Name:  

**Study Guide WITH ANSWERS: Biology Spring Semester Final Exam**  
Check your grades in Pinnacle or with Mrs. Campbell on the following standards. Write your grades in the table below.

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**Your final is next week!** You have a chance to improve these grades by doing well on the final. I will do grade replacements ONLY if you finish final corrections. Lower grades on the final will be averaged with your current grades. Prepare yourself for the final by completing the following study guide. This study guide will cover the BASICS from each unit and refresh your memory on some of the trickier parts, but you should review your notes if you wish to earn a 4 on each standard.

**MEIOSIS AND GENETICS**  
**Standard 2a. Students know** meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type.

Define *diploid* and *haploid.*  
A diploid cell has two copies of each unique chromosome. A haploid cell has one copy of each chromosome.  
Define *homologous.*  
Homologous mean similar but not identical. Homologous chromosomes have the same genes in the same places, but may not have the same alleles.  
How many cell divisions occur during meiosis?  
There are two cell divisions in meiosis.  
How many daughter cells result from meiosis?  
Meiosis results in four daughter cells.  
What happens during crossing over? When does crossing over occur?  
When chromosomes cross over, they exchange homologous sections. Crossing over only occurs during meiosis.
Standard 2b. **Students know only certain cells in a multicellular organism undergo meiosis.**

Define gamete.
A gamete is a sex cell (an egg cell or a sperm cell). Also called *germline cells.*
What kinds of cells are produced from meiosis?
Meiosis produces gametes.

Compare and contrast oogenesis and spermatogenesis.
Both oogenesis and spermatogenesis are sex-specific forms of meiosis and result in gametes. Oogenesis is the production of egg cells. Oogenesis results in one large egg cell and three smaller, non-functional polar bodies. Spermatogenesis is the production of sperm cells. Spermatogenesis results in four equal sized sperm cells.

Compare and contrast germline cells and somatic cells.
Germline cells are egg cells and sperm cells only. Somatic cells are all other cells of the body – muscle cells, neurons, skin cells, etc.

**Standard 2c. Students know how random chromosome segregation explains the probability that a particular allele will be in a gamete.**

What is Mendel’s Law of Segregation?
Mendel’s law of segregation states that allele pairs separate during gamete formation.

Define **heterozygous.**
An organism that is heterozygous for a particular trait will have two different alleles. The dominant allele will be expressed in the phenotype.

Define **homozygous dominant** and **homozygous recessive.**
An organism that is homozygous dominant has two copies of a dominant allele for particular gene. An organism that is homozygous recessive has two copies of a recessive allele for particular gene.

After meiosis, how many chromosomes are in the final daughter cells compared to the original parent cell?
After meiosis, the daughter cells have \( \frac{1}{2} \) the number of chromosomes as the parent cells.

If you have one allele for attached earlobes and one allele for free-hanging earlobes, what is the probability that one of your gametes, selected at random, has the allele for attached earlobes?
50%. All of your gametes will have one copy of the allele, and there are two possible alleles to choose from.

**Standard 2d. Students know new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).**

Define **fertilization.**
Fertilization occurs when a sperm cell enters an egg cell.

Define **zygote.**
A zygote is a fertilized egg that has NOT started to divide yet.

Define **embryo.**
An embryo is a fertilized egg that HAS started to divide and grow.
If you collected 1000 egg cells (or sperm cells) from a single organism, would they have identical DNA? Explain.
No, they would not be identical. The purpose of meiosis is to create sex cells that are different from each other in order to increase diversity of the offspring. Random chromosome segregation and crossing over both contribute to genetic diversity in gametes.

**Standard 2e. Students know why approximately half of an individual’s DNA sequence comes from each parent.**
Explain how you got half of your DNA from your mom (excluding mitochondrial DNA) and the other half of your DNA from your dad.
When an egg cell and a sperm cell join during fertilization, a new organism has formed. This organism got half of its DNA from the sperm cell and half from the egg cell. Sperm cells are haploid and contain half of a male’s DNA. Egg cells are also haploid and contain half of a female’s DNA.

**Standard 2f. Students know the role of chromosomes in determining an individual’s sex.**
Define *autosome* and *sex chromosome*.
Autosomes are chromosomes that do not determine an organism’s sex (humans have 22 pairs of autosomes). Sex chromosomes are the X and Y chromosomes, and the combination determines the gender (sex) of an organism.
What sex chromosomes does a normal human female have? **XX**
What sex chromosomes does a normal human male have? **XY**

**Standard 2g. Students know how to predict possible combinations of alleles in a zygote from the genetic makeup of the parents.**
Define *dominant* and *recessive*.
A dominant allele or gene is one that will always be expressed, even when only one allele is present. A recessive allele or gene is weaker and is only expressed when there are two copies present in an organism.
Complete Punnett squares for the following crosses:

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3
### Standard 3a. *Students know how to predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).*

Flower color in snapdragons shows incomplete dominance. If you crossed a red snapdragon (RR) with a white snapdragon (WW), what flower color would the offspring have?

All offspring (RW) would have pink flowers because when alleles show **incomplete dominance**, the traits blend together to make a phenotype that is in between the original two phenotypes.

Coat color in cats is codominant. If you crossed a white cat (WW) with a black cat (BB), what coat color would you expect to see in the offspring?

All of the offspring (BW) would have both black and white fur (not gray fur). They may have stripes, spots, patches, or any other pattern. When alleles are **codominant**, both traits appear in the phenotype.
In humans, hemophilia type B is an X-linked recessive disorder that causes problems with blood clotting. If a carrier woman has children with a normal man, and they have one son, what is the probability (%) that the son will have hemophilia type B?

Using X for a normal X chromosome, X^B for the X chromosome carrying the hemophilia gene, and Y for the Y chromosome:

Mom = X X^B, Dad = XY
Offspring:
25% XX^B carrier female
25% XX normal female
25% XY normal male
25% X^BY male with hemophilia

Now, read the wording of the question CAREFULLY. It says that the couple has a son and asks what is the probability that the son has hemophilia. Based on this, you can eliminate the females from the equation. So, out of the two possibilities for male offspring, one is normal and one has hemophilia. \( \frac{1}{2} = 50\% \), so there is 50% chance that a son has hemophilia.

**Standard 3b. Students know the genetic basis for Mendel's laws of segregation and independent assortment.**

Define *nondisjunction* and list one genetic disorder that can result from it.

Nondisjunction is when chromosomes fail to separate form each other during meiosis, resulting in one gamete that has an extra chromosome and one gamete that is missing a chromosome. Down syndrome aka trisomy 21 results from nondisjunction when the two copies of chromosome 21 fail to separate, so one defective gamete has two copies and the other normal gamete has one for a total of three copies of chromosome 21. Klinefelter's syndrome is when an individual has XXY sex chromosomes instead of XX or XY. The process is the same as the one described above for Down syndrome.

Explain Mendel's law of segregation as it relates to chromosomes and individual genes.

During meiosis, chromosomes separate from each other. This also separates allele pairs.

Explain Mendel's law of independent assortment as it relates to individual genes.

During meiosis, chromosomes assort independently of each other – meaning the chromosomes that came from your mom and the chromosomes that came from your dad end up in gametes randomly – you do not produce gametes that have all chromosomes from your mom or all chromosomes from your dad.

**EQUATION**

**Standard 7a. Students know why natural selection acts on the phenotype rather than the genotype of an organism.**

Define *natural selection*.

Natural selection is the process in which organisms that are better adapted to their environment tend to survive and produce more offspring than organisms that are not as well adapted.

Who came up with the idea of natural selection? **Charles Darwin**

Define *mutation*. A mutation is any change in the DNA sequence. Mutations can happen randomly or can happen from exposure to a mutagen.

What interacts with the environment – an organism’s genotype, or an organism’s phenotype? Why is this important? Only phenotypes interact with the environment. The environment does not “know” what an organism phenotype is. A bird does not know if a green beetle is homozygous or heterozygous, it just knows that it looks tasty. This is important because it means natural selection can only act on **phenotypes**, not genotypes.
Standard 7 b. Students know why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool.

What is a carrier for a disease? Will a carrier show symptoms of the disease?
A carrier is a person who has one copy of the allele for a recessive disease, but does not show symptoms of the disease. So, no, a carrier does not show symptoms.

Can an organism be a carrier for a disease that results from a dominant allele?
Explain why or why not.
An organism cannot be a carrier for a dominant disease because one dominant allele is enough for the disease to be expressed. A person with one copy of a dominant disease allele will have the disease. A carrier does not have symptoms of the disease.

Standard 7c. Students know new mutations are constantly being generated in a gene pool.

List two reasons mutations happen.
- randomly (DNA polymerase makes a mistake)
- exposure to a mutagen

What is antibiotic resistance? How does antibiotic resistance occur?
Antibiotic resistance is when bacteria cannot be killed by antibiotics. Sometimes, a few bacteria in a population may have a mutation that makes them resistant to antibiotics. Then, when antibiotics are used, most of the bacteria die, but the resistant ones survive and reproduce.

Standard 7d. Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.

Define adaptation.
An adaptation is a trait that gives an advantage to an organism, helping it survive.

Why is it good for members of the same species to be genetically different from each other? How can this benefit the species as a whole if the environment changes?
Genetic diversity makes it more likely that some organisms in a population will survive if the environment changes. Let’s use a population of green and brown beetles as an example. In the environment that these beetles live in, there are green and brown surfaces for the beetles to hide on. If the environment changes and there are no more green surfaces (maybe all the plants died), the green beetles would probably all get eaten because they cannot hide anymore, but the brown beetles would be more likely to survive.

Standard 8a. Students know how natural selection determines the differential survival of groups of organisms.

What is a niche? A niche is an organism’s specific job or role in its environment.
What were the **three** conditions that Darwin said must be met in order for evolution by natural selection to occur? Explain what each one means.

1. **Variation in characteristics:** different individuals in a population must have different characteristics. For example, beetles of the same species may come in green or brown.

2. **Differences in fitness:** the differences in characteristics between individuals must contribute to their probability of surviving and reproducing. For example, the green color beetles might help them survive by making them harder to see and therefore less likely to get eaten.

3. **Heritability of characteristics:** the different characteristics that affect fitness must be heritable (able to be passed down to offspring)

List two things that might affect the evolution of beak shape in finches.
- type of food available (big food, small food, hard food, soft food)
- where the food is – does the finch have to dig through a cactus to get it? Is thr food found behind the bark of trees?
- other things the finch uses its beak for besides eating – maybe it has developed an elaborate mating dance that involves its beak somehow
- there are other answers, I just wanted you to brainstorm 😊

List two things that might affect the evolution of running speed in rabbits.
- running speed of predators
- running speed of prey
- other answers are possible

**Standard 8b. Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment.**

Why is biodiversity on earth a good thing? How can a high level of biodiversity benefit life as a whole if the environment changes drastically? Biodiversity, or having different types of organisms, increases the chances that some species will survive even if the environment changes drastically. For example, when an asteroid hit the earth in the Yucatan peninsula, it changed global weather patterns, killing the dinosaurs and many other species. However, mammals were able to survive.

A severe rainstorm hits several local nature parks. What would help ensure that at least some organisms in the park survive the resulting flood? The park with the greatest number of species (the most biodiversity) is most likely to have organisms that survive the flood.
Standard 8c. *Students know the effects of genetic drift on the diversity of organisms in a population.*

Define *genetic drift* and explain its effect on genetic diversity within a population. Genetic drift is a random change in allele frequency that is caused by random chance, not natural selection. The smaller a population is, the more likely genetic drift will happen. Genetic drift causes a loss of variation in populations.

Define *bottleneck.*
A bottleneck is when many members of a species die, leaving only a few to reproduce. It is a cause of genetic drift.

Define and explain the *founder effect.*
The founder effect is the reduced genetic diversity that results when a population is descended from a small number of colonizing ancestors. The founder effect may cause certain rare alleles to become more common simply because that allele happened to be carried by an above average number of individuals in the founding population.

Standard 8d. *Students know reproductive or geographic isolation affects speciation.*

Define *speciation.*
Speciation is the formation of a new species.

What are the four types of isolation that can cause speciation?
- reproductive
- geographic
- temporal
- behavioral

How can isolation cause speciation?
Isolated populations cannot interbreed (breed with each other) and therefore have separate gene pools. Each population now responds to natural selection or genetic drift in separately.

Standard 8e. *Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.*

List the names and dates of the five mass extinctions that life on earth has experienced (excluding the probable mass extinction that is happening now).

Ordovician – about 440 MYA (millions of years ago)
Devonian – about 360 MYA
Permian – about 245 MYA
Jurassic/Triassic – about 200 MYA
Cretaceous – about 65 MYA
Have mass extinctions had a significant effect on the course of evolution of life on Earth? Explain your answer.
Yes. Each mass extinction left many niches open, allowing organisms that survived to flourish and diversify rapidly.

What have we learned about life on Earth from the fossil record? (Hint – think about the number of species alive today compared to the number of total species that have ever lived on earth, and if species have changed over time).
The fossil record shows that the species that exist on earth now all evolved from older, similar species. The number of species alive on earth today is just a small fraction of the total species that have ever lived on earth.

HUMAN BODY (ANATOMY & PHYSIOLOGY)

Standard 9a. Students know how the complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide.

Put these units in order from smallest to largest:
Organ, organ system, cell, tissue

Cell, tissue, organ, organ system

What are the two main jobs of the excretory system?
- remove toxins from blood
- help maintain water balance in body (not too much or too little water)

What other body system does the excretory system work with to accomplish its jobs?
The circulatory system (excretory system filters the blood).

Explain how the circulatory system and the respiratory system work together to provide the body’s cells with oxygen and remove carbon dioxide.
The heart (circulatory system) carries blood to the lungs (respiratory system) where it releases carbon dioxide and picks up oxygen. The heart then receives oxygenated blood from the lungs and pumps it to the rest of the body.
Make sure you know the parts of the heart and can trace blood flow through the heart.

Label the following:

- aorta
- aortic valve
- inferior vena cava
- left atrium
- left ventricle
- mitral valve
- pulmonary artery
- pulmonary valve
- pulmonary vein
- right atrium
- right ventricle
- superior vena cava
- tricuspid valve

Where does gas exchange occur? Be more specific than “the lungs.”
At the junction between the capillaries and the alveoli in the lungs.

**Standard 9b. Students know how the nervous system mediates communication between different parts of the body and the body’s interactions with the environment.**

Label the cerebrum, cerebellum, and brain stem.

Which part of the brain is the site of learning and intelligence?
The cerebrum.

Which part of the brain is responsible for coordinating and balancing the body’s movements?
The cerebellum.

Which part of the brain controls blood pressure, heart rate, and breathing?
The brain stem.
What organs make up the central nervous system (CNS)? What does the CNS do?
The CNS is made up of the brain and the spinal cord.

What organs make up the peripheral nervous system (PNS)? What does the PNS do?
The PNS consists of all of the peripheral nerves in the body.

**Standard 9c. Students know how feedback loops in the nervous and endocrine systems regulate conditions in the body.**

Define *homeostasis*.
Homeostasis is the process by which organisms keep internal conditions relatively constant despite changes in external environments. Basically, homeostasis is how balance is maintained in the body.

Name two things in the body that are controlled by feedback loops.
- body temperature (negative)
- blood sugar levels (negative)
- calcium levels (negative)
- childbirth (positive)

Explain the differences between a positive feedback loop and a negative feedback loop.
In a negative feedback loop, the body's response is the opposite of the stimulus that caused it. For example, body temperature is regulated by negative feedback. When your body is too cold (the stimulus), reactions happen that will make you warm (the response).
In a positive feedback loop, the response increases. One example is oxytocin levels during childbirth. Oxytocin causes contractions of the uterus, which cause more oxytocin to be released. This cycle continues until the baby is born.

Explain how regulation of body temperature is similar to the way a thermostat works.
A thermostat is a sensor that detects the temperature of a room. It sends signals to warm up the room when it is too cold or to cool down the room when it is too hot. Temperature regulation in the body is similar because there are sensors that detect body temperature in the medulla oblongata (part of the brain). When your body temperature is too hot, the medulla oblongata sends signals to start processes that cool you down (sweating, slowing metabolism). When your body is too cold, the medulla oblongata sends signals to start processes that will warm you up (shivering, increasing metabolism).

What does shivering do to your body temperature?
Shivering increases your body temperature.

What does sweating do to your body temperature?
Sweating decreases your body temperature.
Standard 9d. Students know the functions of the nervous system and the role of neurons in transmitting electrochemical impulses.

Make sure you know the parts of a neuron and their functions.

What is a sodium-potassium pump and what does it do?
A sodium potassium pump is a membrane protein that controls the balance of sodium and potassium inside cells. They are important in action potentials (see next question).

What is an action potential and which direction does it travel in?
An action potential is a nerve impulse (how neurons send messages to each other). It travels down the axon toward the axon ending. The membrane potential (electrical charge) of a cell quickly rises and falls along the axon. This charge on the membrane is caused by the ratio of sodium and potassium ions inside and outside the membrane.

Standard 9e. Students know the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response.

What does a motor neuron do? Where does it carry impulses to and from?
A motor neuron send signals to muscles that control movement. These impulses come from the brain (or possibly from the spinal cord if the movement is a reflex).

What does a sensory neuron do? Where does it carry impulses to and from?
A sensory neuron sends signals to your brain from your peripheral neurons that sense the environment – what the environment feels like, smells like, looks like, tastes like, etc.
What does an interneuron do? Where does it carry impulses to and from?
Interneurons connect sensory and motor neurons and carry impulses between them.

What is a reflex? Do reflexes always involve the brain?
A reflex is an instant, involuntary movement that occurs in response to a stimulus. Many reflexes do not even make it to the brain and are processed in the spinal cord.

Standard 9i. Students know how hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.

What body system produces hormones?
The endocrine system.
Fill in the table below.

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<thead>
<tr>
<th>Hormone</th>
<th>Where it is produced in the body (what organ makes it)</th>
<th>Function of Hormone (what it does in the body)</th>
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<tr>
<td>Growth Hormone</td>
<td>Pituitary gland</td>
<td>Regulates growth of the body</td>
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<td>Insulin</td>
<td>Pancreas</td>
<td>Decreases blood sugar</td>
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<tr>
<td>Glucagon</td>
<td>Pancreas</td>
<td>Increases blood sugar</td>
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<tr>
<td>Estrogen</td>
<td>Ovaries</td>
<td>Required for the development of egg cells and the development of female characteristics such as breasts and wider hips</td>
</tr>
<tr>
<td>Testosterone</td>
<td>Testes</td>
<td>Required for normal sperm production and responsible for male characteristics such as deeper voice and facial hair</td>
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**Standard 10a. Students know the role of the skin in providing nonspecific defenses against infection.**

Define *pathogen*.

* A pathogen is any disease-causing agent.

What is a non-specific immune defense?

* An immune response that occurs the same way no matter what the pathogen (the skin acting as a barrier, the inflammatory response)

Explain how the skin is part of your immune system.

* The skin acts as a barrier, keeping pathogens out.

**Standard 10b. Students know the role of antibodies in the body’s response to infection.**

What are white blood cells and what do they do in the body (in general, you don’t have to be too specific here)?

* White blood cells are cells of the immune system that help fight infections.

Define *antigen*.

* An antigen is any substance that causes an immune response.

What cells produce antibodies?

* B-cells (plasma cells).

Explain the difference between memory B cells and plasma B cells.

* Plasma B cells produce large amounts of antibodies during an infection. Memory B cells are capable of turning into plasma cells if the same pathogen invades the body again.

There are two ways that antibodies can help get rid of pathogens. What are these two ways and how do they work?

1. Antibodies attach to pathogens, signaling phagocytes to engulf and destroy the pathogen.

2. Antibodies attach to cells that are infected with a pathogen, signaling other cells of the immune system (killer T-cells) to kill them.
Standard 10c. Students know how vaccination protects an individual from infectious diseases.

A vaccine is an injection (or a nasal spray) of a weakened or destroyed pathogen.

What is the purpose of getting a vaccine?
Vaccines allow you to become immune to a disease without having to get sick from the disease.

When you get a vaccine, what does your body start producing in response?
Antibodies.

What is herd immunity and why is it important?
When most of the individuals in a population have been vaccinated, the few people who are not vaccinated are still protected from the disease simply because there are not enough people carrying the disease for it to spread. Herd immunity only occurs when the vast majority of a population has been vaccinated. This is important because in any population, some people are too young, too old, or too sick to get a vaccine. Herd immunity protects people who cannot get vaccinated.

Can vaccines cause autism?

**ABSOLUTELY NOT!!!!**
The person who wrote a scientific paper suggesting that the MMR vaccine causes autism had his own personal interests in stopping people from getting the MMR vaccine. Vaccines have NEVER caused autism. Like any medical procedure, vaccines do carry some small risks, but the benefit of being immune to infectious diseases is far greater than those risks.

Is Jenny McCarthy a good person to take medical advice from? Why or why not?

**ABSOLUTELY NOT!!!!**
Jenny McCarthy is an outspoken actress who has zero medical training and a poor understanding of how vaccines work. You should never take medical advice from an uneducated person.

Standard 10d. Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body’s primary defenses against bacterial and viral infections, and effective treatments of these infections.

What do antibiotics kill?
Antibiotics only kill bacteria.

Are viruses living organisms?
No. Viruses are non-living, intracellular invaders.

How do viruses reproduce?
Viruses enter cells and take over the nucleus so that only viral proteins are produced.
What body system works with the immune system to carry the cells of the immune system throughout the body?
The circulatory system carries immune cells in the blood.

Are there any eukaryotic organisms that can cause diseases? If so then list 3 examples.
Yes. Worms, fungi, and protists (like the malaria parasite) can all cause disease.

**Standard 10e. Students know why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign.**

What does HIV stand for?
Human Immunodeficiency Virus

What does AIDS stand for?
Acquired Immune Deficiency Syndrome

What cells of the body does HIV infect?
Immune system cells – T-cells and sometimes others.

Explain the relationship between HIV and AIDS.
HIV is the virus that causes AIDS

Why do people with AIDS get sick from diseases that rarely affect healthy people?

Can you get the HIV virus from kissing someone who has HIV?
No. HIV is spread through blood and other body fluids, but not saliva

Can you get HIV from a dirty toilet seat?
No. The HIV virus can only “live” for a few minutes outside a host.

List **three** ways that the HIV virus can be transmitted from one person to another.
- sex
- needles (drug use, tattoos)
- during childbirth (if the baby comes in contact with an infected mother’s blood)

**Bonus:**
Is everything you read on the internet true? No.
How can you know if you are reading something that is true? You have to look at the source and decide if they are credible (as in, do they know what they are talking about).
What skills are you using when you are trying to determine if a website has true information or false information? Critical thinking skills.