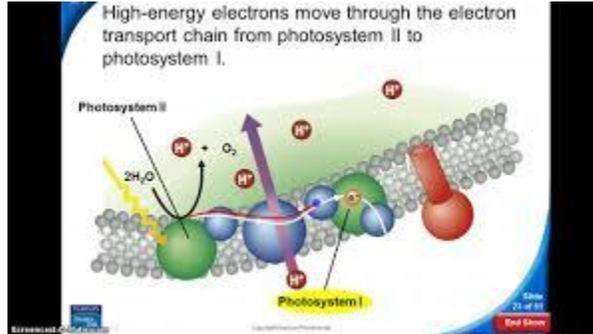
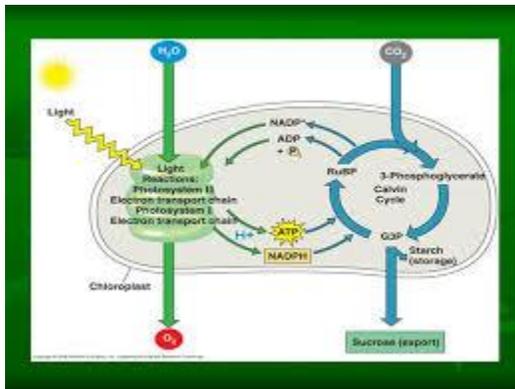
1. What are autotrophs? Give an example. Organisms that can make their own food i.e plants
2. What are heterotrophs? Give an example. Organisms that must obtain food by eating other things i.e. animals
3. What is ATP? What is its role in the cell? ATP (Adenosine triphosphate) ATP is a nucleotide that performs many essential roles in the cell. It is the major energy currency of the cell, providing the energy for most of the energy-consuming activities of the cell.
4. What is photosynthesis (definition)? the process by which green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water. Photosynthesis in plants generally involves the green pigment chlorophyll and generates oxygen as a byproduct.
5. List the 4 things required for photosynthesis to take place. Plants need water, sunlight, carbon dioxide, and chlorophyll.
6. How are chloroplasts, thylakoids, stroma, grana and chlorophyll related?



7. Write the equation for photosynthesis. Under the equation, write the words for each symbol.



8. What is the “purpose” of the light-dependent reactions of photosynthesis? Explain each step in the light-dependent reactions, including light absorption, electron transport, oxygen production (water splitting) and the formation of the energy-containing molecules.



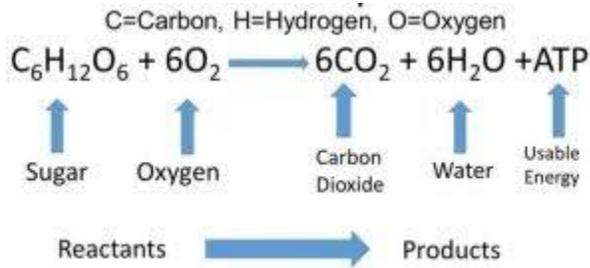
9. What is ATP Synthase? What does it do in photosynthesis? ATP synthase harnesses the flow of protons to make ATP from ADP and phosphate. Gives the cells energy.
10. Why are the light-dependent reactions important to the light-independent reactions (Calvin Cycle)? What is produced from the Calvin Cycle? Light dependent reactions give the energy to the light independent reaction to produce glucose.

Chapter 9 Cellular Respiration

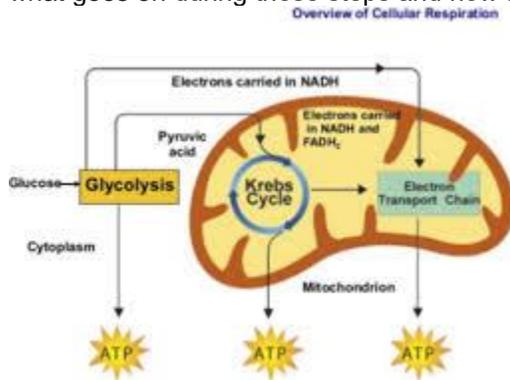
Vocab

calorie
glycolysis
cellular respiration
NAD⁺
fermentation
anaerobic
aerobic
Krebs cycle
electron transport chain

1. Write the equation for cellular respiration. Under the equation, write the words for each symbol.



2. Cellular respiration has three main steps, Glycolysis, Krebs Cycle, and electron transport. Explain what goes on during these steps and how they each relate to the “purpose” of cellular respiration.



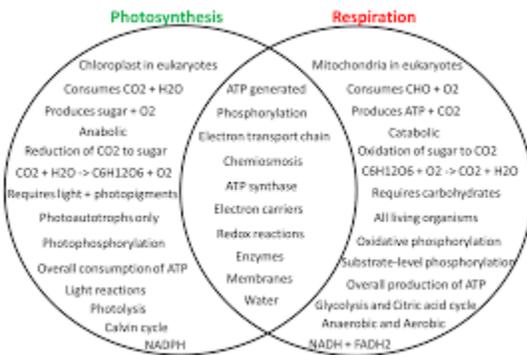
3. What is ATP Synthase? What does it do in cellular respiration?
ATP synthase harnesses the flow of protons to make ATP from ADP and phosphate. Gives energy to the cell.
4. After glycolysis, if oxygen is present, what process occurs next? If no oxygen is present, what process will occur? Krebs cycle. Fermentation.
5. What is fermentation? Why is it called anaerobic?
Fermentation is an anaerobic process in which energy can be released from glucose even though oxygen is not available. Anaerobic – no oxygen present.
6. What is the purpose of lactic acid fermentation, in general? How does it do that?

In lactic acid fermentation, the pyruvic acid from glycolysis is reduced to lactic acid by NADH. Which maintains energy production in cells when no oxygen is present.

7. What is the purpose of alcoholic fermentation, in general? How does it do that?

The main purpose of alcohol fermentation is to produce ATP, the energy currency for cells, under anaerobic conditions. The 2 pyruvate molecules are converted into 2 carbon dioxide molecules and 2 molecules of ethanol.

8. How does yeast make bread rise? This organism lies dormant until it comes into contact with warm water. Once reactivated, yeast begins feeding on the sugars in flour, and releases the carbon dioxide that makes bread rise (although at a much slower rate than baking powder or soda).
9. In the end, how many molecules of ATP are produced from all parts of cellular respiration?
34-38 ATP
10. Which organisms use photosynthesis? Which organisms use cellular respiration?
Plants, Animals
11. Compare and contrast photosynthesis and cellular respiration. Include at least 2 similarities and 3 differences.



12. Find your diagrams of photosynthesis and cellular respiration. Write a paragraph describing both cycles in detail.

Chapter 10 Cell Cycle

Vocab

cell division
mitosis
cytokinesis
chromatid
centromere
interphase
cell cycle
prophase
centriole
spindle
metaphase
anaphase
telophase
cyclin
cancer

1. During most of a cell's life cycle, chromosomes exist as uncoiled __Chromatin_____.
2. Before a cell begins to divide, chromatin begins to _____condense_____, forming tightly packed __chromosomes_____.

3. Sister Chromatids are attached to each other by a _____centromere_____.
4. _____cell regulation ____ occurs when cells stop growing because they are touching each other.
5. The _____spindle____ is the cage-like structure that helps pull chromosomes apart during mitosis.
6. DNA is replicated during the _____S_____ stage of interphase.
7. During metaphase, the fibers of the spindle are anchored at the ends by the ____centrosome_____.
8. _____interphase_____ is the period of non division and growth during the cell cycle.
9. _____Cancer____ may occur as a result of a loss of control of the cell cycle.
10. What are the 3 parts of the cell cycle? What occurs during each part?

Interphase- cell growth and preparing for division mitosis- dividing the parts of the cell cytokinesis- division of the cytoplasm

11. What is the main function of mitosis? The main function is for cell growth and repair
12. What is cytokinesis? The cytoplasmic division of a cell at the end of mitosis or meiosis, bringing about the separation into two daughter cells.
13. What are sister chromatids? Identical copies formed by DNA replication of a chromosome held together at the centromere.
14. Describe the 3 parts of Interphase. They are G1, S, and G2. ... The G1 and G2 phases are times of growth and preparation for major changes. S phase is the synthesis phase when DNA replication occurs.
15. What is the role of the spindle during mitosis? The spindle is necessary to equally divide the chromosomes in a parental cell into two daughter cells during both types of nuclear division: mitosis and meiosis.
16. What are Cyclins and what do they do? They are proteins that regulate the timing and control of the cell cycle.
17. What is cancer? A disease associated with uncontrolled cell growth.
18. What causes cancer? Inability for cell to control growth and divides uncontrollably.

Chapter 11 Genetics

Vocab

genetics
 fertilization
 true-breeding
 trait
 hybrid
 gene
 allele
 segregation
 gamete
 probability

Punnett square
 homozygous
 heterozygous
 phenotype
 genotype
 independent assortment
 incomplete dominance
 codominance
 multiple alleles
 polygenetic traits
 homologous
 diploid
 haploid
 meiosis
 tetrad
 crossing-over
 gene map

1. For flower color, purple (P) is dominant over white (p). Cross a heterozygous purple flower with a white flower.

50% hetero
 50% homo re
 50% purple
 50% white

	P	p
P	Pp	Pp
p	Pp	pp

$Pp \times pp$

2. Cross a heterozygous purple flower with a heterozygous purple flower.

25% homo dom
 50% hetero
 25% homo re.
 75% purple
 25% white

	P	p
P	PP	Pp
p	Pp	pp

$Pp \times Pp$

3. In some zebras, the allele for floppy ears (F) is dominant over the allele for rigid ears (f), and the allele for black hooves (B) is dominant over the allele for brown hooves (b). Predict the results of a cross between a parent of the genotype FfBB and a parent of the genotype ffBb.

50% floppy
 black

50% rigid
 black

	Fb	Fb	fb	fb
Fb	FfBb	FfBB	ffBB	ffBb
fb	FfBb	FfBb	ffBb	ffbb
Fb	FfBB	FfBB	ffBB	ffBb
fb	FfBb	FfBb	ffBb	ffbb

Fb Fb fb fb

ffBb
 FfBb
 FfBB
 ffBB

4. Now cross two doubly heterozygous zebras ($FfBb \times FfBb$).

	FB	Fb	fB	fb
FB	$FFBB$	$FFBb$	$FfBB$	$FfBb$
Fb	$FFBb$	$Ffbb$	$FfBb$	$Ffbb$
fB	$FfBB$	$FfBb$	$ffBB$	$ffBb$
fb	$FfBb$	$Ffbb$	$ffBb$	$ffbb$

FB	Fb	fB	fb	
$ffbb$	$ffBb$	$Ffbb$	$ffbb$	9/16 floppy black
$ffBB$	$FfBB$	$ffBB$	$ffBb$	3/16 floppy brown
$FFbb$	$FFBb$	$Ffbb$	$FFbb$	3/16 rigid black
$FFBb$	$FFBB$	$FfBb$	$FFBB$	1/16 rigid brown

- What is a testcross? When is it used? Create an example of how it would be used. Test crosses are used to test an individual's genotype by crossing it with an individual of a known genotype. The purpose of a test cross is to determine if this individual is homozygous dominant or heterozygous.
- List 2 differences between mitosis and meiosis. Mitosis – one stage, diploid daughter cells Meiosis- 2 stages, haploid cells
- How many chromosomes do human cells contain? 46
- What is a zygote? The cells that form with the fusion of two haploid cells- sperm fertilizing an egg
- What does it mean if a cell is haploid? Give an example of a haploid cell.
Haploid is the term used when a cell has half the usual number of chromosomes. Sex cells- sperm, egg
- What does it mean if a cell is diploid? Give an example of a diploid cell.
A diploid cell is a cell that contains two sets of chromosomes. All your body cells.
- Explain crossing over. When does it occur? When homologous chromosomes pair up with each other and exchange different segments of genetic material to form recombinant chromosomes. It occurs between prophase 1 and metaphase 1 of meiosis
- Describe oogenesis and how it differs from spermatogenesis. Oogenesis, second meiosis results into 4 daughter cells, one of which becomes mature secondary oocyte (egg) while other 3 are converted to polar bodies that degenerate. spermatogenesis is the formation of sperm (mature male germ cells)

Chapter 12 DNA and RNA

Vocab

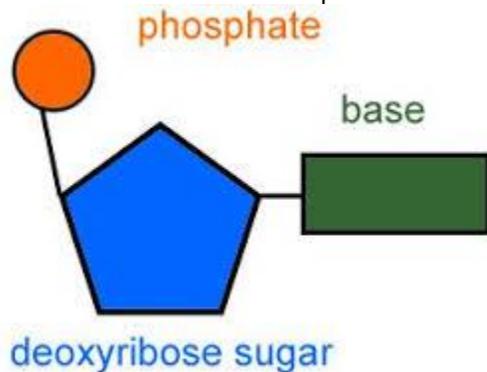
transformation
bacteriophage
nucleotide
base pairing
chromatin
histone
replication
DNA polymerase
gene
messenger RNA
ribosomal RNA
transfer RNA
transcription
RNA polymerase
promoter
intron
exon
codon
translation
anticodon
mutation
point mutation
frameshift mutation
polyploidy
operon
operator
differentiation
hox gene

1. What technique did Rosalind Franklin use to get information about the structure of DNA?

Rosalind Franklin using a technique called X-ray crystallography, it revealed the helical shape of the DNA molecule.

2. Describe Watson and Crick's model of DNA. Watson and Crick's model is composed of two strands that are connected by bonds between nitrogen bases that has a spiral shape. The model showed that the DNA molecule is a double-helix.

3. What are the three basic parts of a nucleotide?



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4. What are the two parts that make up the backbone of DNA? It has an alternating chemical phosphate and sugar backbone, making the 'sides' of the ladder.

5. What are Chargaff's rules with regards to base pairing? Chargaff's rules states that DNA from any cell of all organisms should have a 1:1 ratio (base Pair Rule), that the amount of guanine is equal to cytosine and the amount of adenine is equal to thymine

6. Where is the DNA of eukaryotes located? The nucleus

7. List the steps of replication.

The Replication Process

1. DNA separates into two strands
 - Accomplished by the enzyme helicase
 - Creates a replication fork
 - Each strand is a template for a new one
2. New bases are added
 - Accomplished by the enzyme DNA polymerase, which also proofreads DNA
 - Follows the rules of base pairing
 - Moves in opposite directions
3. Two identical copies are created
 - Each copy has an original strand and a new strand



8. Name and describe the functions of the three types of RNA. Messenger or mRNA- transcribes from DNA, ribosome or rRNA – where translation occurs. Transfer or tRNA brings the amino acids to the ribosome to match with the codon

9. Explain the process of going from DNA to RNA to protein. DNA-RNA is transcription RNA to protein is translation

10. What would be the complimentary strand of DNA for the following sequence? ATTCGCA - TAAGCGT

11. Complete the following sequence given the following DNA code. DNA: ATG CTC ACT TTA mRNA: UAC GAG UGA AAU

12. Compare and Contrast

	DNA	mRNA	tRNA
Is it double or single stranded?	Double	single	single
What type of sugar is used?	Deoxyribose	ribose	ribose
List all nitrogen bases it has.	Thymine, Guanine, cytosine, adenine	U,A,C,G	U,A, C,G
Which nitrogen base is missing?	Uracil	Thymine	Thymine
Where is it located in the cell?	Nucleus	ribosome	ribosome

Chapter 13 Genetic Engineering

vocab

selective breeding
hybridization
inbreeding
genetic engineering
restriction enzyme
gel electrophoresis
recombinant DNA
polymerase chain reaction (PCR)
plasmid
genetic marker
transgenic
clone

1. What is meant by selective breeding? Selective breeding, also known as artificial selection, is a process used by humans to develop new organisms with desirable characteristics. Breeders select two parents that have beneficial phenotypic traits to reproduce, yielding offspring with those desired traits.

2. Circle the letter of each organism that has been produced by selective breeding:

a. Horses b. Dogs c. Cats d. Potatoes

3. Complete the table describing the types of selective breeding:

Type of Breeding	Description	Examples
Hybridization	Crossing dissimilar individuals to bring together the best of both organisms	Puggle, horse,
Inbreeding	The continued breeding of individuals with similar characteristics	Golden retriever, cows

4. True or False: Hybrids are often hardier than either of the parents. True

5. True or False: To maintain the desired characteristics of a line of organisms, breeders often use hybridization. False

6. What are the risks of inbreeding? Inbreeding can increase risk of undesirable genes and a reduction in genetic diversity.

7. Circle the letter of an inheritable change in DNA.

a. Variation b. Trait c. Mutation d. Genotype

8. True or False: Mutations cannot occur spontaneously. True

10. Name 2 methods used by breeders to increase the rate of mutation.

a. radiation b. chemicals

11. True or False: Scientists have produced bacteria that can digest oil. True

12. Circle the letter of each sentence that is true about polyploidy:

- a. Polyploid plants have many sets of chromosomes.
- b. Polyploidy is usually fatal in animals.
- c. Polyploidy produces new species of plants that are weaker and smaller than their diploid relatives.
- d. Bananas and some citrus fruits are polyploid.

13. What is genetic engineering? Genetic engineering is making changes in the DNA code of a living organism.

14. True or False: Making changes to the DNA code is similar to changing the code of a computer program. True

15. Biologists use _____ restriction enzymes _____ to cut DNA molecules at a specific sequence of nucleotides to make smaller fragments.

16. Circle the letter of the process by which DNA fragments are separated and analyzed:

- a. Gel electrophoresis
- b. extraction
- c. transformation
- d. restriction

17. Circle the letter of each sentence that is true about gel electrophoresis:

- a. An electric voltage applied to the gel separates the DNA fragments.
- b. DNA molecules are positively charged.
- c. Gel electrophoresis is used to compare the genomes of different organisms.
- d. Gel electrophoresis can be used to locate and identify one particular gene in an individual's genome.

18. True or False: The pattern of colored band on a gel tells the exact sequence of bases in DNA. True

19. Enzymes that splice DNA together can also be used to join ___synthetic___ DNA sequences to natural DNA sequences.

20. How is recombinant DNA produced? It is produced by combining DNA from different sources.

21. What is polymerase chain reaction (PCR)? It is a technique that allows biologists to make many copies of a particular gene.

22. What occurs during transformation? A cell takes in DNA from outside the cell. This external DNA becomes a part of the cell's DNA.

23. True or False: Griffith's extract of heat-killed bacteria contained DNA fragments. True

24. Give 2 reasons why a plasmid is useful for DNA transfer. It has a DNA sequence that serves as a bacterial origin of replication, ensuring that the foreign DNA will be replicated. It has a genetic marker—a gene that makes it possible to distinguish bacteria that carry the plasmid from those that don't.

25. Describe what occurs in a successful transformation of cells. The recombinant DNA is integrated into one of the chromosomes of the cell.

26. True or False: The DNA molecules used for transformation of animal cells do not require marker genes. False

27. True or False: Gene replacement has made it possible to identify the specific functions of genes in many organisms. True

28. What is a transgenic organism? It is an organism that contains genes from other organisms.

29. Describe how to make a transgenic organism. Using basic techniques of genetic engineering, a gene from one organism can be inserted into cells from another organism.

30. Circle the letter of each sentence that is true about transgenic microorganisms:

- a. Transgenic bacteria will never produce useful substances for health and industry.
- b. Transgenic bacteria produce human proteins cheaply and in great abundance.
- c. People with insulin-dependent diabetes are now treated with pure human insulin.
- d. In the future, transgenic organisms may produce the raw materials for plastics.

31. List 4 ways in which transgenic animals have been used.

- a. study genes
- b. To improve the food supply
- c. To study the effects of diseases on the human immune system
- d. To produce human proteins

32. Many transgenic plants contain genes that produce a natural _____ insecticide ____, so the crops do not have to be sprayed with pesticides.

33. What is a clone? It is a member of a population of genetically identical cells produced from a single cell.

34. True or False: All cloned animals are also transgenic. false