This packet contains helpful information for you to prepare for the upcoming Biology Keystone Test on May 15th and 16th. As you will see, this packet is broken down into several major themes that the Keystone Test will cover. You will be assigned to do parts of this packet over the next several days for a grade. Please take the time to read through and complete each section with your best possible efforts. The preparation you put into this packet and trying to “re-learn” the material will benefit you as if you do well on the test this time, you will not have to take it again. If the score of the test does not meet expectations of the state, the test will need to be taken again. So this is a big deal.

We all understand that you still have your regularly scheduled science class and that this is a lot of stuff coming at you (again) in a short amount of time, but we are confident that we can do this together. Refresh your biology memories, advocate for yourself with a science teacher if you do not understand concepts or ideas, put forth a solid effort in completing the tasks and learning the material...it can be done!

Major themes covered in this packet:
- Themes of Life
- Organic Chemistry
- Cells and Cell Transport
- Energy
- Cell Reproduction & Genetics
- Protein Synthesis
- Evolution/Phylogeny
- Ecology

Each section will have major vocabulary words that you should be familiar with, the major content anchors that you should be able to answer questions about, some questions that will refresh your memory and then some practice test questions.

A wikispace has been set up to help you be successful in relearning the material. The address of the wikispace is www.udkeystone.wikispaces.com - use this to your advantage. Your teachers have worked very hard to help you - now it is your turn.
Cell Reproduction & Genetics

Vocabulary
Allele
Cell cycle
Chromosomes
Cloning
Co-dominance
Crossing over
Cytokinesis
DNA replication
Dominant inheritance
Gamete
Gene
Gene splicing
Gene therapy
Gene recombination
Genetic engineering
Genetics
Incomplete dominance
Inheritance
Interphase
Meiosis
Mitosis
Multiple alleles
Nondisjunction
Polygenic trait
Recessive inheritance
Semiconservative replication
Sex-linked trait
Genetically modified organism
genotype
phenotype

Concepts to Know

Main Concept #1: Describe the events that occur during the cell cycle: interphase, nuclear division (i.e. mitosis), cytokinesis.

- The Cell cycle – period of time from the beginning of one cell division to the beginning of the next
  - During the cell cycle, a cell grows, prepares for division, and divides to form two daughter cells, each of which then begins the cell cycle again
  - Consists of 4 phases
    - M phase – mitosis – the division of the cell nucleus and cytokinesis
    - G1 – intense growth and activity
    - S phase – copying of chromosomes
    - G2 – intense growth and activity
● G stands for gap

● Interphase – time between two cell divisions
  o Interphase can be broken into 3 phases: G1, S, G2
    ▪ G1 cells do most of their growing, increasing in size and synthesizing new proteins and organelles
    ▪ S chromosomes are duplicated and the synthesis of DNA molecules takes place
  ● Once cell enters S phase, it completes cell cycle
    ▪ G2 usually shortest of 3 phases
  ● Organelles and proteins required for cell division are produced
  ● Cell enters M phase once complete

MITOSIS

● Biologists divide the events of mitosis into 4 phases: prophase, metaphase, anaphase, and telophase
  1. prophase – 1\textsuperscript{st} and longest phase of mitosis (50-60\% of total time)
    o chromosomes become visible
    o centrioles separate and take up positions on opposite sides of the nucleus
     ▪ focal point that helps organize spindle (fan-like microtubule structure that helps separate the chromosomes
     ▪ chromosomes attach to spindle at the centromere
     ▪ plants do not have centrioles
    o organize spindle from areas called centrosomes
    o nucleolus disappears
    o nuclear envelope breaks down
  2. metaphase – 2\textsuperscript{nd} phase of mitosis
    o chromosomes line up along center of the cell
    o microtubules connect the centromere of each chromosome to the poles of the spindle
  3. anaphase – 3\textsuperscript{rd} phase of mitosis
    o centromeres that join the sister chromatids split
    o chromatids separate and become individual chromosomes
    o chromatids get pulled apart, to the poles of the spindle
    o ends when they stop moving
  4. telophase – 4\textsuperscript{th} phase of mitosis
    o chromosomes become loose and begin to disperse
    o nuclear envelope reforms
    o spindle breaks apart
    o a nucleolus reappears
    o cytokinesis – division of the cytoplasm
     ▪ usually occurs at the same time as telophase
     ▪ in animals, cell membrane pinches in at the middle
     ▪ in plants, cell plate forms midway through the cell
    o beginning at the cell wall
**MEIOSIS**

- meiosis is a process of reduction division in which the number of chromosomes per cell is cut in half and homologous chromosomes in a diploid cell are separated
  - involves two distinct stages: meiosis I and meiosis II
  - one diploid cell becomes 4 haploid cells
- homologous – two sets of chromosomes (one from mom and one from dad)
  - if a cell has both sets of chromosomes = diploid (2n)
    - 2 complete sets of chromosomes with 2 complete sets of genes
  - gametes with only one set of chromosomes = haploid (n)
    - contain only one set of genes
- **meiosis I** – prior to meiosis I, each chromosome is replicated
  - chromosomes line-up similar to mitosis, except the homologous chromosomes for a tetrad (4 chromatids)
    - occurs during prophase I
    - crossing over may occur – results in the exchange of alleles between homologous chromosomes and produces new combinations of alleles
  - homologous chromosomes separate and two new cells are formed
- **meiosis II** – cells from meiosis I enter meiosis II
  - cell does not undergo chromosome replication
  - anaphase II – chromatids separate

![Diagram of meiosis](image)
Main Concept #2: Compare the processes of mitotic and meiotic nuclear division.

In the table provided, check all of the parts of the cell cycle that apply to the description in the left column. In mitosis, meiosis I, and meiosis II columns – state whether it happens in prophase (P),
**metaphase (M), anaphase (A), or telophase (T)**

<table>
<thead>
<tr>
<th>Description / Event</th>
<th>Interphase</th>
<th>Mitosis</th>
<th>Meiosis I</th>
<th>Meiosis II</th>
<th>Neither</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear membrane breaks down</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex cells result</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daughter cells are identical to parent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body cells result</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromatids line up single file during metaphase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final chromosome # is the same as the parent cell</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diploid cells result at end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homologous chromosomes join</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetrads form</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNA is replicated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromosomes are double file</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cytokinesis begins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transcription / translation occur</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spindle fibers form</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haploid Cells Result</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sister chromatids separate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crossing over happens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNA Replication occurs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- nondisjunction – failure of homologous chromosomes to separate during meiosis
  - if nondisjunction occurs, abnormal numbers of chromosomes may find their way into gametes, and a disorder chromosome numbers may result

**Main Concept #3: Describe how the process of DNA replication results in the transmission and/or conservation of**
Main Concept #4: Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.

- DNA Replication – copying of DNA
  - Ensures that each resulting cell will have a complete set of DNA molecule
  - During DNA replication, the DNA molecule separates into two strands, then produces two new complementary strands following the rules of base pairing. Each strand of the double helix of DNA serves as a template against which the new strand is made called semiconservative replication.

Two conclusions from Mendel’s experiments with the pea plant:
1. Biological inheritance is determined by factors that are passed from one generation to the next = **genes**
   - Each gene controlled one trait with two contrasting characters
   - Different forms of a gene = **alleles**
2. Principle of dominance – states that some alleles are dominant and others are recessive
   - Organism with dominant allele for a particular form of a trait will always have that form
   - Organism with recessive allele for a particular form of a trait will have that form only
- Segregation – separation of alleles
  - Done during formation of gametes (reproductive cells)

Main Concept #5: Describe and/or predict observed patterns of inheritance (i.e. dominant, recessive, co-dominance, incomplete dominance, sex-linked, polygenic, and multiple alleles).

- Probability – likelihood that a particular event will occur
  - Probability of two events happening, you multiply the individual probabilities
Past outcomes do not affect future ones
o The principles of probability can be used to predict the outcomes of genetic crosses
● Punnett square – diagram that helps determine gene combinations that might result from a genetic cross
● Capital letters represent dominant alleles; lower case letters represent lower case letters
● Homozygous – have two identical alleles – true-breeding
● Heterozygous – have two different alleles – hybrid – carrier
● Phenotype – physical feature
● Gentotype – genetic make-up

● for two genes, alleles segregate independently
o independent assortment – genes segregate independently and do not influence each other’s inheritance
  ▪ the principle of independent assortment states that genes for different traits can segregate independently during the formation of gametes
● some alleles are neither dominant nor recessive, and many traits are controlled by multiple alleles or multiple genes
  o incomplete dominance – one allele is not completely dominant over another
  ▪ heterozygous phenotype is somewhere between two homozygous phenotypes
  o codominance – both alleles contribute to the phenotype of the organism
  ▪ heterozygous phenotypes have some of both homozygous phenotypes
  o multiple alleles – genes that have more than 2 possible alleles
  o polygenic traits – traits that result from the interaction of many genes
  ▪ these traits are also greatly influenced by the environment

Monohybrid Cross

1. Two fish meet at the coral reef, fall in love, and get married that same night. They decide to make babies right away. The mom fish has a big fluffy tail (TT) while the dad has a very boring flat tail (tt). The dad is worried that he will pass his ugly tail down to his kids. What is the chance that the first child will have a flat tail?

T = fluffy tail     t = flat tail

Genotypic Ratio: ___________________________  Phenotypic Ratio: ___________________________
Codominance

1. The palomino horse is a hybrid (mix) showing a golden coat with a lighter mane and tail. A pair of codominant alleles, D1 and D2 is known to be involved in this trait. Horses with the D1D1 genotype are chestnut colored, horses with the D1D2 genotype are palomino, and horses with the D2D2 genotype are white in color.

A. Two palomino horses are mated by artificial insemination. What types of offspring could be produced?

Sex-Linked Traits

1. White eyed fruit flies are the result of a sex-linked recessive gene. Show the results from a cross between a red-eyed (R) male and white-eyed (r) female fruit fly.

Main Concept #6: Explain how genetic engineering has impacted the fields of medicine, forensics, and agriculture (e.g., selective breeding, gene splicing, cloning, genetically modified organisms, gene therapy).

- selective breeding – allowing only those animals with desired characteristics to produce the next generation
- humans use selective breeding to pass desired traits on to the next generation of organisms
- genetic engineering – making changes in the DNA code of living organisms
- Cutting / Splicing DNA
- Restriction enzymes – cuts DNA at a specific sequence of nucleotides
- cutting and pasting
  - recombinant DNA – taking DNA and “pasting” it to another organism’s DNA
- transgenic organisms /genetically modified organisms– organisms that contain genes from other organisms
- using the basic techniques of genetic engineering, a gene from one organism can be inserted into cells from another organism. These transformed cells can then be used to grow new organisms
- clone – member of a population or genetically identical cells produced from a single cell
- gene therapy is the process of attempting to cure genetic disorders by placing copies of healthy genes into cells that lack them

Practice Questions:
1. Which statement best describes the phase of the cell cycle shown?
   A. The cell is in prophase of mitosis because the number of chromosomes has doubled.
   B. The cell is in prophase I of meiosis because the number of chromosomes has doubled.
   C. The cell is in telophase of mitosis because the cell is separating and contains two copies of each chromosome.
   D. The cell is in telophase of meiosis because the cell is separating and contains two copies of each chromosome.

2. Mitosis and meiosis are processes by which animal and plant cells divide. Which statement best describes a difference between mitosis and meiosis?
   A. Meiosis is a multi-step process.
   B. Mitosis occurs only in eukaryotic cells.
   C. Meiosis is used in the repair of an organism.
   D. Mitosis produces genetically identical daughter cells.

   Suppose that the central C-G base pair in the DNA molecule below is substituted by an A-T base pair.

![DNA molecule with central C-G base pair substituted by A-T base pair]

3. What is the most likely result of this mutation?
   a. genetic variation
   b. genetic clones
   c. incomplete translation
   d. identical offspring

4. Hemophilia is an inheritable genetic disorder that prohibits the proper formation of blood clots. The recessive gene that causes hemophilia is located on the X-chromosome. Given this information, which of the following statements is true?
   a. In order for a male offspring to be a hemophiliac, his mother must be a hemophiliac.
   b. In order for a female offspring to be a hemophiliac, her father must be a hemophiliac.
   c. In order for a male offspring to be a hemophiliac, his father must be a hemophiliac.
   d. In order for a female offspring to be a hemophiliac, her mother must be a hemophiliac.

5. Which of the following statements is true?
a. Mitosis results in the formation of two haploid gametes which can then combine to form a diploid daughter cell.
b. During the process of meiosis, haploid cells are formed. After fertilization, the diploid number of chromosomes is restored.
c. The process of meiosis forms daughter cells which are genetically identical to their parent cells.
d. The daughter cells formed during mitosis are genetically similar to, though not identical to, their parent cell.

6. Which of the following best describes the way that genes, chromosomes, and DNA are related?
a. Chromosomes contain several genes, which are made up of sequences of DNA.
b. Genes contain several chromosomes, which are made up of sequences of DNA.
c. Genes contain several sequences of DNA, which are made up of chromosomes.
d. Sequences of DNA contain several genes, which are made up of chromosomes.

7. If a cat has 38 chromosomes in each of its body cells, how many chromosomes will be in each daughter cell after mitosis?
   a. 19  b. 76  c. 11  d. 38

8. Tom is going to buy two hamsters. He wants to breed them and sell the baby hamsters to a local pet store. The store owner tells him that his customers prefer dark brown hamsters with white bellies, long fur, black eyes, and long tails. Tom found a female hamster with all of those characteristics. Which male hamster should Tom buy in order to have the BEST chance of breeding baby hamsters with MOST of those characteristics?

<table>
<thead>
<tr>
<th>Hamster W</th>
<th>Hamster X</th>
<th>Hamster Y</th>
<th>Hamster Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tan Fur Dark</td>
<td>Brown Fur</td>
<td>Tan Fur</td>
<td>Dark Brown Fur</td>
</tr>
<tr>
<td>White Belly</td>
<td>White Belly</td>
<td>White Belly</td>
<td>Dark Brown Belly</td>
</tr>
<tr>
<td>Long Fur</td>
<td>Long Fur</td>
<td>Short Fur</td>
<td>Long Fur</td>
</tr>
<tr>
<td>Long Tail</td>
<td>Long Tail</td>
<td>Long Tail</td>
<td>Short Tail</td>
</tr>
<tr>
<td>Brown Eyes</td>
<td>Brown Eyes</td>
<td>Black Eyes</td>
<td>Black Eyes</td>
</tr>
</tbody>
</table>


Open-ended Question:
9. Patau syndrome can be a lethal genetic disorder in mammals, resulting from chromosomes failing to separate during meiosis.

**Part A:** Identify the step during the process of meiosis when chromosomes would **most likely** fail to separate.

*Most likely chromosomes would fail to separate during anaphase I or Anaphase II. In anaphase, chromosomes (anaphase I) or sister chromatids (anaphase II) are supposed to separate, or move AWAY from each other. This is called Nondisjunction.*

**Part B:** Describe how chromosome separation in meiosis is different from chromosome separation in mitosis.

*During meiosis cells and the genetic material is divided twice (the first set of division is meiosis I and the second set is meiosis II). In mitosis, the cell and chromosomes divide once.*

**Part C:** Compare the effects of a disorder caused by chromosomes failing to separate during meiosis, such as Patau syndrome, to the effects of chromosomes failing to separate during mitosis.

*Due to the improper number of chromosomes, the organism has an improper amount of genetic material in the form of DNA of the sperm or egg. This mutation will be found in*
every cell of the organism’s body.

If chromosomes fail to separate during mitosis, it does not affect the sex cells but a body cell. This mutant body cell then can be reproduced and produce more of the abnormal cells. The cell either dies or is replicated quickly. This could possibly lead to cancer if the cells are not destroyed by the immune system.