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AP BIOLOGY

11 Must Know AP Biology Concepts

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Introduction

AP Biology is notorious for containing more content than almost any AP course. 5s are very elusive, and even carrying the textbook around can be a significant challenge. However, Biology is central course for many ambitious students, and this class has the potential to broaden your perspective and impart new critical thinking and memorization skills.

Since this is a big opportunity, we've put together an eBook which is packed with helpful crash courses on some central AP Biology topics.

It's useful as an early year primer, a supplement to your teacher's instruction, and as a review packet in the spring. Much of the information contained here is from the **Albert Blog**. If you're looking for additional help in preparing for the APs, be sure to regularly check the blog, and subscribe to hear about our new posts.

E-mail us at hello@albert.io if you have any questions, suggestions, or comments!

Last Updated: October 2016

About Us

What is Albert?

Albert bridges the gap between learning and mastery with interactive content written by world-class educators.

We offer:

- Tens of thousands of AP-style practice questions in all the major APs
- A complete competitive online leaderboard to see where you stand compared to others
- Immediate feedback on each question answered
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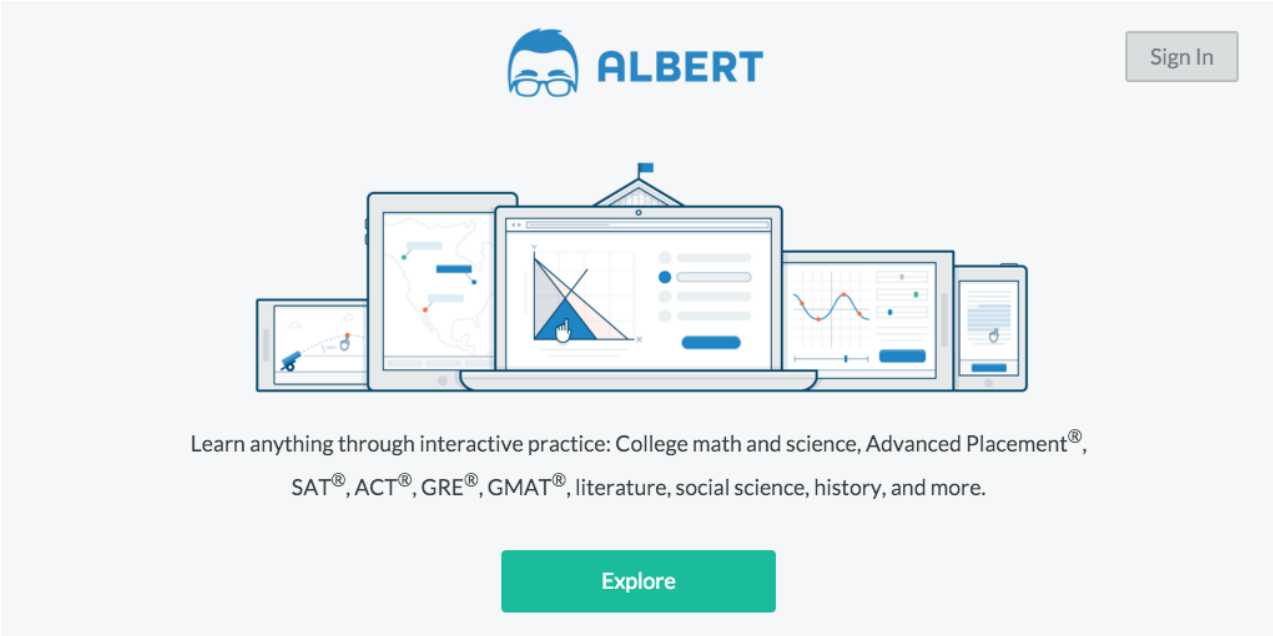


Why Educators Love Us

We asked teachers how their students did after using Albert.

Here is what they had to say:

My students had an 81.2% passing rate - the previous year was 76% (the highest rate in our county)! I am thrilled. I had 64 students total, with 6 receiving 5s, 19 scoring 4s, 27 receiving 3s, 10 scored 2s and 2 received 1s.

Susan M., JP Taravella High

70% of my students scored 3 or higher. This is up from last year, and is also well above the national average. Needless to say, I am very happy with my students' success. I used Albert more intentionally this year. In the beginning of the year, I wanted students simply to answer questions and practice. Once they had 150-200 questions answered, we looked for trends, strengths, and weaknesses and worked on addressing them. Students were tasked with increasing their answer accuracy no matter how many questions it took, then they set their own goals (some wanted to focus around tone; others needed practice with meaning as a whole).

Bill S., Lapeer High School

Last year 40% passed with 3s and 4s. This year 87% passed, most had 4s and 5s. We used the stimulus-based multiple choice questions throughout the year and as review for the exam. I think it helped tremendously.

Alice P., First Baptist Christian Academy

Why Students Love Us

We asked students how they did after using Albert.

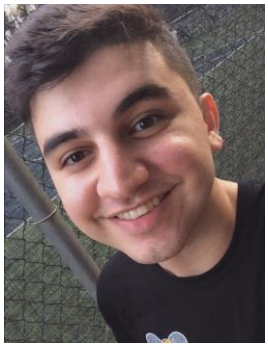
Here is what they had to say:

I scored very well this year – four 5s and one 4. Albert helped me get used to the types of questions asked on the exam and overall my scores were better this year.

Robyn G., Chambersburg Area Senior High School

Last year was my first year taking an AP test, and unfortunately I did not do as well as I had hoped. The subject had not been my best, and that was definitely displayed on my performance. However this year, I made a much higher score on my AP test because Albert pushed me to focus on my weaknesses and form them into strengths.

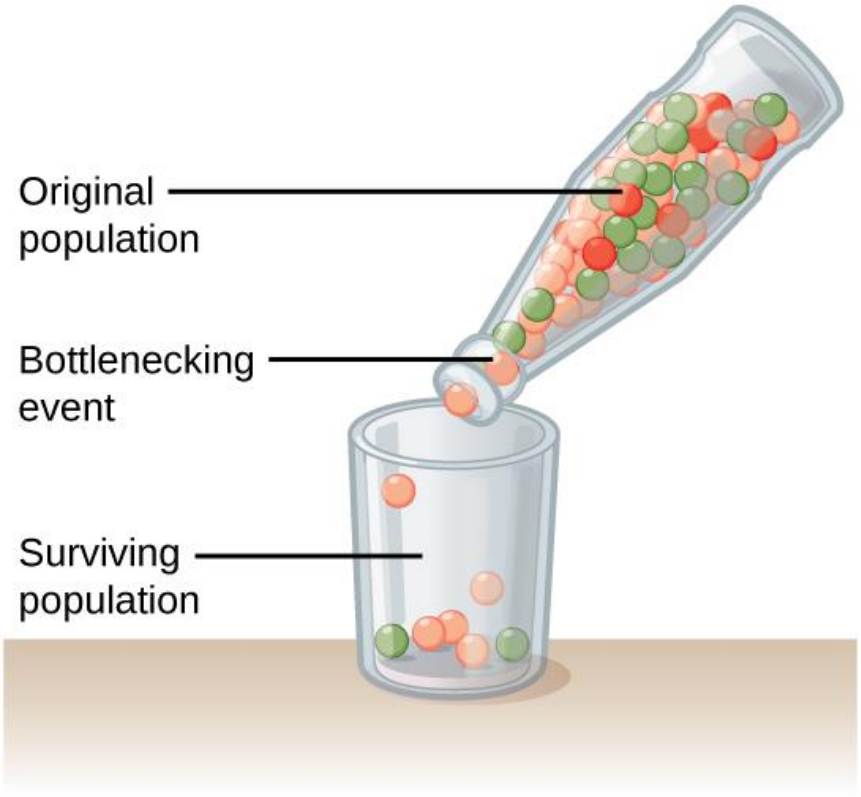
Charlotte R., Rome High



Albert allowed me to get extra practice and be exposed to questions similar to that on the AP exams. Overall, I did great this year with passing all my exams with 5's and 4's!

Shwan N., Central Gwinnett High School

Bottleneck Effect: AP Biology Crash Course Review



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Evolutionary biology is an important component of AP Biology. An understanding of the processes by which populations evolve is essential for success on the AP Bio exam. This AP Biology Crash Course Review covers the bottleneck effect, the effect of dramatic reduction in population size, including key concepts and clues to look for in exam questions.

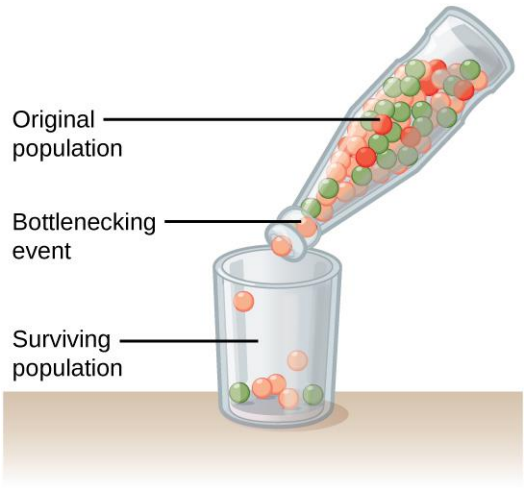
Bottleneck Effect:
AP Biology Crash Course Review Cont.

The Bottleneck Effect & Genetic Drift

The bottleneck effect(sometimes called a genetic bottleneck or population bottleneck) is a unique example of genetic drift, a non-selective change in allele frequencies due to random chance. **Genetic drift** affects small populations most strongly, but also comes into play when a large population is suddenly reduced to a small one, such as during a genetic bottleneck. Bottlenecks occur when a large portion of the population is killed off at random due to a natural disaster or human activity. For example, an earthquake kills all of the white flowers in a population of white, red, and yellow flowers. The new population will only have red and yellow flowers.

A population bottleneck has the effect of reducing genetic diversity within the population. This is because the surviving individuals do not have the full range of alleles seen in the original population. Rare alleles are more likely to be lost than common ones and allele frequencies are different than the original population. In the example above, the alleles for white flowers are lost following the earthquake.

A Bottle of Marbles



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Bottleneck Effect:
AP Biology Crash Course Review Cont.

To remember the bottleneck effect, imagine a bottle filled with marbles of many colors. The opening of the bottle is only wide enough to allow one marble at a time to pass through. If we shake up the bottle and then attempt to pour out marbles, they will flow slowly through the narrow opening, representing an event that narrows population size.

Further, if we pour out ten marbles, it is unlikely that we will get the same proportions of marble colors as was in the bottle. Instead, we might get many common colors and few or no rare colors. If we think of the marbles as alleles for a gene, this represents what happens to genetic diversity during a bottleneck event. Many alleles may be lost, and allele frequencies are shifted.

Elephant Seals

Image Source: Wikimedia Commons

A real life example of the bottleneck effect is the northern elephant seal. Northern elephant seals were hunted heavily for their oil producing blubber in 1800's. It was believed that they had been hunted to extinction until a population of just eight seals was discovered off the coast of Mexico on Guadalupe Island in 1892.

Bottleneck Effect:
AP Biology Crash Course Review Cont.

Following protection from the Mexican and U.S. governments, population sizes have rebounded to over 100,000 seals today, despite drastic reductions in genetic diversity due to the bottleneck effect. Though population sizes have rebounded, genetic diversity in northern elephant seals is still much lower than it was in pre-hunting populations.

Bottleneck Effect Key Concepts

To approach questions about the bottleneck effect on the AP exam, focus on the key features of the process and context clues that might give away the right answer.

The key features of the bottleneck effect:

- Drastic reduction in population size
- Loss of genetic diversity

Context clues to look for:

- Natural disaster or over-hunting

Important note: Since the bottleneck effect is a type of **genetic drift**, it has all of the same features of genetic drift, such as changes in allele frequency due to random chance and a loss of genetic diversity. The unique thing about a bottleneck is the reduction in population size due to a non-selective event, like a natural disaster.

Let's look at an example question.

Which of the following is an example of the bottleneck effect?

A. A researcher observing a diverse population of birds on an island notices new birds are migrating to the island from the mainland.

Bottleneck Effect:
AP Biology Crash Course Review Cont.

B. A researcher observing a diverse population of birds on an island notes that some of the bird have developed longer tail feathers.

C. A researcher observing a diverse population of birds on an island finds that the population was decimated following a hurricane. A year later the population is restored, but the population is now homogenous.

D. A researcher observing a diverse population of birds on an island notes that birds with long tail feathers are eaten more often by predators.

How do you know which answer is correct?

A researcher observing a diverse population of birds on an island notices new birds are migrating to the island from the mainland. This answer involves an increasing population size – no bottleneck here!

B. A researcher observing a diverse population of birds on an island notes that some of the birds have developed longer tail feathers. In this answer diversity is increasing, and there is no effect on the population size. This is not the bottleneck effect.

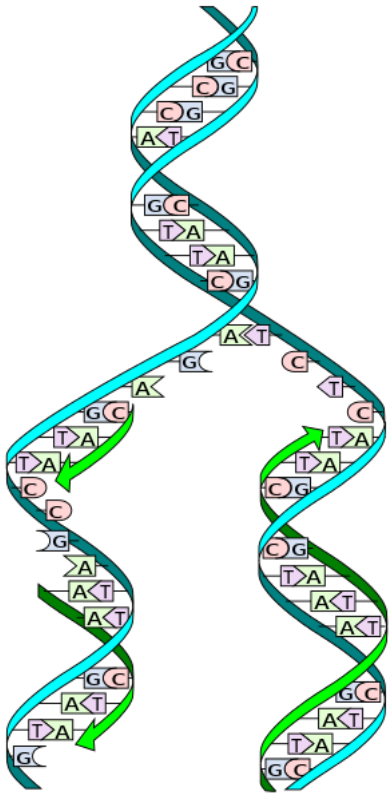
C. A researcher observing a diverse population of birds on an island finds that the population was decimated following a hurricane. A year later the population is restored, but the population is now homogenous. This answer has a decreasing population size following a natural disaster and indicates that genetic diversity has been lost. This is the best answer!

D. A researcher observing a diverse population of birds on an island notes that birds with long tail feathers are eaten more often by predators. This answer is tempting because the predator might cause a reduction in population size, but careful reading indicates that the reduction is non-random. This is an example of predator-mediated selection, not a bottleneck.

Bottleneck Effect:
AP Biology Crash Course Review Cont.

Genetic bottlenecks can lead to large-scale evolutionary changes in a population. Understanding the effects of a bottleneck on genetic diversity and allele frequencies is critical to understanding the topic of evolution as a whole. By mastering these concepts, you are on your way to success on the AP Biology exam!

DNA Replication: AP Biology Crash Course Review



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Introduction to DNA Replication

The AP Biology exam has a lot of content on DNA, and DNA replication will be a topic that you will be tested on so it is very critical to know it! In this AP Biology Crash Course Review we will go over what you should know about DNA replication for the AP Biology exam.

DNA Replication:
AP Biology Crash Course Review Cont.

DNA replication is a process that is constantly occurring. When cells replicate, they must pass their DNA to their daughter cells. During the development at conception, growth during the lifetime of the organism, and replacement of damaged or aged tissue there will be rapid cell division, and thus, we need a fast system. The DNA code must also be correct. If there is a difference in one base pair, it could be very problematic to the organism; thus the system must be precise and accurate. First, we will review the scientific history that lead to the modern understanding of how DNA is replicated. Next, we will review the actual mechanism for DNA replication. Finally, we will review the differences between eukaryotic and prokaryotic DNA replication.

History

The AP biology exam wants you to know and understand scientific theories. There were three major theories of how DNA could be replicated after the discovery of DNA by Watson and Crick. The three theories included: the semiconservative replication model, the conservative replication model, and the dispersive replication model. Semiconservative replication posited that the DNA strands were separated during DNA, and each single strand was used as a template for a new DNA strand. The theory of conservative replication hypothesized that during replication, the original DNA molecule would be used to form the new DNA molecule but after replication, it would become double stranded again creating the old molecule and a completely new molecule. Finally, dispersive replication supporters believed that the original DNA molecule was scattered into the new DNA and that the new DNA would contain both old and new pieces.

In order to figure out this controversy, a famous experiment was conducted. The experiment is after the scientists who conducted it; the Meselson-Stahl experiment. DNA is composed of sugar, phosphate, and a nitrogenous base. This experiment focused on the nitrogenous bases. The experiment added heavy nitrogen (15N) to bacteria and then transferred the DNA from the original bacteria to a tube with different bacteria which had been given regular nitrogen (14N).

DNA Replication:
AP Biology Crash Course Review Cont.

The first bacteria, treated with the heavy nitrogen, had DNA with heavy nitrogen in the bases while the second bacteria did not. The experimenters tracked where the nitrogen went in order to understand how the DNA was replicated. They found that the DNA was made up of one strand with heavy nitrogen and one with regular nitrogen supporting the semiconservative theory.

Now that we know how DNA is replicated we can delve into the detail of replication. There are three stages of replication which need to be addressed for the two strands of the parent DNA molecule.

Initiation

We will start first with our double stranded DNA parent molecule. When it is time for DNA to replicate, it first must be “unzipped”. The unzipping is done by an enzyme called DNA helicase. DNA helicase will cause the DNA to become single stranded. The single stranded DNA is not stable and wants to be double stranded again. Single stranded binding proteins (or SSBs for short) help to ensure that the DNA remains single stranded by stabilizing and covering the hydrophobic DNA strands.

When the two strands are separated, one strand will be 5 prime to 3 prime and one strand will be 3 prime to 5 prime. These strand orientations refer to where the phosphate and hydroxyl groups are. The 5 prime end is the end of the DNA with a phosphate group and the 3 prime end refers to the end of DNA with a hydroxyl group (on the sugar). The enzyme which carries out replication, DNA polymerase, can only move in the 5’ (‘ indicates prime) to 3’ direction. Because of this, there are two different ways that DNA is synthesized. We will start with the strand that is oriented in the 5’ to 3’ direction, and we will call it the leading strand.

DNA Replication:
AP Biology Crash Course Review Cont.

Elongation: Leading Strand

After the strands have been separated (just a few base pairs will be exposed), DNA primase (another enzyme) attaches to the leading strand and puts down a short RNA or DNA primer. The primer will flag the DNA polymerase to attach to the primer and continue to synthesize the DNA by adding on matching nitrogenous bases. The base pairs match in the following ways: adenosine will pair with tyrosine and cytosine will match with guanine. The new strand will be given nitrogenous bases that pair with the template strand which will allow them to become a double stranded molecule at the end of replication. DNA polymerase will sit near the replication fork, as DNA helicase unzips the DNA, and then DNA polymerase will add the free nucleotides to the DNA strand. This type of replication is called continuous because DNA polymerase just moves down the strand adding the complimentary base pair to the DNA strand.

Elongation: Lagging Strand

The lagging strand is much more difficult to visualize and understand. The lagging strand is DNA which is oriented in the 3' to 5' direction; therefore DNA polymerase cannot just attach and run down the DNA strand. Replication of the lagging strand begins with DNA primase providing a short primer sequence on the template DNA, much like it does in the leading strand. Because it is not oriented 5' to 3', the lagging strand must replicate in fragments called Okazaki fragments. The fragments are synthesized away from the replication fork in fragments of about 100 to 200 base pairs long. DNA polymerase extends the primed sequence forming the fragments. The RNA fragments are removed by exonuclease activity (the DNA polymerase digests the RNA nucleotides) and the RNA is replaced by DNA. Finally, in order to put the Okazaki fragments together, another enzyme is needed. DNA ligase comes down the lagging strand and pushes the Okazaki fragments together to create a full strand of DNA. This type of DNA replication is considered discontinuous due to all of the fragments.

DNA Replication:
AP Biology Crash Course Review Cont.

If you are having trouble visualizing this try to imagine DNA polymerase making a loop of the template DNA so that it can read it in the correct way (5' to 3') at the end of the loop it starts to read 3' to 5' again and must create a new loop. If this still seems difficult try checking out videos online like **this one**.

Because DNA is constantly being replicated, it is not unusual for mistakes in nucleotide placement to occur. To correct for this DNA polymerase has a subunit which proofreads the DNA as it moves down the strand. Any mutation in the DNA could cause a phenotypic change in the organism. It is essential for survival that mutations are limited.

Termination

After the DNA strands have been elongated they have been semi-conservatively replicated and there are two copies of the DNA. This will allow the DNA to be used in a new daughter cell.

Eukaryotic vs. Prokaryotic Replication

It is important to be able to distinguish DNA replication in prokaryotes and eukaryotes for the AP biology exam. Now that you understand replication, the differences between the two should be easier to understand.

Prokaryotes:

In prokaryotes, DNA replication occurs in the cytoplasm. The origin of replication (where replication begins) is a single spot in the DNA. Also, remember in prokaryotes the DNA is double stranded, but circular. Termination will occur when the circle has been completed. Additionally, in prokaryotes Okazaki fragments are much larger, usually about 1000-2000 base pairs.

DNA Replication:
AP Biology Crash Course Review Cont.

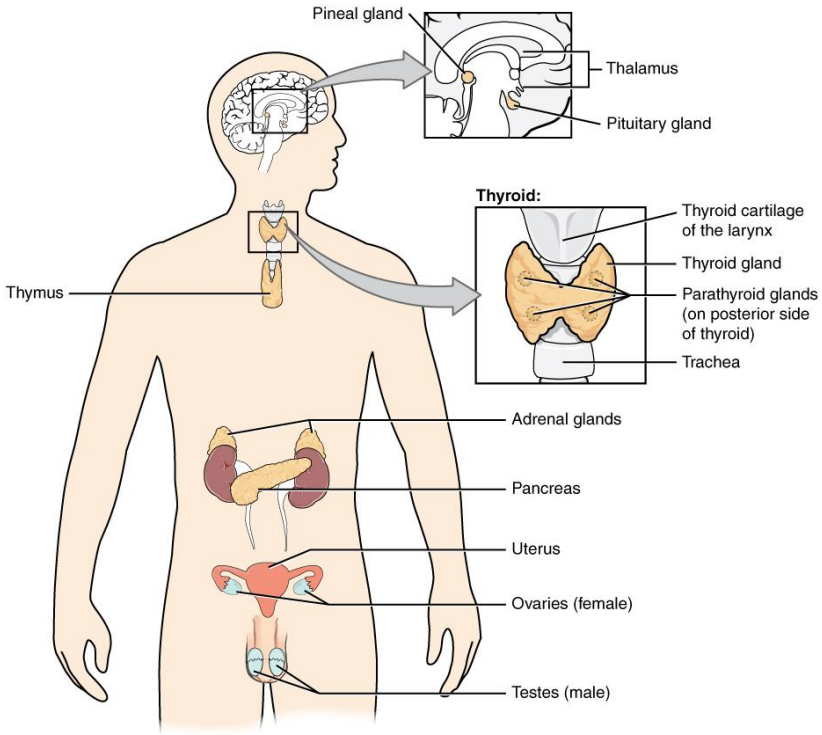
Eukaryotes:

In eukaryotes, DNA replication occurs in the nucleus. There are many different origins of replication because DNA primase lays down primers at many different spots and because the DNA is much longer than in prokaryotes this helps optimize the time spent during replication. Even with multiple origins of replication, eukaryotic replication takes longer than prokaryotic replication due to the longer DNA.

Summary

In this AP biology crash course review, we went over DNA replication. We began with a review of the experiments done to understand DNA replication. We then reviewed all of the details of DNA replication. We finished up by contrasting eukaryotic and prokaryotic DNA replication.

Endocrine System: AP Biology Crash Course Review



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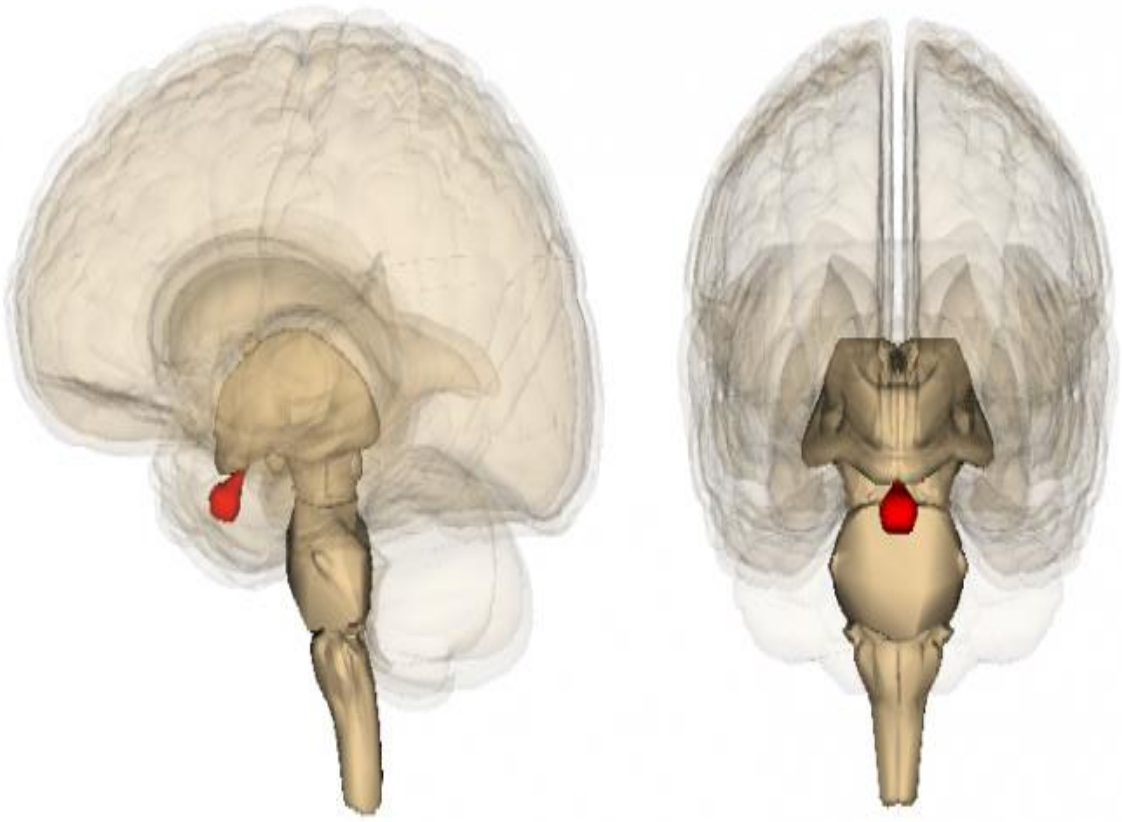
Introduction to Endocrine System

In this AP Biology crash course we will be talking about the endocrine system. The endocrine system is a system that regulates the secretion of hormones in order to control the body and mind. This system allows our bodies to do certain functions and have certain emotional states. All over our bodies are glands and vital organs that are controlled by the brain to direct our flow of hormones to allow life to happen.

Endocrine System:
AP Biology Crash Course Review Cont.

The Pituitary Gland



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One of the most important parts of the endocrine system is the pituitary gland. The pituitary gland is found at the bottom of the brain in humans and this glad contains two parts. These parts are called the anterior lobe and the posterior lobe. Each lobe has a specific function, although both release hormones.

Endocrine System:
AP Biology Crash Course Review Cont.

The Anterior Lobe

The anterior lobe has seven hormones that it secretes. One of the most important hormones is the human growth hormone, or otherwise known as somatotropin. This hormone allows regular growth to occur when the pituitary gland releases the correct amount. When the anterior lobe secretes too much of this hormone, then the result is gigantism. Gigantism is often caused by a tumor on the pituitary gland and is often passed genetically through mutated genes. If there is not enough human growth hormone released, then dwarfism occurs. Dwarfismis when the opposite occurs. The individual simply does not grow as expected and the individual ends up below four feet ten inches tall. People with gigantism and dwarfism can lead normal lives with some alterations to their homes and day to day activities as well as medical attention to their different skeletal issues.

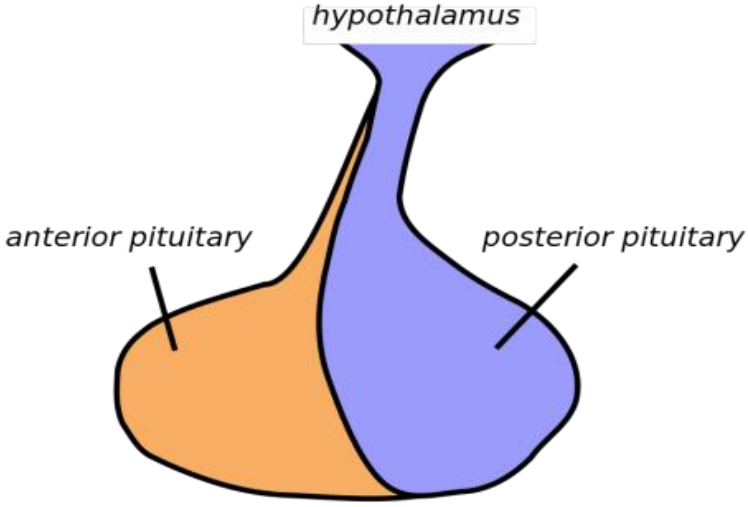
The anterior lobe also secretes prolactin. Prolactin, also referred to as the lactogenic hormone, triggers breast development and lactation in females. The third hormone, the adrenocorticotropic hormone, is another hormone secreted by the anterior lobe, and it controls the adrenal glands that secrete adrenaline in a dangerous situation. Adrenaline is used to trigger the fight or flight response in a scary situation.

The fourth hormone is a thyroid-stimulating hormone that does exactly that. The thyroid is triggered to secrete glands that can affect the weight gain or loss of the individual as well as other factors.

The fifth hormone is the follicle-stimulating hormone, which triggers the ovaries to make egg cells. This is followed later by the luteinizing hormone that matures those egg cells. For men, these two hormones are not present. Instead, the interstitial cell-stimulating hormone stimulates the production of sperm in the testicles.

Endocrine System:
AP Biology Crash Course Review Cont.

The final hormone that is secreted by the anterior lobe of the pituitary gland is the melanocyte-stimulating hormone. This hormone allows pigment that colors our skin to be made.



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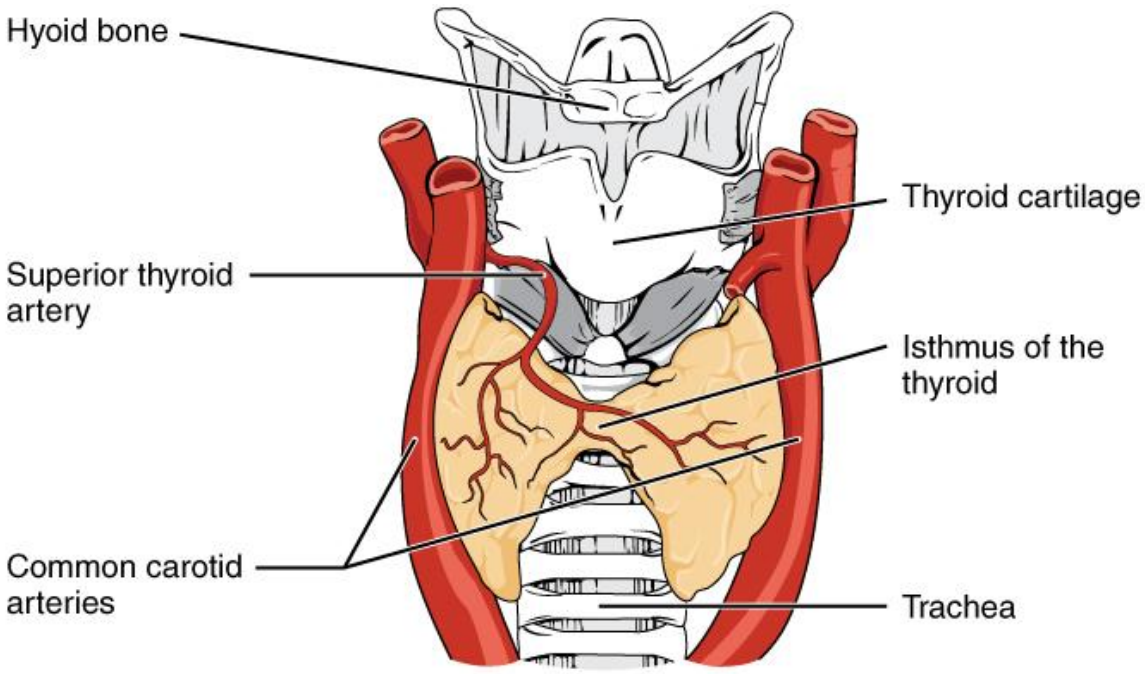
The Posterior Lobe

The posterior lobe to the pituitary gland produces only two hormones. The first one is an anti-diuretic hormone. This means that this hormone, normally called vasopressin, triggers the kidneys to reabsorb water. If this hormone is not sent out, then the body will not save enough water. The water filtered through the kidneys will be sent out of the body as waste when it could be reused. This will make you extremely dehydrated, which may cause complications.

The second hormone is found in women. This hormone is called oxytocin, and oxytocin allows the uterine muscles to contract during labor. This allows child birth to happen naturally. If your posterior area of the pituitary gland does not send out oxytocin, then a Caesarian section must be done, as opposed to a natural birth, in order to remove the unborn baby from the uterus.

Endocrine System:
AP Biology Crash Course Review Cont.

The Thyroid Gland



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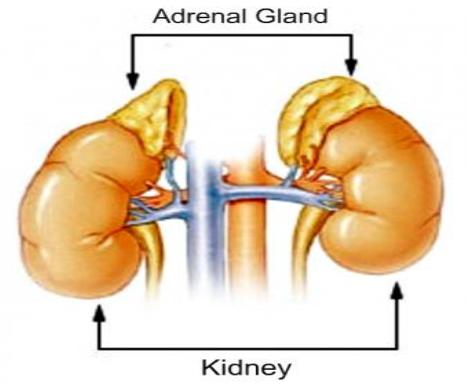
The next portion of the endocrine system is the thyroid gland. This important gland releases a hormone called thyroxine that controls the rate at which your body metabolizes glucose into **adenosine triphosphate** during **cellular respiration**. The amount of thyroxine available to the body depends on how much iodine is present. An iodine deficiency is often the main cause for the thyroid to enlarge. This enlargement is often called a goiter and is treatable with iodine supplements.

The thyroid gland also releases another hormone that is called calcitonin. Calcitonin is the hormone that releases calcium into the blood stream, which allows the body to benefit from the vitamin. We need this hormone to keep up good bone health!

Endocrine System:
AP Biology Crash Course Review Cont.

Adrenal Glands



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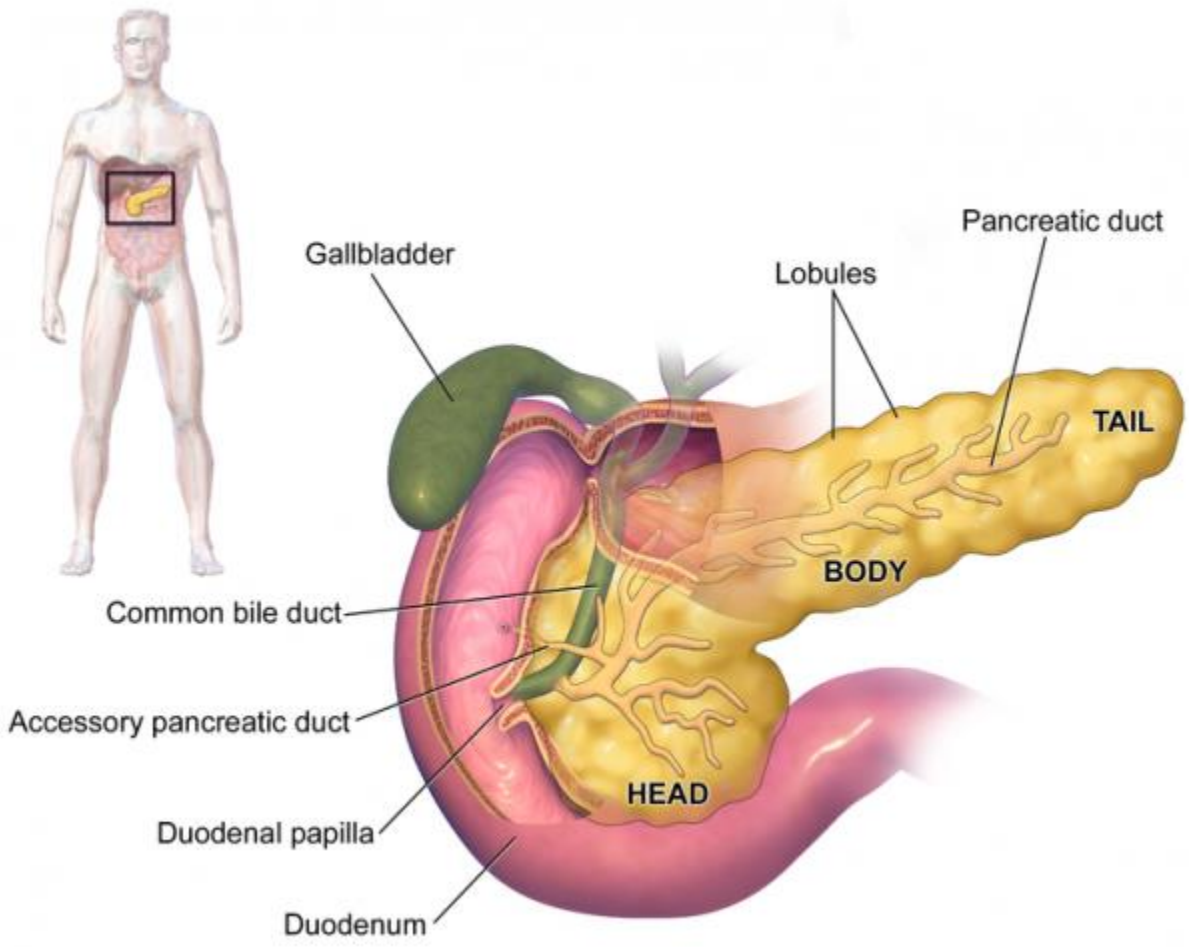
The next part of the endocrine system is vital to the survival of our species. The adrenal glands are two triangle shaped glands that are located on top of the kidneys within the body. These glands secrete epinephrine, otherwise known as adrenaline. Epinephrine, when triggered to be released by the adrenal glands, elevates your breathing, heart rate, blood pressure, and blood supply to the skeletal muscles. This is because adrenaline is usually triggered in a circumstance that causes you distress. Your body responds by giving you a boost of energy and oxygen to your muscles that it assumes that you will need. Adrenaline is nice when you are actually in a dangerous situation, but unfortunately it is often used most commonly in my body when I need to give a speech. The flight or fight response that is triggered has kept our species alive; however, it can be cumbersome in modern society.

The adrenal glands have another function in the body as well. Corticosteroids are sent out to the body through the adrenal glands. The two steroid hormones that are released are mineralocorticoids and glucocorticoids. Mineralocorticoids are used to control how fast or slow the body uses up minerals in the body. One example of a mineralocorticoid is aldosterone. Glucocorticoids are steroids that assist with protein synthesis as well as glucose metabolism and anti-inflammatory agents within the body. Some examples of a glucocorticoid are cortisol and cortisone.

Endocrine System:
AP Biology Crash Course Review Cont.

Pancreas



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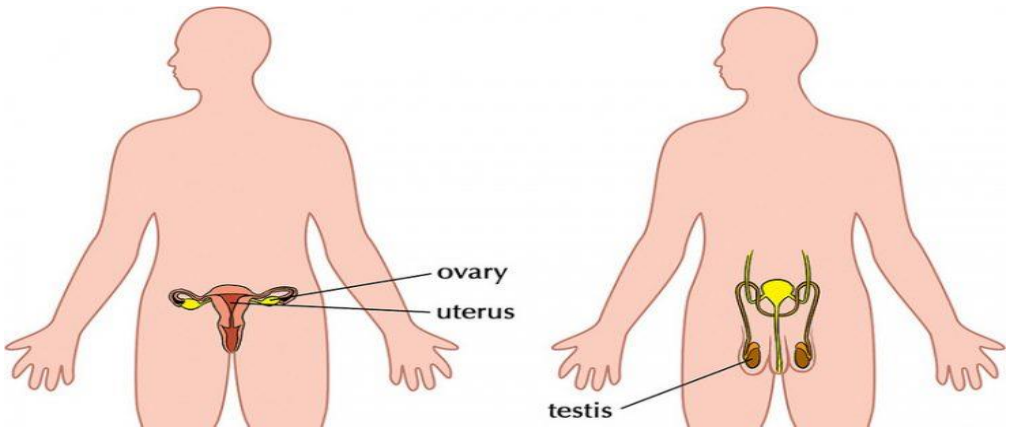
The pancreas, an obscure organ that you may have forgotten during an anatomy quiz, is another vital part of the endocrine system. This vital organ is located behind the stomach and is a hormonal powerhouse. While only two hormones are pumped out of the pancreas, these hormones are extremely important. The pancreas sends out the hormones insulin and glucagon.

Endocrine System:
AP Biology Crash Course Review Cont.

Insulin is the hormone that regulates the glucose metabolism. Insulin also allows sugar passage into the cells. This can be problematic when the pancreas does not produce enough or produces way too much insulin, which is a condition called diabetes. Diabetes does not allow the cell to have enough accessor too much access to sugar, a substance that the cells need to live and thrive. Some types of diabetes can be managed with insulin injections and diet.

Glucagon is another hormone that is necessary in the body. This hormone within the endocrine system releases adipose tissue and other fat cells to be used for energy. Without glucagon the body would just build up fat until the person died from obesity complications. Having the correct glucagon levels are very important for that reason. Sometimes men and women that are trying to lose weight cannot because they are not releasing enough of this hormone.

The Ovaries and Testicles



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Believe it or not, the ovaries are also part of the endocrine system. Ovaries give off estrogens, which is also a hormone. This allows women to go through puberty to eventually be able to have a child. In men, testicles give off testosterone, which triggers puberty in males. This allows men to be ready for sexual reproduction as well as developing secondary sex characteristics like body hair.

Endocrine System:
AP Biology Crash Course Review Cont.

The Thymus Gland

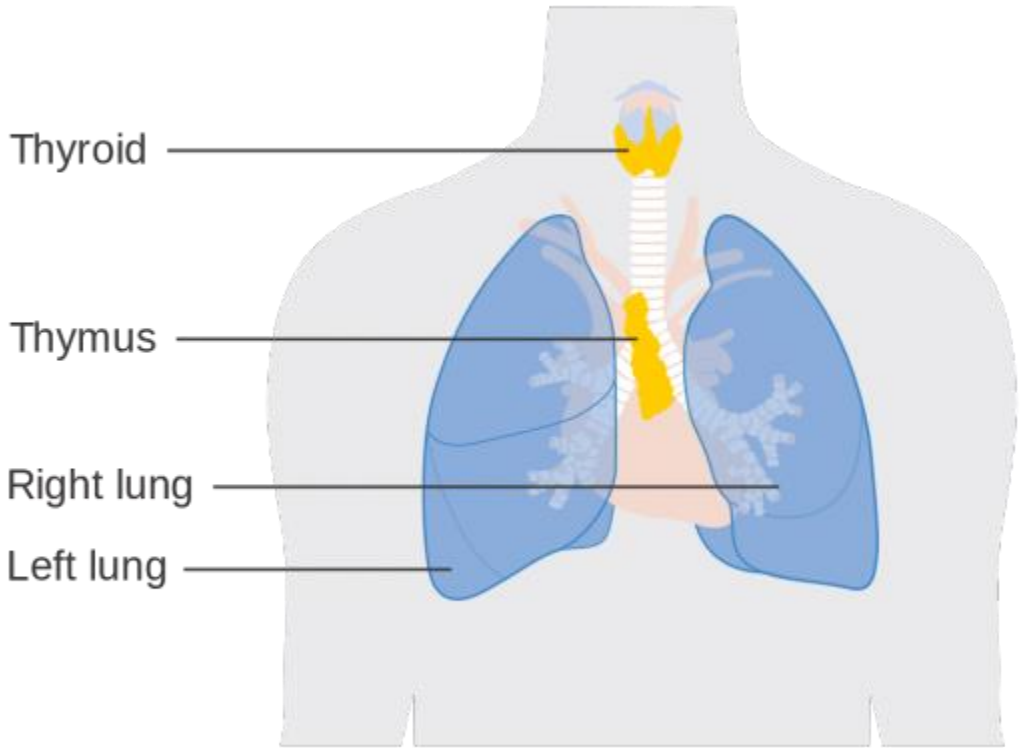

Image Source: Wikimedia Commons

The thymus gland is a small gland that is located in the tissues of the neck. The thymus gland has a very important job in that it secretes thymosins. Thymosins regulate the creation of T-lymphocytes in the body, which strengthens the immune system.

Endocrine System:
AP Biology Crash Course Review Cont.

The Pineal Gland

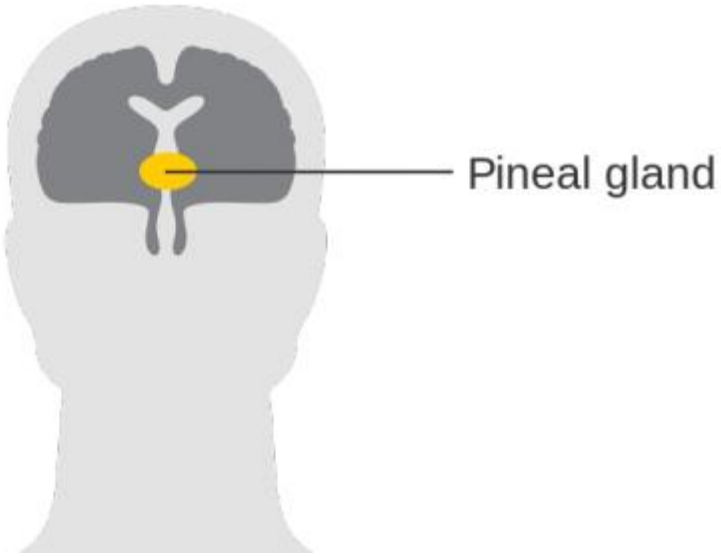

Image Source: Wikimedia Commons

This gland is the last major gland in the endocrine system. While most of the pineal gland's functions are shrouded in mystery, scientists can agree that it has something to do with secreting hormones that control behaviors in mating and day-night cycles.

Why is this Important to AP Biology?

The endocrine system is important to AP Biology, because of the impact it has on every part of the organism. The endocrine system controls sexual reproduction, which is the point of life for many organisms. It also controls your metabolism, your feelings, and everything in between. The endocrine system is sometimes glossed over, but the fact that you have these chemicals affecting your cells and tissues allows your body to understand what it needs to do. The brain controls your body, but it needs help to get those messages across. The hormones of the endocrine system help the brain do that. Do you have any questions about the endocrine system? Let us know!

Ready to get a 5?

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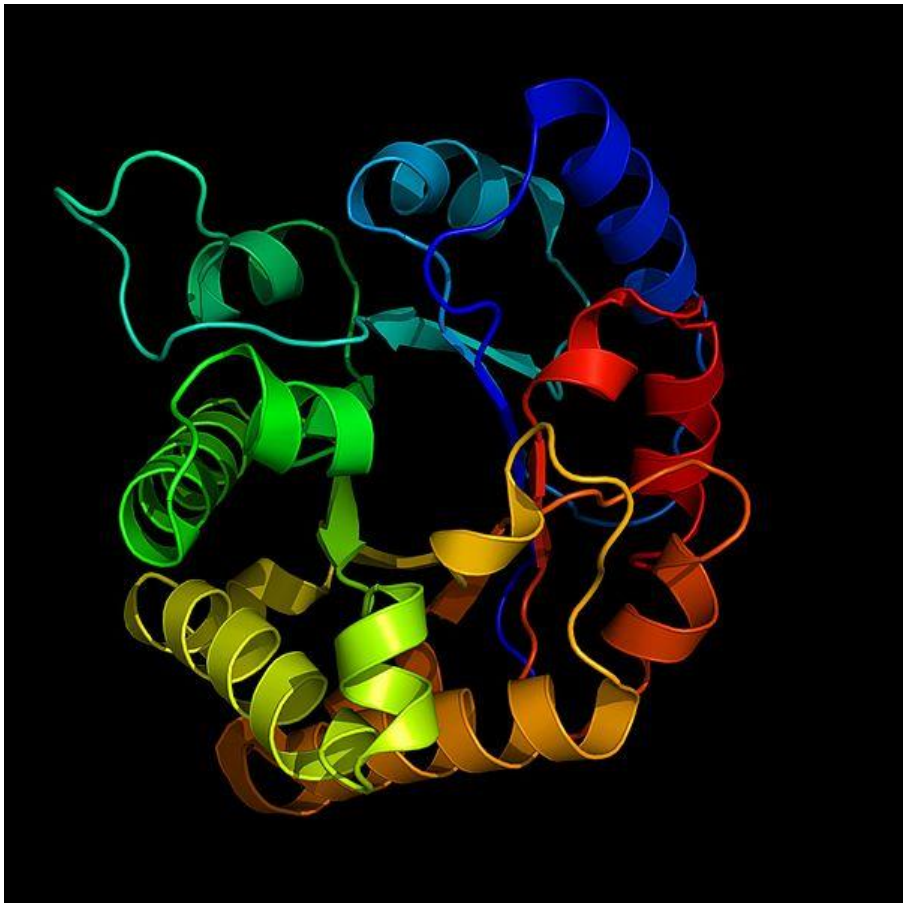
Start Practicing

Enzymes: AP Biology Crash Course Review



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In this **AP Biology Crash Course**, we will review what you need to know about enzymes for the AP Biology exam. We will cover what enzymes are, how enzymes work, some factors that affect how they work, and finally an example of an AP Bio question about enzymes.

Enzymes:
AP Biology Crash Course Review Cont.

What are Enzymes?

Enzymes are proteins that catalyze chemical reactions. Molecules at the beginning of the chemical reactionary process are called substrates, and these are converted into products. Enzyme kinetics, or Michaelis-Menten kinetics, investigate how enzymes bind substrates and turn them into products. The amount of substrate needed to reach a given rate of reaction is the Michaelis-Menten constant. Almost all metabolic processes require enzymes to occur at the proper rate.

Some chemical reactions take a lot of energy to start. The amount of energy needed to kick off a chemical reaction is called its **activation energy**. **Enzymes** help the chemical reaction reach the activation energy by lowering the amount of energy needed to overcome it.

French chemist AnselmePayen discovered the first recognized enzyme, **diastase**, in 1833. Louis Pasteur also noticed when studying a mixture of sugar, alcohol, and yeast, something was happening to ignite the fermentation process. The word "enzyme" was first used by a German physiologist in 1877 named Wilhelm Kuhne.

Enzyme Structure

As you may have learned in your AP Biology course, an enzyme's **primary structure** is nothing more than a long sequence of amino acids that bond with one another. Short-range interactions (**secondary**) between amino acids can be alpha-helix or beta sheet. Alphas look like spirals, and betas look like flat, wavy sheets.

The long-range interactions (**tertiary**) are when amino acids interact with other amino acids a long way down the strand, and as they fold over, they form a globular structure. The **quaternary structure** is when one globular strand interacts with other tertiary pieces.

Enzymes:
AP Biology Crash Course Review Cont.

When bonds are formed at this level, they are often hydrogen bonds, but sometimes it is two hydrophobic pieces interacting, or even ionic bonds. Alternatively, when an enzyme is unfolded, it's referred to as being denatured.

Enzymes are quite large relative to their substrates, yet only a small portion of the structure is involved in the reaction; that part is referred to as the **catalytic site**. This site is located next to a binding site where residues orient the substrates. These two sites together are referred to as the **active site**.

Enzyme Activation

In order for an enzyme to work, it must be activated by the binding of another molecule. Activators can either be **cofactors** or **coenzymes**; cofactors are small, inorganic chemicals, and coenzymes are organic compounds. Both of these activators bind to the active site but are not considered substrates. When they bind to the active site, there is often a conformation change. A **conformation change** is a change in the enzyme's configuration or shape. The change in shape alters the active site and allows the substrate to bind.

How do Enzymes Work?

Enzymes are extremely selective about which substrates they are able to bind to. Related to the specificity of enzyme and substrate bonding, Emil Fischer proposed the **lock and key model** where the two would have complementary geometric forms. Daniel Koshland suggested that these complementary geometric pieces can actually shift and can even be reshaped by their interactions with substrates. This new discovery led to the **induced fit model**.

The **induced fit model** refers to the ability for the substrate and enzyme to modify their shape in order to fit together.

Enzymes:
AP Biology Crash Course Review Cont.

After the enzyme and substrate have bound to each other, the enzyme will work to lower the **activation energy** of the chemical reaction.

In order to understand how enzymes work, we should review activation energy and **Gibbs free energy**. Using the Gibbs free energy models, we can see that the energy of the reactants is lower than the activation energy. The activation energy (delta G) is the amount of energy that is needed to make this reaction move forward. When the reaction is catalyzed by an enzyme, the amount of activation is greatly reduced, making that hump easier for the reactants to get over.

Enzymes are able to lower the activation energy of a chemical reaction by making changes to the **transition state** of the reaction. By stabilizing the transition state, the reaction will move toward the transition state more easily. Without an enzyme, the transition state is often not energetically favorable. The enzyme will alter the transition state in order to make it more favorable and to move the reaction forward. Similarly, the enzyme can lower the energy of the transition state, which will allow the reaction to move forward.

Inhibition

Inhibitors bind to an enzyme to decrease its activity. The prevention of substrate-enzyme binding is a form of regulation. **Negative feedback** is an example of a time when inhibitors are important. If the body has produced too much of the final products of a reaction, those final products can feedback to the reaction and prevent the enzyme and substrate from binding. In essence, in negative feedback, the end products are telling the body to stop creating them.

There are two types of inhibition that are used for regulation, **competitive** and **non-competitive**. In competitive inhibition, the inhibitor binds directly to the active site, effectively completely blocking access from the substrate.

Enzymes:
AP Biology Crash Course Review Cont.

Non-competitive inhibition, also known as **allosteric inhibition**, is when the inhibitor binds to a different part of the enzyme but induces a change in the active site to prevent binding by the substrate. The binding often changes the shape or charge of the binding site, preventing the substrate from being able to bind. The other way to inhibit is to bond. These processes all help to regulate rates of enzyme activity.

Factors that Affect Enzyme Activity

Enzyme activity is affected by many factors, including **temperature** and **pH**. An increase in temperature increases the rate at which the molecules in a system move. This increase in temperature will allow the substrates and enzymes to locate each other more quickly. However, there is a point at which the enzyme will become denatured due to the higher temperature, adding stress to its bonds. Many enzymes operate at an ideal temperature called the **optimum temperature**.

pH can also affect an enzymes activity. pH controls the balance between positively and negatively charged amino acids. Ionic interactions are important to hold the enzymes together. Most enzymes have an optimum pH between 6 and 8.

Example

Now that we have covered the topic of enzymes, let's explore a real life example. At this point in your studies, you may have come across an enzyme called DNA polymerase (if you haven't please check out **AP Biology Crash Course Review: DNA Replication**). DNA polymerase is an enzyme that catalyzes the chemical reaction of deoxynucleoside triphosphate plus DNA to diphosphate and DNA (plus the nucleotide).

Enzymes:
AP Biology Crash Course Review Cont.

In this reaction, the enzyme breaks a phosphate bond from the deoxynucleoside triphosphate and uses that energy to add the nucleotide base to the DNA molecule. Without DNA polymerase, this process would not be able to occur because it is energetically unfavorable to catalyze. If this process could not occur, our cells would not be able to replicate and repair. This would result in death of the organism.

AP Biology Question

Now that we have reviewed the information you need to know about enzymes for the AP Biology exam, here is an example of a multiple choice question you could see:

Which of the following is characteristic of enzymes?

A. They lower the energy of activation of a reaction by binding the substrate.
B. They raise the energy of activation of a reaction by binding the substrate.
C. They lower the amount of energy present in the substrate.
D. They raise the amount of energy present in the substrate.

What did you pick? If you chose A you are correct! Enzymes lower activation energy when they bind to the substrate and alter the transition state. If you had trouble with this question, go back through and read this review. If you have any questions, let us know in the comment section!

Enzymes:
AP Biology Crash Course Review Cont.

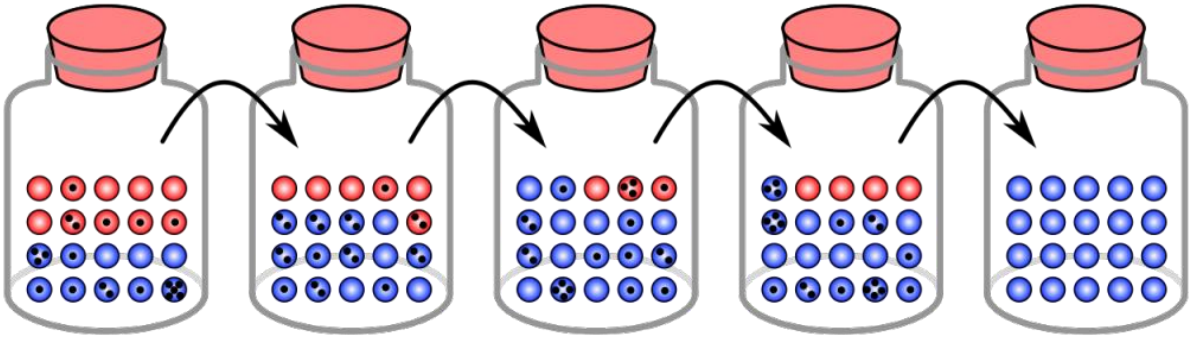
Summary

In nearly every chemical reaction of life, enzymes are used. Dr. Richard Wolfenden recently found that if enzymes were removed, the biological reactions necessary to life would take 2.3 billion years to spontaneously occur. Clearly, enzymes are a necessary part of life!

In this **AP Biology Crash Course Review**, we went over the general structure of an enzyme and its activation site. We then reviewed what exactly enzymes do and how they do it. We then reviewed different types of activation and inhibition molecules. Finally, we wrapped up with an example of a real life enzyme and why it is important to survival.

The AP Bio exam will likely have questions about enzymes on it. Do you feel prepared? Let us know!

Genetic Drift: AP Biology Crash Course Review



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Understanding how populations evolve is one of the central themes of AP Biology. Genetic drift is an important driver of evolution, that you will see mentioned on your AP Bio exam. This AP Biology Crash Course Review covers the basics of genetic drift, including key concepts and clues to look for in exam questions.

Evolution and Genetic Drift

Remember that evolution is defined as a change in allele frequencies between generations. We normally think about evolution occurring due to selection, but when population sizes are small, allele frequencies are more likely to change due to random events – this effect is known as genetic drift. Genetic drift is a non-selective change in allele frequency due to the random sampling of individuals in a population. Drift most strongly affects small populations or populations that have recently experienced a drastic reduction in size.

Genetic Drift:
AP Biology Crash Course Review Cont.

A simple way to think about genetic drift is to imagine a jar with 100 marbles – 50 red and 50 green. If you were to shake up the jar, close your eyes, and pull out ten marbles, there is a good chance that you will not grab five red and five green. Instead, you might randomly grab two red and eight green, or nine red and one green. If you imagine the marbles as alleles, your new population of 10 marbles might have very different allele frequencies than the parent population of 100 marbles, simply due to random chance.

Genetic Drift, Genetic Diversity and Fixation

An important component of genetic drift is a reduction in genetic diversity. Since drift often involves a shift from a large population to a smaller one, it is likely that rarer alleles will be lost. Genetic drift often leads to the fixation of an allele – fixation occurs when all variants of an allele are lost except for one. Going back to our marble example, imagine that you pulled three red marbles and seven green marbles from the original 50/50 population. If you were to fill a new jar with 100 marbles in the same frequency (30 red and 70 green), then repeat a random sampling of 10, there's a good chance that this time you'll pull more green than red marbles again. If you kept repeating this process, eventually you would end up with only one color of marble. At this point, you would say that the color of marbles in the jar has become.

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Genetic Drift:
AP Biology Crash Course Review Cont.

Two examples of genetic drive that you may encounter on the AP Biology exam are the bottleneck effect and founder effect.

1. Bottleneck Effect

Perhaps the most commonly used example of genetic drift is the **Bottleneck Effect**, also known as a genetic bottleneck. A genetic bottleneck occurs when a natural disaster, or similar event, kills off a large portion of a population at random, leaving a smaller population with different allele frequencies from the original population. For example, an earthquake kills all of the white flowers in a population of white, red, and yellow flowers. The new population will only have red and yellow flowers, and thus different frequencies of flower color alleles, due only to random chance.

To remember bottleneck effect, think again of our 100 red and green marbles, but this time, imagine them in a bottle with an opening that is only wide enough to allow one marble at a time. If we shake up the bottle and then pour out ten marbles, once again it is likely that the new 'population' of marbles will not be 50/50 red and green, but instead a new frequency.

2. Founder Effect

Another common example of genetic drift is the founder effect. The founder effect is when a group of individuals from a large population splits off to form a new population. The random group of alleles in the new population is unlikely to fully represent the genetic diversity of the original population, especially if the new population is small. For example, imagine during colonial times if a ship were to wreck on an uninhabited island – the surviving people would be the founders of a new human population. The people on the ship are unlikely to carry all the alleles that existed in their country of origin, and since they are isolated from other people, their new island population will have different allele frequencies than those in their homeland.

Genetic Drift:
AP Biology Crash Course Review Cont.

Genetic Drift on the AP Biology Exam

To approach questions about genetic drift, think about the key features of the process and what clues might give away the right answer.

The key features of genetic drift:

- Change due to random chance
- Reduction in population size
- A loss of genetic diversity

Context clues for common genetic drift examples:

- **Bottleneck effect**: Natural disaster randomly reducing a population
- Founder effect: A few individuals splitting off from a larger population to form a new population

Let's look at an example question.

Which of the following is an example of genetic drift?

A. In a population of red and yellow beetles, red beetles are eaten more often by birds, because they are easier to see.
B. In a population of red and yellow beetles, both red and yellow females prefer to mate with red males over yellow males.
C. A red beetle migrates to from a population of mostly red beetles, to a different population of mostly yellow beetles.
D. In a population of red and yellow beetles, a new mutation leads to a green beetle.

Genetic Drift:
AP Biology Crash Course Review Cont.

E. During a hurricane, four red beetles from a population of 30% red and 70% yellow beetles are blown to a new island and start a new population of beetles.

How do you know which answer is correct?

A. In a population of red and yellow beetles, red beetles are eaten more often by birds, because they are easier to see. While both population size and genetic diversity might be lost in this answer, the cause is selection due to non-random predation. If it's not random chance, it's not genetic drift.

B. In a population of red and yellow beetles, both red and yellow females prefer to mate with red males over yellow males. Here, female mate choice is the cause of allele frequency changes, NOT random chance. This is not an example of genetic drift.

C. A red beetle migrates to from a population of mostly red beetles, to a different population of mostly yellow beetles. Some students might be tempted by this answer because the red beetle is splitting off from its original population, but since it is joining an already existing population, not founding it, this is not an example of genetic drift.

D. In a population of red and yellow beetles, a new mutation leads to a green beetle. Here we have an increase in genetic diversity due to mutation – big red flag that it's not genetic drift.

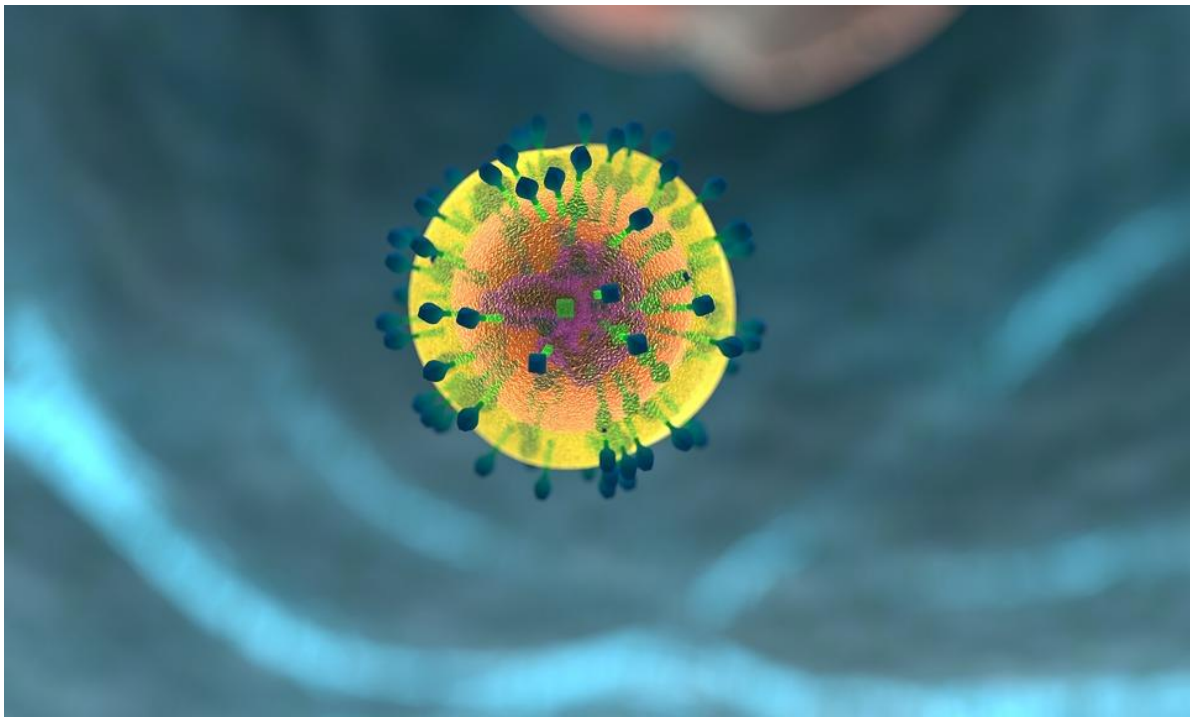
E. During a hurricane, four red beetles from a population of 30% red and 70% yellow beetles are blown to a new island and start a new population of beetles.

Genetic Drift:
AP Biology Crash Course Review Cont.

This answer has it all! A major reduction in population size and genetic diversity due to random chance, including a few individuals splitting off to form a new population! This is an example of genetic drift due to a founder effect. This is the best answer!

By operating as a random, non-selective force, genetic drift shapes the evolution of small populations in unpredictable ways. By understanding these key components of genetic drift, you're one step closer to acing the evolutionary biology questions on your AP Biology exam!

Immune System: AP Biology Crash Course Review



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What do you think of when you hear “immune system?” Maybe your body fighting a cold, maybe white blood cells? Your body’s immune system is there to protect you, both from inside and outer-body offenses. Animals must defend themselves against viruses, bacteria, and other types of intruders. Our cells have no walls, as we traded in mobility for susceptibility over the course of evolution. So our immune system is there to help keep us safe. Let’s take a closer look at the workings of the immune system as far as what you’ll want to know for the AP Biology exam.

Immune System:
AP Biology Crash Course Review Cont.

Attacks on the Immune System

Your body can be attacked from within, whether by mutated cells, or more often, viruses or bacteria. Viruses have been a topic for discussion over a long time as they are rather unique in both their structure and function. Viruses do not have cells. They need energy from their environment, as they can't maintain an internal stable environment on their own. They are no considered to be alive, yet do take great strides to replicate themselves.

Viruses have a capsid (protein code) and inside this is DNA or RNA. Lysogenic virus DNA hides in your chromosomes and generally remains dormant. It does not automatically cause disease. Lytic viruses destroy the cell. To lyse something is essentially to cut it up, or destroy it. There is a lytic phase to many viruses in which they copy themselves and then destroy the host cell before moving on to other cells in the body. The flu is an example of this type of virus. It attached to a host cell, injects its DNA (or if it uses RNA, then it undergoes reverse transcription to have DNA available), and then the lytic cycle turns off the cell's machinery and forces it to make **proteins** for the virus.

When a virus becomes part of the chromosomes, the virus DNA in there is called prophage. It's dormant, and when the cells divide, the DNA from the virus also divides and is copied. Occasionally, there may be a stimulus that drives it out of the chromosome and into a lytic cycle. Most viruses are actually a bit of both, part lysogenic, part lytic. They may lean more heavily to one side, as in the flu virus, which exists mostly in a lytic phase. Viruses can generally only be prevented with vaccines, though bacteria can be cured with antibiotics.

General Immune Defenses

There are three general lines of defense the body has against invaders. The first lines of defense are physical barriers such as skin and mucus membranes. The second is non-specific, as well, but internal.

Immune System:
AP Biology Crash Course Review Cont.

This would include phagocytic white blood cells. The third and last line of defense is what's typically referred to as the immune system. This includes lymphocytes and antibodies, more specific to definitive types of invaders.

The first line of defense includes epithelial cells and mucus membranes. This involves the skin, respiratory system, digestive tract, and genito-urinary tract. These are most exposed to the outside world. Sweat has an acidic pH and can help to prevent bacterial infections. Stomach acid also has a low pH. Tears, saliva, and mucus have antimicrobial properties, themselves, and can serve to trap potential invaders and neutralize them. Lysosomes within the saliva digest the **cell walls** of bacteria and destroy them.

The second line of defense is generally made of the white blood cells, which patrol the body looking for any type of foreign particles. They are phagocytic cells, which is to say they eat other cells. They also have microbial proteins and work with inflammatory responses. There are several types of white blood cells, and these are basophils, eosinophil, neutrophils monocytes, and lymphocytes. Monocytes and neutrophils are phagocytic and digest invaders with **enzymes**. Monocytes start as cells and become macrophages. Most white blood cells are neutrophils, which are rather short-lived cells, which neutralize invaders. Eosinophils fight parasites. Basophils are part of an inflammatory response and produce histamine.

Basophil produces histamine, which attract more white blood cells. This makes the blood vessels more leaky, which allows fluids to leave and enter more easily, which allow for the more efficient transport of white blood cells to a site. As they are also involved in inflammatory responses, the temperature in the area may go up then, and swelling will occur.

When a local response is not enough, a fever is a common reaction. This resets the body's thermostat. The higher temperatures are helpful in that they can inhibit the growth of microbes, facilitate phagocytosis, and speed up the repair of tissues.

Immune System:
AP Biology Crash Course Review Cont.

The lymph system produces leukocytes. Lymph fluid moves throughout the body by way of contractions of muscles and vessel with one-way valves. Lymph nodes are located in certain parts of the body and act as little police stations, all containing a large number of lymphocytes and macrophages.

Lymphocytes

The third line of defense is the lymphocytes, the B and T cells, which develop in the bone marrow. T cells mature in the thymus. They are attracted by chemical signals, the process of which is referred to as positive chemotaxis. In this way, lymphocytes are able to respond to specific toxins, microorganisms, abnormal body cells, and antigens (which in general, is just anything that elicits an immune response). Once the signal triggers a response from them, they move faster and look to destroy invaders. B cells produce antibodies to remember the chemical print of a foreign invader and allow for faster responses in the future. T cells facilitate the production of chemicals used by lymphocytes to kill off the foreign particles.

B cells recognize specific antigens, which each stimulate a unique antibody to be made. B cells are spurned to reproduce clone colonies, clone cells being either plasma cells or memory cells. Plasma cells facilitate the immediate production of antibodies, and release them in the short-term. Memory cells are for long-term immunity. They produce plasma cells to fight off invaders if they recognize the same foreign particle at a later date. These play a big role in vaccines.

Antigens are **proteins** that elicit a specific response by lymphocytes based on where they're coming from. B cells recognize intact antigens, and T cells recognize antigen fragments.

Antibodies are proteins that bind to a specific antigen. If it's designed to work against e. coli, for example, that is the only invader it works against.

Immune System:
AP Biology Crash Course Review Cont.

They are multi-chain proteins produced by B cells that “tag” invaders as being foreign so other cells can recognize them as invaders.

There are four main ways an antibody will work to rid the body of invaders. In neutralization, it would bind to a locking site on a virus so that it can’t take over a cell then. With agglutination, it causes invaders to clump up. The reason this helps is this: think of peas. Is it easier to get one pea off a plate to eat, or use a spoon to eat many at once? When bacteria are clumped up, and a white blood cell finds it, it eats up the entire clump. Precipitation is where antigens are connected together by antibodies and they become dense and separate out the bad parts from the rest of the blood. And in a complement reaction, antibodies bind to a foreign cell, and complement proteins form and encircle the invader, and a hole is put in the ring and the cell dies. Plasma cells are typically involved in this type of attack.

There are millions of types of B cells with all different receptors for all different antigens. An antigen binds with a B cell and then it’s triggered to make many, many copies of itself. Clones can become memory cells or plasma cells.

A first invasion usually takes about 10-17 days to mount an effective response. If it happens again, it is much faster. Memory cells stick around after a first attack and the antibody concentration becomes much higher far more quickly if the same invader comes back.

Vaccines work by giving partially destroyed viruses to the recipient so that memory cells can be created without actually harming the host. Vaccines are a form of active immunity. They stimulate the immune system to produce a response of its own. This is most effective against viral diseases.

Passive immunity comes from an outside source and is only short-term. A person receives antibodies only in this case. An example would be a mother making antibodies and passing them to her child by way of breast-feeding.

Immune System:
AP Biology Crash Course Review Cont.

If the child stops breast-feeding, it will no longer have those antibodies. Antivenom works in a similar way. Scientists inject rabbits with snake venom and the rabbits produce antibodies. The antibodies are separated, and now you have an antivenom. Those antibodies will lock up the **proteins** in venom and serve to neutralize them.

Another concern in immunity is recognizing self from non-self. MHC (major histocompatibility complex) tells the body what is a part of itself, and develops early in life. T cells use this in knowing what to go after.

There are helper T cells and cytotoxic T cells in the body. Helper T cells stimulate immune components while cytotoxic T cells kill off cells. If you have an invading bacterial infection, they would be taken up by a macrophage in response. Now the macrophage becomes APC (antigen present cells) and presents an antigen on the outside of the cell for MHC to recognize. Helper T cells are activated and then activate the cytotoxic T cells to destroy cells with that same antigen mark. Cytotoxic T cells bind to infected cells and produce a protein called perferin which perforates that alien cells to rip them apart.

Wrap-up for the Immune System in AP Biology

This has been a very complete description of the immune system including everything you need to know for the AP Biology test. Remember all three lines of defenses and the different types of cells that play a role, including B and T cells.

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Lipids:
AP Biology Crash Course Review

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Introduction

Lipids have gotten a bad reputation over the past few years due to all the hype about fats being bad, but in reality, lipids are much more than just "fat." They are, in fact, one of the building blocks of life. In this crash course review, we will go over everything you need to know about lipids to not only be prepared for the AP Biology exam but also to better understand what an important role lipids play in biology as a whole. We'll start with going over what lipids are in general; then we will look at how the three main types of lipids differ in structure and function; and finally we'll have some review questions and a quick recap. By the end of this crash course review, you should feel confident enough in your knowledge of what lipids are and why they are important to be able to answer whatever the AP Bio exam may throw at you.

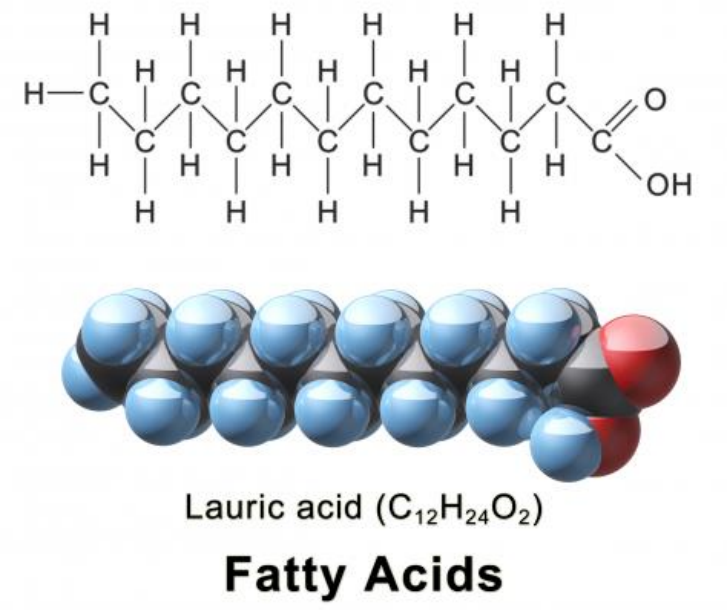
Lipids:
AP Biology Crash Course Review Cont.

What are Lipids?

Lipids, like carbohydrates and proteins, are a class of organic compounds. They are hydrocarbon-based macromolecules that are grouped together because of their **hydrophobic** qualities. This means that all lipids are insoluble in water, which you may have already noticed if you have ever tried to wash butter or oil off of your hands. There are three main families of lipids: fats, phospholipids, and steroids. Let's look at each of these in a bit more detail.

Fats

Fats are energy storing macromolecules that are made up of two main components: a molecule of **glycerol** and **three fatty acids**. Because of this structure, they are sometimes referred to as **triglycerides**, with the 'tri-' prefix meaning "three." These fatty acids are long chains made up a hydrocarbon tail with a carboxyl group head.



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Lipids:
AP Biology Crash Course Review Cont.

The fatty acids are linked to the glycerol backbone through the process of **dehydration synthesis**, which you may remember reading about if you have already reviewed other macromolecules like **carbohydrates**. If not, here is a brief explanation:

Dehydration synthesis, sometimes known simply as *condensation*, is a process where monomers are bound together through the loss of a water molecule. A covalent bond is formed. The reverse process of dehydration synthesis is **hydrolysis**.

Now, back to fats. There are two main types of fatty acids: saturated and unsaturated. **Saturated fats** contain only single bonds between carbon atoms. All the carbons are bonded to hydrogens, and there are no carbon double bonds. Generally, saturated fats come from animals (but also some tropical oils like coconut and palm oil), and they are solid at room temperature. Consumption of saturated fats is linked to heart disease due to plaque deposits in the blood vessels. A good example of saturated fat is butter.

Unsaturated fatty acids have at least one double bond in their chains. This is formed by removing hydrogen atoms from the carbon skeleton, meaning that unsaturated fatty acids have fewer hydrogen atoms than saturated fatty acids (i.e., they are less saturated with hydrogen). Unsaturated fatty acids usually come from plants or fish and are liquid at room temperature. When fats are in liquid form, they are known as **oils**. Some good examples unsaturated fatty acids include vegetable oils like canola oil and olive oil as well as fish oil.

You may have also heard of a third type of fat called **trans fats**. Trans fats are sometimes known as '*partially hydrogenated oils*' because they are created through an industrial process where hydrogen is added to vegetable oils to make them more solid. A good example of this is margarine, which is vegetable oil but can be bought in a solid form similar to butter. Consuming lots of trans fats increases your risk of heart disease, stroke, and type 2 diabetes.

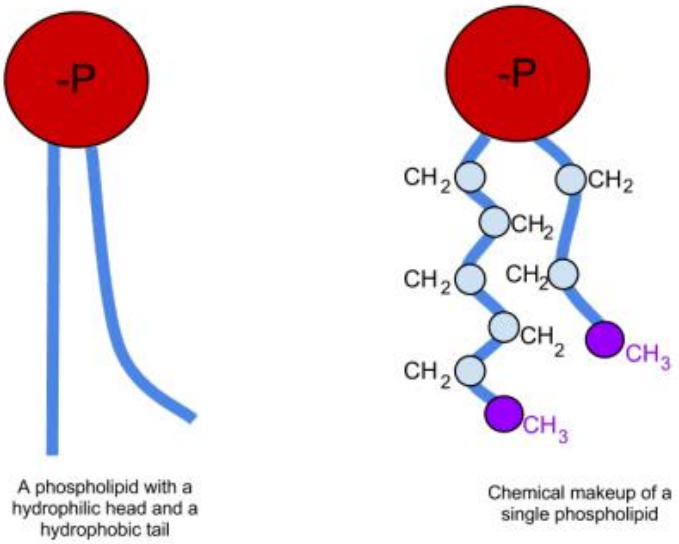
Lipids:
AP Biology Crash Course Review Cont.

So if fats increase the risks for all these bad things like heart disease and stroke, what are they good for? Fats are incredibly important for **energy storage**: 1g of lipid will release nine calories when burned, while in comparison 1g of carbohydrates only releases four calories. Although we are lucky enough to live in a time and place where our food sources are abundant, this was not always the case, and certainly still is not the case for most life on earth. Plants and animals need to be able to store energy as fat to be able to access it in times when food is scarce, and their fat reserves are all they can live off of.

Fats also serve the important function of protecting the organs and insulating the body. Whale blubber, for example, is entirely made of fat.

Phospholipids

Phospholipids are very similar to fats in their structure, but instead of having three fatty acids bound to glycerol, they have two fatty acids and a **phosphate group (PO4)** bound to glycerol.



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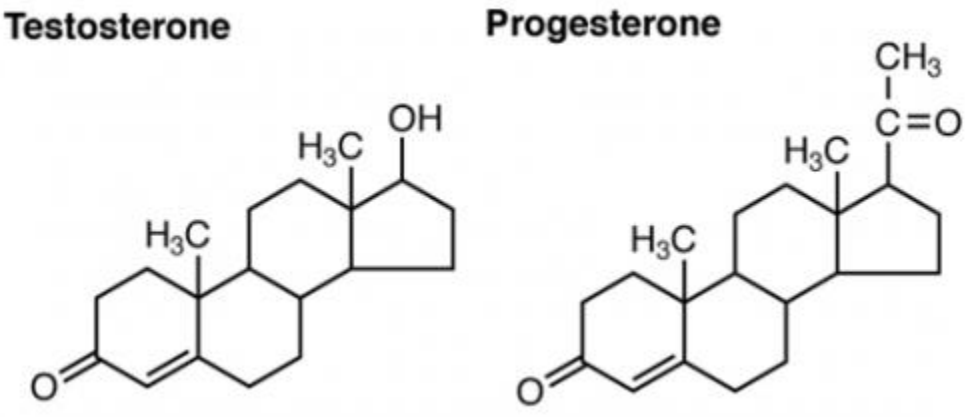
Lipids:
AP Biology Crash Course Review Cont.

Phospholipids serve essential functions in the structure of **cell membranes**. While the fatty acid tails are hydrophobic, the PO4 head of a phospholipid is hydrophilic. This allows them to arrange themselves into a **phospholipid bilayer**, where the hydrophilic heads face outward, and the hydrophobic tails face inward to create a nonpolar zone that is essentially a barrier in water. This is how cell membranes are formed.

Steroids

Steroids are a family of lipids that have quite a different structure compared to fats and phospholipids. Steroids have **four fused hydrocarbon rings** with various chemical attached to them that determine which specific steroid it is. One steroid you will need to know for AP Biology is **cholesterol**. Cholesterol is a component of the plasma membranes in **animal cells**, making it a vital part of cell structure – it helps keep membranes flexible and fluid. It is also the precursor to many other important steroids, such as the sex hormones **testosterone**, **estradiol**, and **progesterone**.



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Lipids:
AP Biology Crash Course Review Cont.

Other Lipids

We've gone through the three main types of lipids, but there are a few more less-common types that are also worth mentioning. **Waxes**, for example, are also considered lipids due to their hydrophobic nature. Wax can coat the outside of some plants, as well as the feathers of birds and even the fur of some animals to keep them dry from rain and other water. **Omega fatty acids** like Omega-3 and Omega-6 are also lipids and are essential for normal growth and brain health. They also protect against cardiovascular disease.

Review Questions

Question 1. *Why are sex hormones considered lipids?*

A) They consist of fatty acids

B) They are essential to the structure of cell membranes

C) They store energy

D) They are hydrophobic

E) They are hydrophilic

Question 2. *What happens when hydrogen is added to vegetable oils?*

A) The hydrogenated vegetable oil will have fewer trans fats

B) The hydrogenated vegetable oil will be solid at room temperature

C) The hydrogenated vegetable oil will be less likely to cause heart disease

D) The hydrogenated vegetable oil will become a saturated fat

Question 3. *True or False: Of the three main families of lipids, phospholipids are most important for energy storage.*

A) True

B) False

Lipids:
AP Biology Crash Course Review Cont.

Answers

Question 1. The correct choice is option D – they are hydrophobic. The criteria that all lipids must meet to be considered lipids is that they must be insoluble in water.

Question 2. The correct answer is option B – the oil will be solid at room temperature. The process of hydrogenation creates trans fats that cause many health problems.

Question 3. The correct answer is B – False. Of the three main classes, the group of lipids that is most important for energy storage is fats. Phospholipids serve a vital purpose in providing structure for cell membranes.

Crash Course Review Recap

- Lipids are hydrophobic organic compounds that are divided into three main categories: fats, phospholipids, and steroids.
- Fats are composed of a glycerol and three fatty acids and are used for energy storage.
- Saturated fats have single bonds, are solid at room temperature, and generally come from animal sources.
- Unsaturated fats have double bonds, are liquid at room temperature (oils), and generally come from plant sources.
- Trans fats are created industrially by adding hydrogen to vegetable oils.
- Phospholipids have a glycerol, two fatty acids, and a phosphate group; they are essential for the structure of cell membranes.
- Steroids are made of four fused hydrocarbon rings and are important for structural and endocrine functions; main example to know is cholesterol.

Mendelian Genetics: AP Biology Crash Course Review

Image Source: Flickr

Do you know your classical Mendelian genetics inside and out? If not, then read on, because Mendelian genetics is always a crucial part of the AP Biology Exam. All forms of life are composed of DNAs, which Mendelian genetics can explain, and this crash course can help you out with the studying.

Mendel's famous pea plant experiments have launched the study of genetics into an intense research subject area that has saved lives. So while this man's experiments started with a pea plant, the knowledge gained by many grew to so much more. In this AP Biology crash course we will illustrate Mendel's discoveries.

Mendelian Genetics:
AP Biology Crash Course Review Cont.

What is Mendelian Genetics?

Mendelian genetics and characteristic intelligence is a fancy term for the way that genes get information from your parent's sex cells to integrate it into your characteristics. At the very heart of Mendelian genetics is **heredity**, which is the passing on of genetic traits from parent to offspring. The definitions for Mendelian genetics and heredity are similar, because Mendel based his research off of this idea. He researched what happens genetically when parents mate to form offspring. Mendelian genetics sounds like a complex concept, but it is the foundation of everything that modern science knows about genetics. Genetics is what gives your eyes their color and what makes you tall or short.

Gregor Mendel, in 1865, published a hypothesis about inheritance of the characteristics of the peas in his garden. Mendel did this in order to prove the popular blending hypothesis of the time invalid. Before, it was believed that the traits of both parents blended to produce a hybrid offspring that was a perfect mix of both parents.

An example of this is that a white flower mated with a purple flower would produce a light purple offspring. Mendel disproved this theory, because when he bred his flowers, the F1 generation, were all the original deep shade of purple. The colors did not mix as what was believed in the blending hypothesis. Mendel claimed that genes will retain their individuality generation after generation as a result of his experiment.

This is also why the human gene for red hair color may skip generations. The red coloring is not blended with the hair color of the other parent. Instead, the red is only masked by another version of the gene within the chromosome.

Mendelian Genetics:
AP Biology Crash Course Review Cont.

Chromosomes and Genes

But what are chromosomes? To put it simply, chromosomes are coils and coils of genetic information. Humans have forty-six chromosomes that are combined in pairs, which make it twenty-three pairs all in all. This happens, because humans are diploid organisms, meaning that we gain a chromosome from each parent's haploid sex cells, which contain twenty-three chromosomes in the sperm and another twenty-three in the egg cell. Once they combine, then the forty-six chromosomes come together to create a full genetic code. These chromosomes pairs are homologous, as these encodes for the same traits, and they link up because of the genes housed in their DNA.

Genes housed within the DNA are made up of specific parts of a chromosome and are used to determine the characteristics of an organism. Genes code for specific functions and characteristics in the body.

Within the body, genes sometimes work together to form a trait. This is called a polygenic trait. Other genes, called pleiotropic genes, affect multiple characteristics with only the single genes. Even less genes are encoded to form a single trait. This is the type of trait that Mendel studied with his peas, and we refer to it as a Mendelian Trait.

Determining Traits

Traits are determined by which form, or allele, of the gene is expressed. These alleles can be dominant, meaning they overpower the recessive gene. The expression of the trait is called the phenotype. Therefore, if the purple and white flowers bred together and produced purple flowers, then the purple coloring would be the phenotype.

Mendelian Genetics:
AP Biology Crash Course Review Cont.

Through Mendelian genetics, we can also determine that the purple flower is the dominant trait, because it was expressed over the white. The genotype is the combination of alleles within the gene. After gaining a chromosome from Mom and one from Dad you have two alleles. The genotype shows these alleles. This is usually noted as two letters, each representing an allele. Dominant traits are capitalized and the recessive is lowercase (Bb). For example, if your mother has blue eyes, a recessive trait, and your father has blue eyes, then each parent will have a genotype of two recessive alleles for blue eyes, or “bb”. They will pass one of each recessive allele down to you, causing you to also have two recessive alleles for blue eyes. Having two recessive alleles allows the recessive trait to show, causing the genotype to be homozygous recessive.

If your parents have brown eyes, the dominant trait, then it gets a bit more complex. Your parents could either have homozygous dominant, or BB, for brown eyes or heterozygous for brown eyes, or Bb. This is because the brown trait is expressed over the blue trait. This gives the child a fifty percent chance of being heterozygous, or brown-eyed, a twenty-five percent chance of being homozygous dominant, or brown-eyed, and a twenty-five percent chance of being homozygous recessive, or blue-eyed. This can be determined by a Punnett Square, which is a visual representation of trait distributions.

Another example of a trait that can be laid out like this is the ability to curl your tongue. We will say that the ability to curl your tongue is dominant (C) and the inability to curl your tongue is recessive (c). Classical Mendelian genetics dictates that if your parents are both homozygous dominant, then all offspring will be able to curl their tongues. If the parents are homozygous recessive, then none of the offspring will be able to curl their tongues. If the parents are heterozygous, then the twenty-five percent will not be able to curl their tongues and seventy-five percent will be able to curl their tongues.

Mendelian Genetics:
AP Biology Crash Course Review Cont.

Not only did Mendel prove that the blending hypothesis was invalid, but he also provided a method to predict the outcome of the genes of the offspring by utilizing Punnett squares. After Mendel proved this he also proved that allele pairs segregate independently. Because of this, your eye color has no effect on your hair color. This is important, because without this, one faulty gene could alter your entire body composition! Mendel proved this with his peas as well when he simultaneously studied the shape of the pea and the color of the pea. He determined that the alleles for each of these traits did not affect each other. This can be represented in a dihybrid Punnett square as seen to the right. As you can see, the color expressed by the pea does not affect the shape expressed by the pea.

Why is this Important to AP Biology?

These Punnett Squares show the variations on the genotypes and the chances of the gene being expressed as a certain phenotype. While this may seem trivial, this ability to predict how offspring will turn out is vital. Mendelian genetics began on a small level of crossing two single traits in a monohybrid Punnett Square. Mendel paved the way for scientists to uncover why certain genetic impairments act the way they do. Deafness, for example is a recessive trait; therefore, through Mendelian genetics scientists could determine why deafness could not be present in the parents but was present in the child. This was because the parents could be heterozygous and both pass on the recessive allele, causing the offspring to be deaf. This is one of the great applications of Mendelian genetics that has truly led to bettering the knowledge of genetics as a whole.

Mendelian genetics is also important to AP Biology and this AP Biology crash course, because knowing how genetic variation works sets the foundation for studying evolution. By understanding Mendel's Laws that state that alleles are individually segregated and that alleles separate as gametes, or sex cells, form, then Charles Darwin's Theory of Evolution is confirmed and even further supported. After all, how could the survival of the fittest come to be so fit without their initial genetic variation? It would not make any sense.

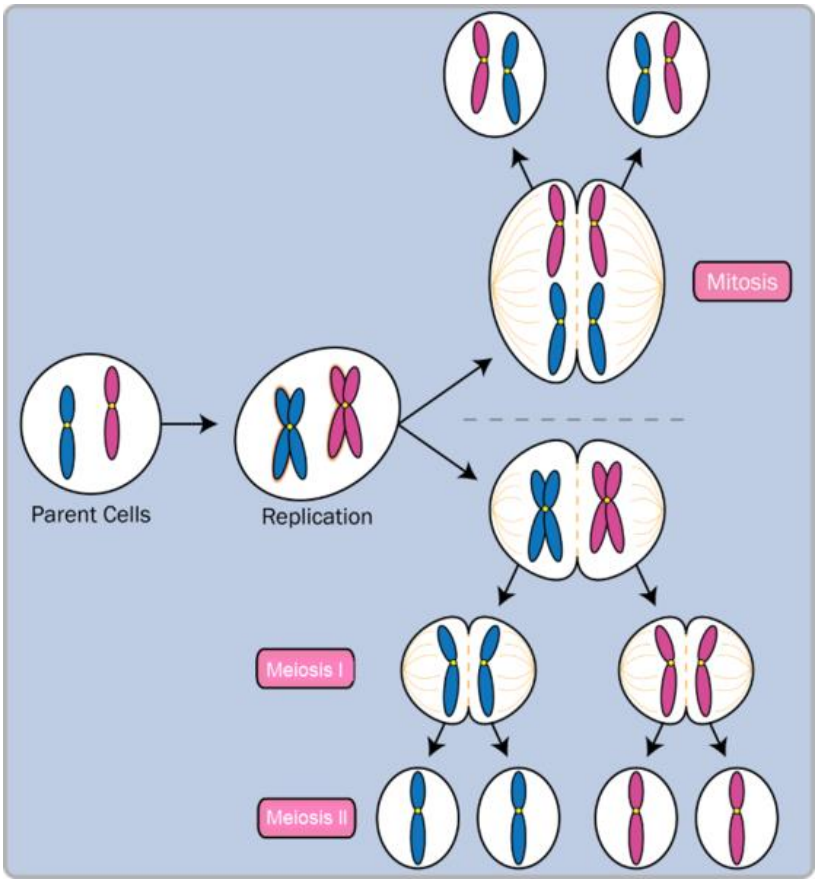
Mendelian Genetics:
AP Biology Crash Course Review Cont.

You were created by the ideas that the laws of Gregor Mendel convey. Your body started out as a single cell, a combination of a sperm cell and an egg cell. You not a clone of your parents, but you are your own individual with both the same and unique traits from each parent. This allows for genetic diversity in the population, which allows for each generation to become stronger than the last.

So yes, Mendelian genetics unlocked the study of genes and DNA to the rest of the scientific community. Those pea plants spurred curiosity, and in turn, changed Gregor Mendel into the properly named father of genetics. Did he figure out every aspect of genetics? No, of course not, but Gregor Mendel did build the groundwork for other scientists to build upon his work, which is science at its best.

Do you have a question about Mendelian genetics? Please ask us about it. Do you have a strange trait that has been passed down through your family? Please share!

Mitosis and Meiosis: AP Biology Crash Course Review



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As a eukaryotic organism grows, its cells are constantly dividing and creating new cells according to the "genetic blueprint" of its DNA. The processes by which these new cells are developed are known as mitosis and meiosis. **Mitosis** is the method by which somatic (or non-reproductive) are created, while **meiosis** is the method that creates gametes (reproductive cells like sperm and eggs).

Mitosis and Meiosis:
AP Biology Crash Course Review Cont.

Keep in mind: prokaryotic cells do not have membrane-bound organelles like nuclei, and therefore do not undergo mitosis and meiosis as eukaryotic cells do (instead, they undergo binary fission). Throughout our discussion of mitosis and meiosis, we will be talking only about eukaryotes.

Before we get into the specifics of each process, let's go over some AP Biology background information that will help us understand the differences between them.

Chromatin, Chromatids and Chromosomes

These are essentially the three forms of a cell's genetic material. **Chromatin** is its loosest, least-organized form, which usually floats freely around inside the defined envelope of the nucleus. **Chromatids** are formed from condensed chromatin and serve as one-half of each chromosome. In its most complete form, two identical "sister chromatids" are joined together by a **centromere** to form a full **chromosome**.

Diploid vs. Haploid Cells

Cells come in essentially two "flavors": **diploid** and **haploid**. As the names imply, a diploid cell contains two sets of genetic information in homologous chromosome pairs, while a haploid cell contains only one set of genetic information in single copies of each chromosome.

Non-reproductive somatic cells are diploid cells, containing two sets of chromosomes. Human cells, for example, have 23 chromosome pairs (46 total chromosomes), with one set of genetic information inherited from each of that human's parents.

Mitosis and Meiosis:
AP Biology Crash Course Review Cont.

Reproductive gametes, on the other hand, are haploid cells, containing only one set of chromosomes. In humans, egg and sperm cells contain only 23 chromosomes. When gametes combine during sexual reproduction, the sets of chromosomes from both parents provide the chromosome pairs for future diploid cells.

Now that we've reviewed the necessary AP Bio background, let's get to the meat of this section: the actual processes of mitosis and meiosis.

Mitosis

The process of cellular mitosis occurs in four primary phases: **prophase, metaphase, anaphase and telophase**. A fifth "phase," known as **interphase**, is the state in which a somatic cell spends most of its lifespan.

Note: you will not need to know the names of these phases for the AP Biology exam, but you will still be required to describe the steps.

Take a look at how each of these phases breaks down.

Interphase

Not necessarily a true "phase" of mitosis, interphase is the normal, non-division state of somatic cells. If you throw a prepared slide of cells under a microscope, chances are the majority of them will be sitting in interphase, looking relatively inactive and uninteresting. If a cell is not in interphase, it is undergoing mitosis (which is sometimes referred to as "M phase").

Mitosis and Meiosis:
AP Biology Crash Course Review Cont.

Interphase itself is split into three stages, as follows:

- **G1:** cell simply grows
- **S phase:** cell continues growing, starts duplicating DNA
- **G2:** growth continues while cell prepares for mitotic division

Prophase

This is where the action begins. As a cell prepares to divide, it enters prophase, in which the nucleoli—spherical structures inside the nucleus that contain RNA and protein—disappear and the chromatin of the nucleus condenses into tightly-packaged chromosomes. Note that because the DNA was duplicated in S-Interphase, each chromosome now contains two copies of the cell's DNA.

The membrane that surrounds the genetic material of the cell (known as the nuclear envelope) then disappears, and a **mitotic spindle** is created as the **microtubule organization centers (MTOCs)** move toward opposite ends of the nucleus. These MTOCs are specialized structures that control the arrangement of a protein called tubulin into long microtubules that can manipulate the positioning of the cell's genetic material. The mitotic spindle is simply the term for the overall structure of microtubules that guide this material.

As the MTOCs move apart, the microtubules they've built increase in length and connect to the centromeres of the chromosomes via a region called the **kinetochore**. The MTOCs are then capable of moving the chromosomes toward or away from the poles of the cell by shortening or lengthening the microtubules.

Mitosis and Meiosis:
AP Biology Crash Course Review Cont.

Metaphase

During metaphase, the fully-formed chromosomes are aligned by the microtubules at the center of the cell in a plane known as the **metaphase plate**. Then, the attached microtubules retract, splitting each chromosome into its individual sister chromatids. These resulting chromatids still have a centromere each, however, and therefore are referred to as individual chromosomes from this point forward.

Metaphase ends as soon as the original chromosomes are split.

Top tip: to determine the number of chromosomes at any time during the process, simply count the number of centromeres.

Anaphase

After the initial separation of the chromosomes, the new chromosomes (the split chromatids) are pulled to the poles of the cell via the shortening of the microtubules. At the end of this phase, each pole contains a complete set of identical chromosomes.

Since the DNA copies made during the **S phase** of interphase have now split, the chromosomes at the poles consist of single chromatids with only a single copy of the parent cell's DNA.

Telophase

To wrap-up the division process, normal cell organelles start to re-build and the newly-formed daughter cells begin to take shape for their own interphase.

Mitosis and Meiosis:
AP Biology Crash Course Review Cont.

Nuclear envelopes develop around the genetic material at each pole, the chromosomes unwind and return to loosely-floating chromatin, and the nucleoli appear once more.

While the nucleus reforms, the dividing cell undergoes **cytokinesis**, which refers to the splitting of the unit and the division of cytoplasm across the two new cells. A **cleavage furrow** develops at the center of the dividing unit and cinches closed like a drawstring, leaving two separate cells with enclosed **cell membranes**.

Final result: two diploid daughter cells containing identical genetic material to the parent cell.

Meiosis

Because meiosis has the special task of creating new sex cells for reproduction, its process is unique, though similar to mitosis in many ways. Meiosis essentially goes through the stages of mitosis twice, with some key variations.

Perhaps the most important thing about meiosis is that it enables the independent assortment of genetic material. The determination of which chromosomes end up in which gametes is random, allowing for natural variation in the gene pool. It is this variation and biological diversity that keeps species naturally resilient.

Now that you're inspired by the beauty of natural genetic diversity, let's discuss how it happens.

Mitosis and Meiosis:
AP Biology Crash Course Review Cont.

Prophase I

This phase begins similarly to prophase in mitosis, with the nuclear envelope breaking down and the chromatin condensing into chromosomes. In meiosis, however, homologous chromosomes pair up into groups of four chromatids (known as **tetrads** or **bivalents**) in a process called **synapsis**.

During synapsis, genetic material may cross over between non-sister homologous chromatids (chromatids that are not connected by a centromere and are therefore not part of the same chromosome).

Metaphase I

Next, homologous chromosome pairs are arranged at the metaphase plate. Instead of a line of single chromosomes, as in mitosis, meiosis sees a line of pairs. Microtubules from each pole then attach to the kinetochore of one chromosome from each pair.

Anaphase I

This next phase starts as soon as the tetrads begin to separate. Like in mitosis, the separate chromosomes are pulled by the microtubules to opposite ends of the cell. Unlike mitosis, however, these chromosomes still comprise two sister chromatids.

Telophase I

The first half of the process completes with the formation of nuclear membranes around the chromosomes at the poles. Unlike in mitosis, the cleavage furrow does not yet develop. Note that once this process repeats to form the final four daughter cells, the resulting cells will be haploid.

Mitosis and Meiosis:
AP Biology Crash Course Review Cont.

Prophase II

The fun starts again with prophase II, in which the two newly-formed nuclear envelopes break down again and the mitotic spindle forms. This time, there is no crossing over.

Metaphase II

Metaphase II is nearly identical to metaphase in mitosis, with single chromosomes aligning at the metaphase plate. In this case, however, there is half the number of chromosomes present as in mitosis.

Anaphase II

Just like metaphase II, anaphase II mirrors the happenings of anaphase in mitosis, but with half as many chromosomes. Each single chromosome is pulled apart by microtubules and the new chromosomes (formerly sister chromatids) are pulled to opposite poles.

Telophase II

The entire process wraps up in telophase II. Four new nuclei form and **cytokinesis** occurs to form the four final cells. Note that the resulting cells' chromosomes comprise only one chromatid each, and even when these are replicated during the **S phase** of interphase the haploid cell will still only contain half the number of chromosomes of the parent cell.

Final result: four haploid daughter cells, each containing copies of half the genetic material of the parent cell.

Mitosis and Meiosis:
AP Biology Crash Course Review Cont.

Review

- **Mitosis** creates two diploid somatic daughter cells that are clones of the parent cell.
- A somatic cell spends most of its time in interphase, growing and replicating DNA in preparation for mitosis.
- The four phases of actual mitotic division are prophase, metaphase, anaphase and telophase. These names will not need to be memorized for the AP Biology exam.
- **Meiosis** creates four haploid gamete daughter cells, each containing half of the original cell's genetic material.
- The phases of meiosis vary in a few key ways from those of mitosis, but follow the same general phase order twice. Again, the names of the phases will not need to be memorized.

That's all there is to it! Can you describe each of the stages and key structures of mitosis and meiosis for the AP Bio exam?

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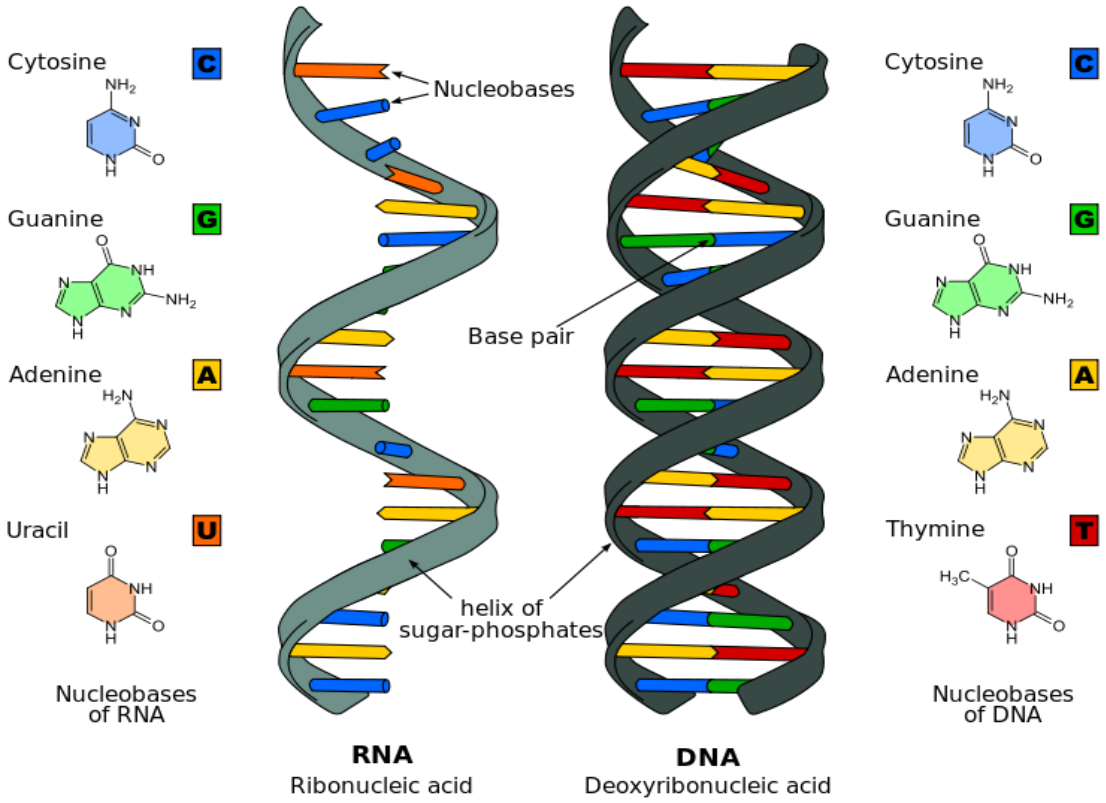
Nucleic Acids: AP Biology Crash Course Review



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Nucleic acids sound so dark, frightening, and scary, do they not? The organic compound sounds like it could melt steel and really wreak havoc on mankind, but in actuality you have nucleic acids inside of you right now that are hard at work. You may be surprised to realize that nucleic acids actually make you, you. Nucleic acids are not chemicals that will melt your eyeballs. Nucleic acids are actually the building blocks of life. Yes, you were built by nucleic acids.

Nucleic Acids:
AP Biology Crash Course Review Cont.

You may recognize a very famous nucleic acid. This famous organic molecule is called deoxyribonucleic acid, or DNA. In this AP Biology crash course, we will show you just how amazing **DNA and RNA** are, allowing you to pass with flying colors on your AP Bio exam.

Nucleic acids are one of the vital organic molecules that allow life to exist. The other organic molecules that are lumped together with nucleic acids are **carbohydrates**, **proteins**, and **lipids**. I would make the argument, however, that nucleic acids are the most important organic molecule. The nucleic acids are used to encode, transmit, and express all of the genetic information of the individual. Two common nucleic acids are deoxyribonucleic acid (DNA) and ribonucleic acid(RNA). These nucleic acids are used to encode and direct the other organelles to do various functions.

Deoxyribonucleic Acid

DNA is a nucleic acid that is made up of monomers called nucleotides, which contain a sugar-phosphate backbone and base pairs. The sugar that is in this backbone is called deoxyribose, and it has five carbons and a deoxygenated ribose sugar. The phosphate aspect of the sugar-phosphate backbone provides the acidity that we attribute to deoxyribonucleic acid. Accompanying the sugar-phosphate backbone is the nitrogenous base. The various nitrogenous bases come in four forms for the DNA. Adenine, thymine, guanine, and cytosine are those forms, and these nitrogenous bases pair up with the other half of the DNA ladder. This is done in order to form the famous double helix structure.

This structure of DNA was discovered by Watson and Crick. The two scientists critically examined the DNA, and through research they discovered that the nitrogenous bases must be on the inside of the double helix, and the sugar-phosphate backbone must be on the outside of the double helix. These two men also discovered that the nitrogenous bases only paired up with nitrogenous bases that complement them.

Nucleic Acids:
AP Biology Crash Course Review Cont.

This means that adenine could only pair up with thymine, and cytosine could only pair up with guanine.

An example of this is that if one side of the DNA ladder has a certain coding like the left side of the ladder below, then the other side of the ladder must have the complimentary nitrogenous bases, like the right side of the ladder.

G	C
C	G
G	C
A	T
T	A
A	T
C	G
G	C
G	C
A	T
T	A

There are countless arrangements of the nitrogenous bases that allow for such diversity in the encodings on DNA. Some arrangements will call for protein synthesis while other encodings may call for a pancreas to be made. Without these different arrangements it would be very difficult for the DNA to encode every piece of the human puzzle.

The DNA also carries with it **heredity** at a molecular level. In fact, studying DNA is often referred to as molecular biology. DNA attributes our genes and expresses our characteristics. If you have red hair, then that coding is from your parents and is bundled up within your DNA. If you have blue eyes, then this gene is also in your DNA. If you have a genetic disorder such as a predisposition to cancer or deafness, then this is also in your genes.

Nucleic Acids:
AP Biology Crash Course Review Cont.

Every individual's DNA holds the key to understanding the road map to building that organism. The small, but extremely long, strands code for **proteins** that are the methods of building cellular function. The Human Genome Project determined that DNA has twenty thousand five hundred genes encoded in it for humans. This number may rise in the coming years as this project progresses. The Human Genome Project is a slow moving project, because the DNA strands are so long that it takes a very long time to gather information about the DNA. Also, there is some DNA that scientists cannot determine is coded for anything. The scientists call this "junk DNA", although more research is being done to figure out just what that "junk DNA" is used for.

DNA and other nucleic acids are being constantly studied to try and figure out more about how they work. Genes within the DNA are studied, and new ways to treat genetic diseases erupt from these findings.

Ribonucleic Acid

Ribonucleic acid, or RNA, is a nucleic acid like **DNA**; however, ribonucleic acid does not have a DNA-like double helix structure. RNA is just a single helix. Also, the deoxyribose sugar is not present in RNA like in DNA. RNA has a ribose sugar instead with an OH group attached to it. RNA also has a phosphate group, just like DNA. The nitrogenous bases are similar to DNA, although thymine has been switched out for uracil. Therefore, there are still four forms of the nitrogenous base. Now they are uracil, adenine, guanine, and cytosine.

The reason that uracil is introduced and thymine is no longer used is because of the different function of the RNA. RNA is a classic example of how the structure influences the function. The structure of the uracil allows RNA to be a short lived entity. This is because the uracil is a less protected nitrogenous base than thymine. Thymine needed to be protected, because DNA has to last a long time. RNA, however, only needs to do quick tasks to get the information to protein synthesis. Therefore, uracil is used because it is quicker than DNA.

Nucleic Acids:
AP Biology Crash Course Review Cont.

An example of an RNA chain is listed below. Please note that the complementary nitrogenous base to uracil is adenine. Also, pay attention to the fact that there is no more thymine in these nitrogenous bases. The guanine and cytosine still fit perfectly together.

A	U
U	A
U	A
G	C
C	G
A	U
G	C
U	A
U	A
C	G
U	A
G	C

There are three types of RNA that can be found in the body. One of them is messenger RNA. Messenger RNA is the form of RNA that has been transcribed from a strand of **DNA** during replication. Transfer RNA is mainly composed of folded molecules that transport amino acids from the cytoplasm to the ribosomes. Ribosomal RNA is the RNA within the ribosome that is in charge of protein synthesis. This allows proteins to be made efficiently and correctly.

Why Nucleic Acids are Important to AP Biology?

If you are taking the AP Biology exam, then it is important to know that nucleic acids are the building blocks of life. Since biology is the study of life, you can be sure that nucleic acids will be on your exam.

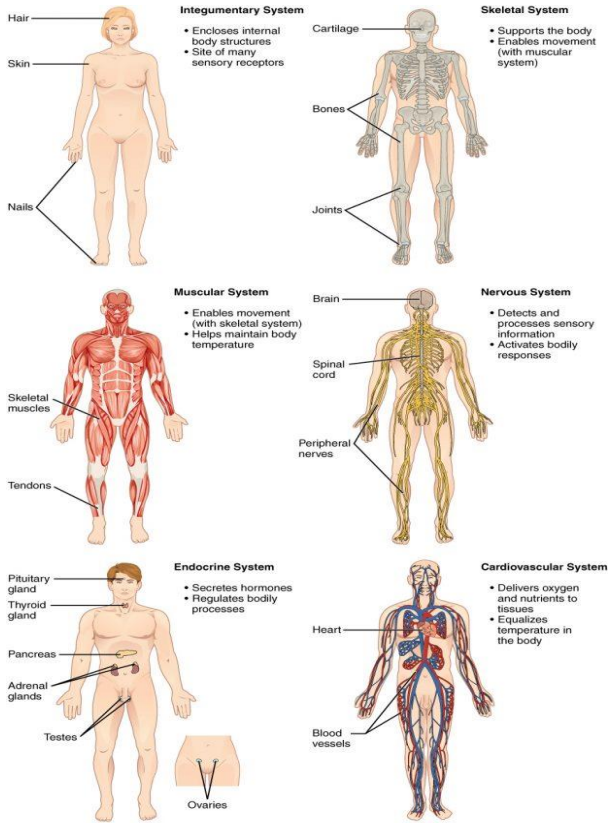
Nucleic Acids:
AP Biology Crash Course Review Cont.

You need to know this, because another topic that will be covered in the exam is going to be the complicated process that is DNA replication. In order for you to fully understand how DNA replicates, you need to have a firm grasp on how it functions. **DNA replication** is a complicated process that involves **translations and transcriptions**, so be sure to know your nucleic acids inside and out before you get hopelessly confused by the next chapter.

The real life application to nucleic acids is even more important for the AP Biology Exam. Nucleic acids like DNA and RNA are in charge of telling the rest of the organelles what needs to be done. Nucleic acids are the leader and the organelles within the cell are the workers. They tell all of the workers what to do and how to do it so that it does not get messed up. This is why the nucleus of a cell is the control center. The nucleus houses the DNA and sends the orders of what needs to happen out to the rest of the cell. Through this method the cell needs to only listen to what the DNA is telling it to do, which is done quickly and efficiently in normal cases.

So yes, nucleic acids may not be scary chemicals that will melt your siblings' faces off, but you cannot deny that nucleic acids are awesome. The **DNA** and RNA that has built your body is simply awe inspiring! The complex combination of sugar, phosphate, and a nitrogenous base has created you, a human being. It is amazing, and because it is so amazing the nucleic acids will most certainly be on your AP Biology Exam.

Organ Systems: AP Biology Crash Course Review



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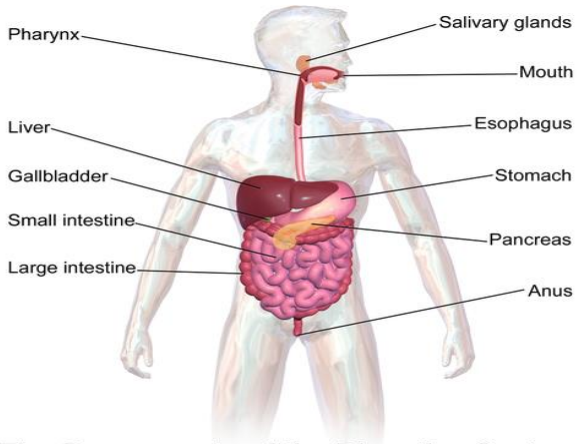
Students often worry about the Organ Systems section of AP Biology. There are so many organs in the body and so much information about each and every one. In this AP Biology crash course review, we will go over the important information that you need to know for the AP exam. We will highlight the nervous system, reproductive system, **muscular system**, skeletal system, circulatory system, respiratory system, **immune system**, excretory system, and digestive system.

Organ Systems:
AP Biology Crash Course Review Cont.

Digestive System



The Components of the Digestive System

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The purpose of the digestive system is to break down food so that it can be used by the organism for energy. The digestive system begins with mechanical digestion. Mechanical digestion is physically done by the teeth chewing and breaking the food into smaller pieces. The larger starches will then be broken down into monomers of carbohydrates by amylase, a digestive enzyme found in saliva. Once the food is swallowed, the pharynx will receive the food. The pharynx will close the tracheal flap so that the food does not travel down the airway. Finally, the esophagus will receive the food and will use peristalsis (muscular contractions of the esophagus) to force the food to the rest of the digestive system.

Once the food reaches the stomach, it will be broken down further by enzymes and hydrochloric acid. The broken down food is then able to become absorbed into the body. The food that is not absorbed by the stomach will be moved to the small intestine which will use enzymes produced by the liver and pancreas to break down food. The large intestine will then process food that will be excreted as waste and will extract any water. Finally, the rectum will hold stool until it is released.

Organ Systems:
AP Biology Crash Course Review Cont.

Excretory System

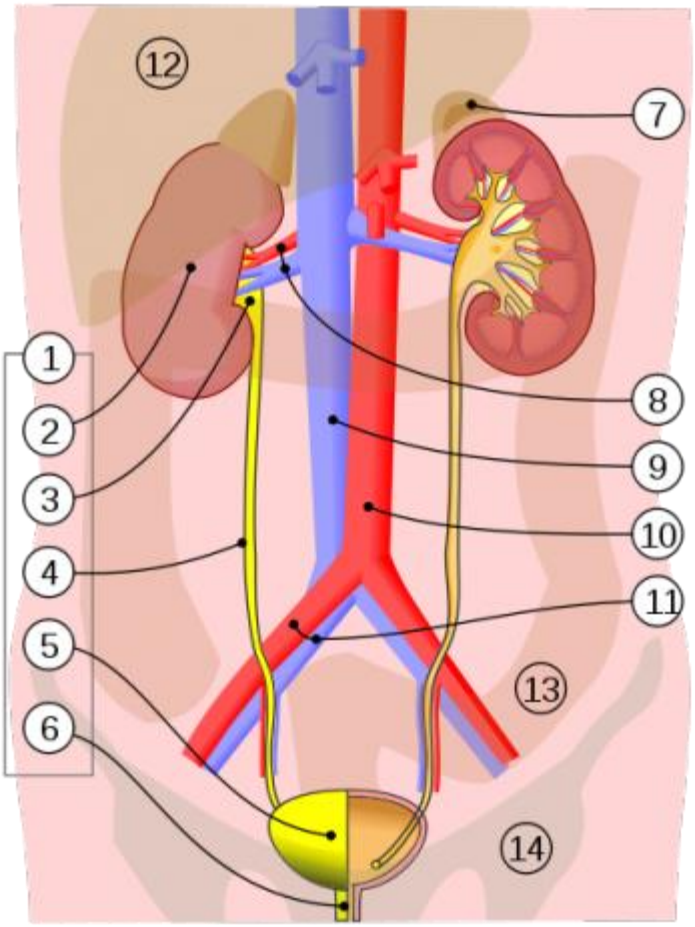


Image Source: Wikimedia Commons

The excretory system functions to remove waste from the organism. This organ system removes the nitrogenous wastes produced by NH_3. Humans excrete a form of nitrogen called urea (a major component of urine). The liver is the organ that is responsible for detoxifying the ammonia by creating urea. The liver will then send the urea to the kidneys which will be responsible for creating urine that will be excreted.

Organ Systems:
AP Biology Crash Course Review Cont.

Circulatory System

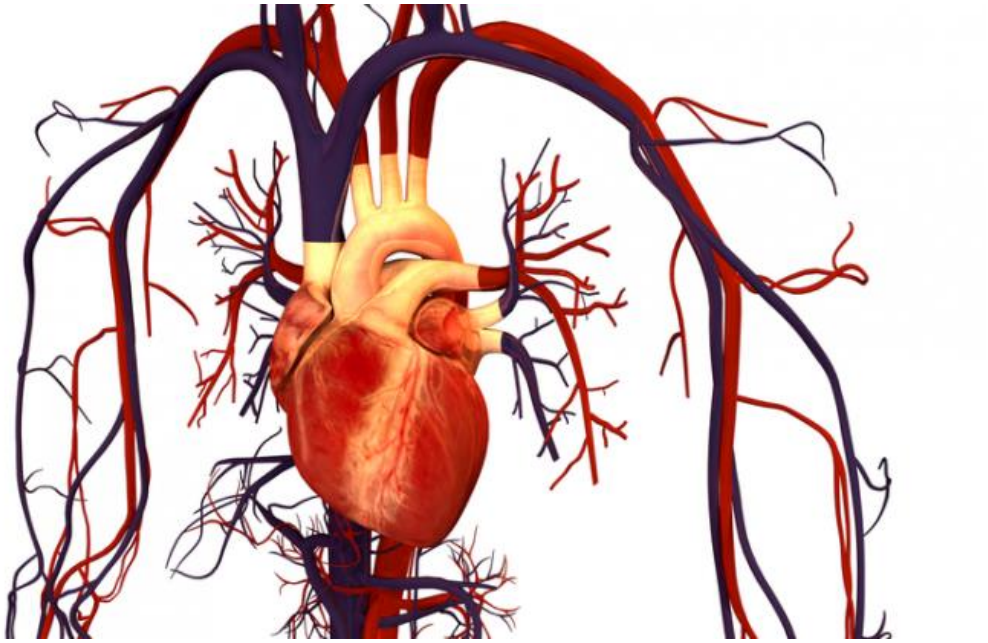


Image Source: Wikimedia Commons

The circulatory system consists of the heart and the blood vessels. The circulatory system is vital to the survival of the organism as it transports nutrients and removes waste all over the body. There are three main types of blood vessels: arteries, capillaries, and veins. Arteries carry blood from the heart; capillaries connect arteries to veins; veins return blood back to the heart.

Blood is transported in a very specific route because oxygenated blood cannot mix with deoxygenated blood. The blood is pumped through the right side of the heart where it is sent to the pulmonary artery. At the pulmonary artery, the blood is oxygenated and then pumped through to the left side of the heart and then on to the rest of the body through the main artery, the aorta. After the blood has distributed oxygen to the rest of the body, it will be sent back to the heart through the venous system.

Organ Systems:
AP Biology Crash Course Review Cont.

Respiratory System

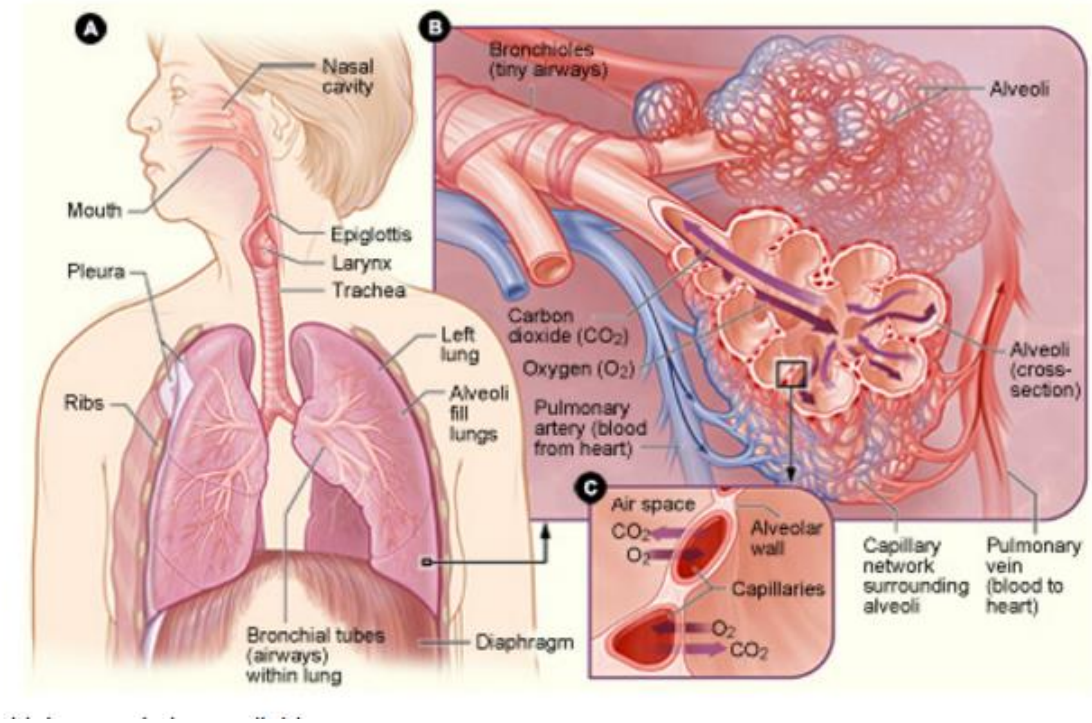


Image Source: Wikimedia Commons

The respiratory system, as we have touched on above, is responsible for supplying blood with oxygen so that oxygen can be delivered to all of the cells in the body. The process of respiration involves the inhalation of oxygen and the exhalation of carbon dioxide. The major parts of this organ system are the lungs. The lungs are made up of tiny alveoli which are the place where gas is exchanged. Gas is exchanged from the alveoli to the red blood cells. Red blood cells contain hemoglobin and hemoglobin binds very effectively to oxygen. This binding will allow the red blood cells to transport oxygen all over the body. When the red blood cells get to an area that needs oxygen, the hemoglobin will release the oxygen allowing it to enter into the cells. The red blood cells will also pick up carbon dioxide to carry back to the lungs for exhalation.

Organ Systems:
AP Biology Crash Course Review Cont.

Immune System

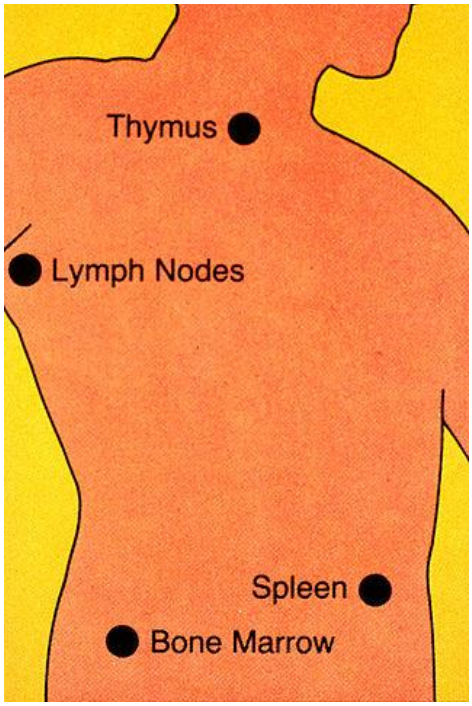


Image Source: Wikimedia Commons

The main function of the **immune system** is to protect the body from foreign cells. This organ system is made up of a lot of working pieces. Bone marrow and the thymus create many of the cells responsible for destroying invading cells (viruses, fungi, bacteria). The spleen and the lymph nodes filter through blood and trap any foreign microorganisms. They then signal to the cells created by bone marrow and the thymus (T-cells, B-cells, NK cells) to come and destroy the invading cells. There are two types of immunity that an organism has: innate and acquired. The innate immunity is immunity that is nonspecific; this is immunity like skin or immune cells which will protect the organism from a host of antigens. The acquired immunity is the specific immunity that the organism has collected for itself due to previous infection.

Organ Systems:
AP Biology Crash Course Review Cont.

Skeletal System

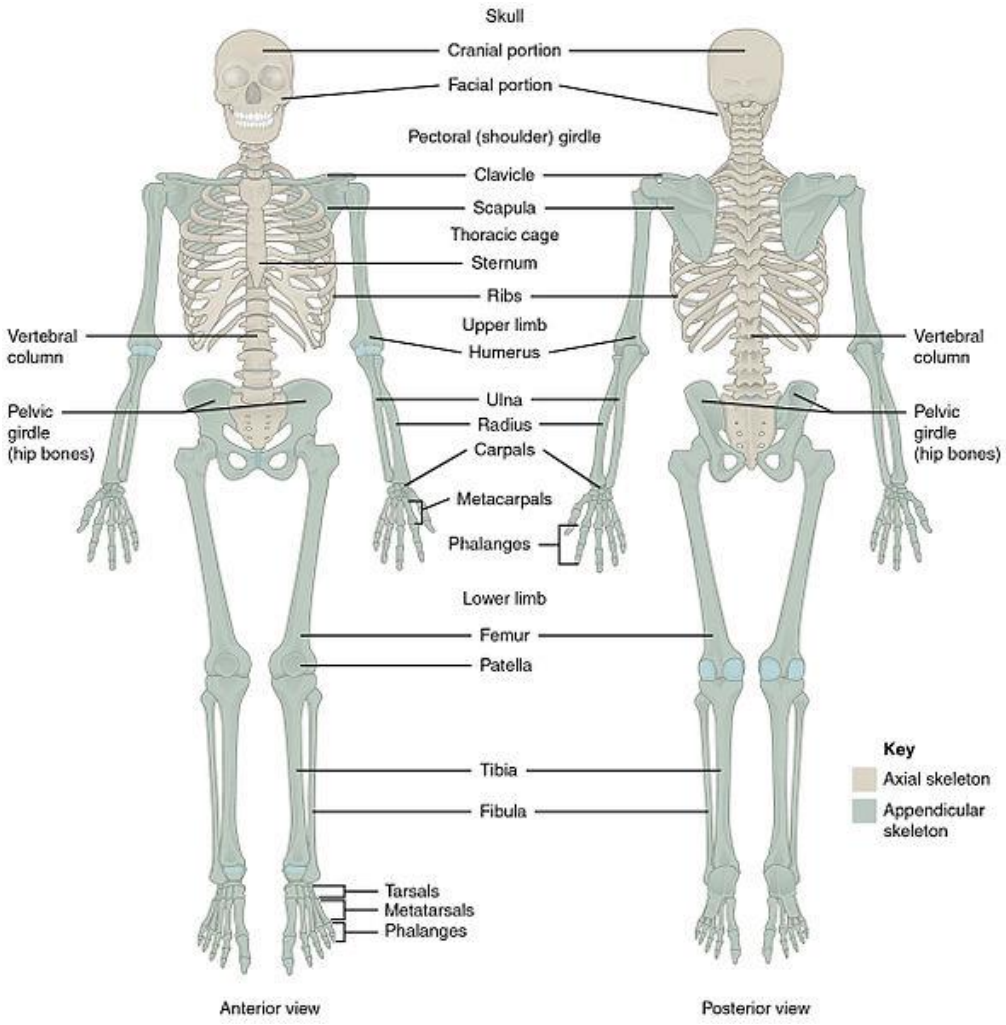


Image Source: Wikimedia Commons

The skeletal system functions to support, protect, store minerals, and produce red blood cells. Bones in the human body fit together at the joints. The bones are surrounded by muscle which allows for movement to occur. The human skeletal system is considered an endoskeleton as it is found inside of the organism.

Organ Systems:
AP Biology Crash Course Review Cont.

Muscular System

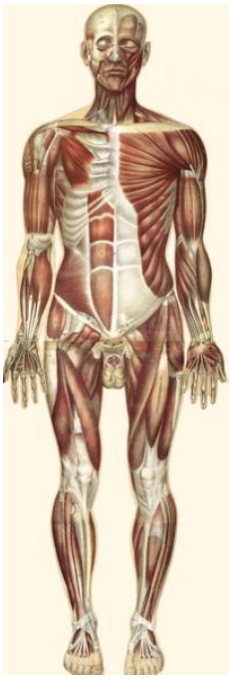


Image Source: Wikimedia Commons

The major function of the **muscular system** is to allow movement and to help circulate blood throughout the body. There are three types of muscular tissue involved in this organ system that you should be familiar with: skeletal muscle, cardiac muscle and smooth muscle. Skeletal muscle is attached to the skeleton and is responsible for movement. Cardiac muscle is found in the heart, and it is involuntary muscle that pumps blood throughout the body in the circulatory system. Smooth muscle is the muscle found around many organs; it is also involuntary.

Muscle contraction involves a protein called myosin. Myosin moves across (the movement looks like walking) the filament using ATP and calcium. The contraction begins by the brain signaling movement, and it travels down the nerves. The nerves release acetylcholine which triggers the release of calcium and allows the muscle to move.

Organ Systems:
AP Biology Crash Course Review Cont.

Nervous System

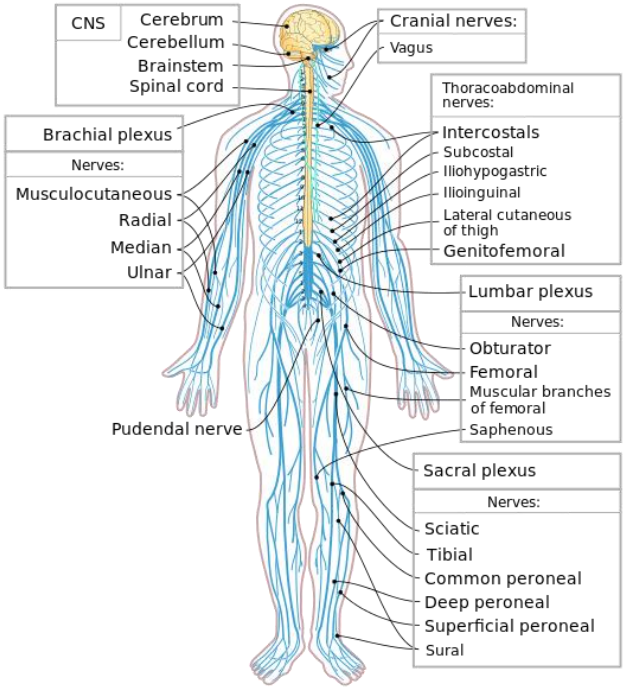


Image Source: Wikimedia Commons

The function of the nervous system is to create coordination between the cells of the body. This organ system is divided into two major groups: the peripheral nervous system and the central nervous system. The central nervous system is made up of solely the brain and the spinal cord, and the peripheral nervous system is made up of all of the nerves that are found throughout the body.

The brain is made up of neurons which transfer a signal from the synapse to the dendrites. The dendrites release the signal, and the signal is taken up by a neighboring neuron which will then produce another signal at its dendrites. Neurons make up the brain and can be activated by a host of emotional, physical, and reflexive needs. Neurotransmitters are the chemicals which transmit the signals from one neuron to the next. There are several important neurotransmitters to know including: GABA, dopamine, histamine, etc.

Organ Systems:
AP Biology Crash Course Review Cont.

Reproductive System

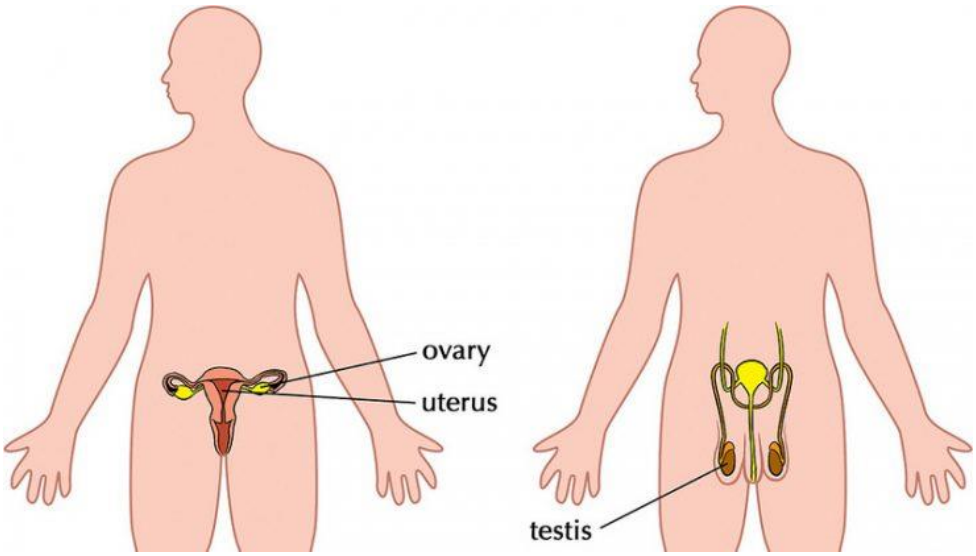


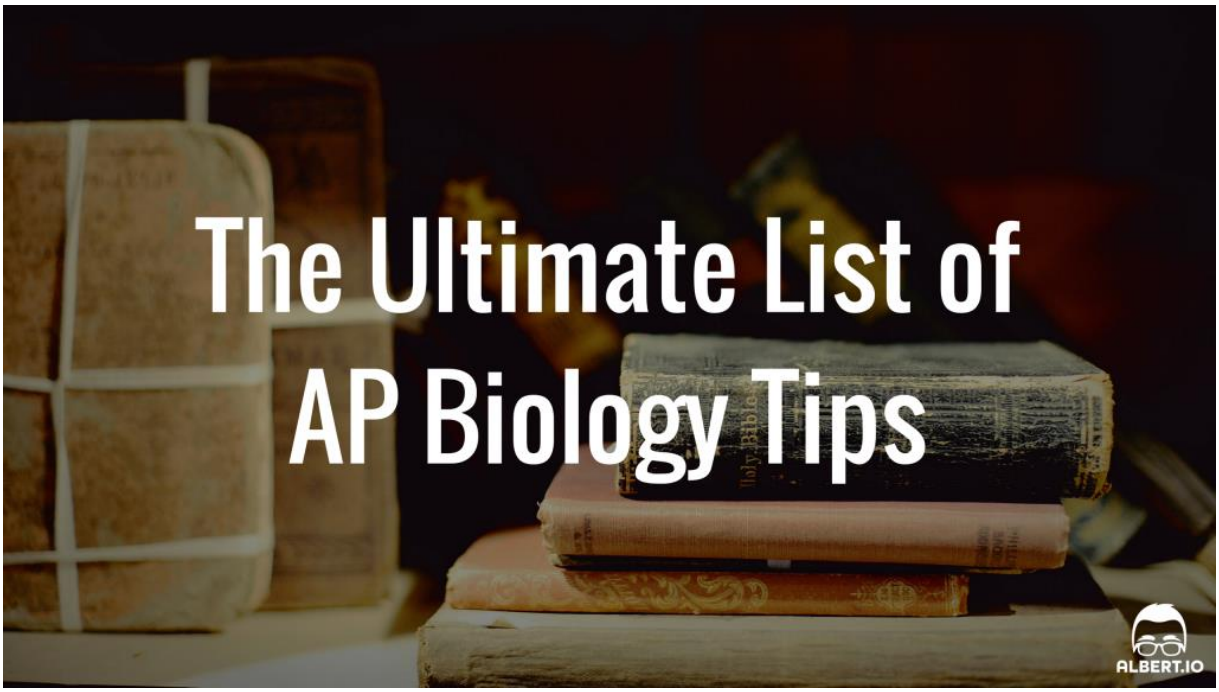
Image Source: Flickr

The function of the reproductive system is to continue the survival of the species via the production of offspring. In male organisms, sperm carries the genetic information. Sperm is created through the process of spermatogenesis which involves meiosis. Female organisms produce eggs through the process of oogenesis. Oogenesis is different from spermatogenesis because it produces a mature ovum (that can be fertilized) and polar bodies which will not be fertilized. Female organisms go through menstrual cycles. In humans, an egg is released every month. If the egg is not fertilized the female body will excrete the lining of the uterus and the egg. Every month the female will produce a new layer of the uterus and a new egg will be released from the ovaries.

Wrapping up the Organ System & AP Biology

This AP Biology crash course covered the major organ systems. There are many more details that may appear on the AP Biology exam, but this crash course has covered the basic knowledge you need for the exam.

The Ultimate List of AP Biology Tips



Are you shooting for a score of 4 or 5 on the AP Biology exam? If you're taking the class, you're probably nodding your head right now or shouting "yes!" After all, who doesn't want free college credit, the experience and challenge of taking a college-level biology course, and a great looking high school transcript? The first thing you need to know, however, is that the AP Bio exam will be a challenge for you, no matter what kind of experience you have.

It's helpful to look at past AP score distributions to show you the level of difficulty of the exam. On the 2014 AP Biology exam, only 6.5% of all test takers earned the coveted score of 5. *(Fun fact: 3 students out of 214,000 got a perfect score!).* That may sound intimidating, but it's not all bad since 22.2% earned a 4 and 35.1% earned a 3, meaning 63.8% of all test takers passed the 2014 exam.

The Ultimate List of AP Biology Tips Cont.

Only 36.2% did not receive a passing score, with 27.4% earning a 2, and 8.8% earning a score of 1. This means that more than half of students passed the exam, which should boost your confidence and show you that it's definitely doable. However, the test is by no means easy. In fact, it's one of the hardest AP exams out there. Sure, you need to memorize facts and concepts, but you also have to be able to think scientifically and analytically, which is much easier said than done.

Luckily, this list of 50 AP Bio tips is here to give you the best chance of getting that 5. Whether you're taking this class in school or self-studying, these tips will tell you everything you need to know, from **how to study**, what to study, what the exam consists of, and everything in between. Let's get started!

How to Study for AP Biology Tips

1. Familiarize yourself with the format of the exam. The first step in getting ready to study for the AP Biology exam is knowing what the exam will look like. The exam is 3 hours long and consists of two sections. The first 90-minute section has two parts: a multiple-choice part with 63 questions and a grid-in part with 6 questions. Section I makes up 50% of your overall exam score. Section II, also making up 50% of your exam score, consists of 8 free-response questions. You'll have 90 minutes to answer two long free-response questions, one of which will be lab or data-based, and six short free-response questions, which each require a paragraph-length argument or response.

2. Get your vocabulary down first! Vocabulary is extremely important in AP Bio, but understanding concepts and making connections is even more important. Why, then, do you have to focus on vocab first? It just makes sense. When you think about it, concepts are useless if you don't understand key terms. *"This thing does this to that and this process works by doing that."* It just doesn't work. Make and use flashcards regularly, learn the **Greek and Latin prefixes, suffixes, and roots**, and take great notes.

The Ultimate List of AP Biology Tips Cont.

When you know vocabulary terms inside and out, it is much easier to think analytically, apply terms to different situations, and make important connections. Quizlet's **Ultimate AP Biology Vocabulary review flashcards** has a great list of all the vocab terms you need to know, complete with definitions and helpful diagrams and images.

3. Know what is NOT included on the exam. There are a number of concepts, facts, terms, and ideas that are beyond the scope of the AP Biology exam. You do NOT have to know:

- Names, molecular structures, and specific effects of plant hormones
- Details of fossil dating methods
- Names and dates of extinction events
- Steps in the Calvin cycle, the structure of the molecules and the names of **enzymes** (EXCEPT for ATP synthase)
- Steps in glycolysis and the **Krebs cycle**
- Names of the specific electron carriers in the ETC
- Names of specific stages of embryonic development
- Genetic code
- Names and phases of mitosis
- Epistasis and pleiotropy
- Details of sexual reproduction cycles in plants and animals
- Specific mechanisms of diseases and action of drugs
- Details of communications and community behavioral systems
- Types of nervous systems, development of the human nervous system, details of the various structures and features of the brain parts, and details of specific neurologic processes
- Molecular structure of specific nucleotides, chlorophyll, amino acids, **lipids**, and carbohydrate polymers
- Functions of smooth ER in specialized cells

The Ultimate List of AP Biology Tips Cont.

- Specific examples of how lysosomes carry out intracellular digestion
- Specific symbiotic interactions

Source: CollegeBoard AP Biology Exam and Course Description

4. Make flashcards with diagrams. Diagrams are important in AP Bio. You'll have to interpret many of them on the exam. That's why it's really beneficial to draw your own diagrams on your flashcards. Use different colors, label the important parts, and list the steps. Whether it's the **Krebs cycle** or the nitrogen cycle, find a way to make it stick in your brain.

5. Don't lose track of the big picture. As you're studying for the exam, you'll probably find yourself getting hung up on little details. AP Bio has a way of throwing a lot of facts, specific names, dates, and functions at you. It would be impossible to memorize everything! That's why it's essential to remember *why* you're reading a certain chapter, *what* that chapter contributes to the bigger picture, and *how* all these concepts you're reading about connect together. Don't overwhelm yourself with trying to know absolutely everything about everything.

6. Keep on top of the readings. Did you know that AP Bio is one of the most reading-intensive AP classes that the CollegeBoard offers? Your teacher will probably require you to read one or two chapters per night, which means you'll probably have to tackle 30 to 60 pages of AP Bio material each evening. That's why you absolutely must keep on top of it since even if you miss one night of reading, you'll fall behind very quickly. Don't just passively read the information, either. You have to actively read and make sure you're actually absorbing the material as you go. Try reading the chapter summary first, highlight important info, take meaningful notes, and explain a concept to yourself out loud if you seem to be struggling with it.

7. Know the 4 Big Ideas. The CollegeBoard divides the AP Biology curriculum into 4 Big Ideas.

The Ultimate List of AP Biology Tips Cont.

This means that all the key concepts and content you need to know for the exam are organized around four main principles:

- **Big Idea 1:** The process of evolution drives the diversity and unity of life.
- **Big Idea 2:** Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
- **Big Idea 3:** Living systems store, retrieve, transmit and respond to information essential to life processes.
- **Big Idea 4:** Biological systems interact, and these systems and their interactions possess complex properties.

To find out more about the 4 Big Ideas and the information you need to know for each, check out the **AP Biology Curriculum Framework**.

8. Invest in a review book. AP Biology textbooks are heavy, thick, and full of details that are sometimes beyond the scope of the exam. How do you know, then, which information you actually need to know? Buy a review book! Many of them come with practice exams, chapter reviews, and helpful hints. It's important to only buy a review book that has been published in 2013 or later, since the exam was completely redesigned in 2013. Check out our **Best AP Biology Review Books of 2015** to find out which review book is best for you.

9. Watch the Crash Course Biology series on YouTube. Sometimes, reading textbooks and review books can get tiring. When you find yourself bored and unmotivated, try watching biology videos. The **Biology Crash Course** on YouTube has 40 videos dedicated to teaching you all the most important biology concepts. Injected with humor, fast-paced, and entertaining, these videos make it feel like you're not actually studying at all. Still, make sure to actively watch, take notes, pause if you don't understand something, or make a flashcard for a new term you hear about.

The Ultimate List of AP Biology Tips Cont.

10. Participate in the "Dirty Dozen" labs. Odds are, you'll be able to participate in these 12 important labs in class. If not, you should research them for yourself. **Bozeman Science** has videos on all 12 labs, walking you through the steps of each. The **LabBench** is also a great resource for understanding the key concepts and technical terms behind the 12 labs, along with self-quizzes to make sure you understand the material.

Start your AP Biology prep today

AP Biology Multiple-Choice Review Tips

1. Know what the multiple-choice questions look like. The multiple-choice questions on the AP Bio exam are probably different to other AP exams you've taken. They involve a lot of reading and analyzing diagrams, data, and images. They aren't just simple "What do plants release during photosynthesis?" fact-recall type questions. You'll have to read a paragraph for each question, or interpret a graph or diagram, and use your knowledge of biological concepts to choose the best answer. Let's look at a few examples:

Example #1.

By discharging electric sparks into a laboratory chamber atmosphere that consisted of water vapor, hydrogen gas, methane, and ammonia, Stanley Miller obtained data that showed that a number of organic molecules, including many amino acids, could be synthesized. Miller was attempting to model early Earth conditions as understood in the 1950's. The results of Miller's experiments best support which of the following hypotheses?

A. *The molecules essential to life today did not exist at the time Earth was first formed.*
B. *The molecules essential to life today could not have been carried to the primordial Earth by a comet or meteorite.*

C. The molecules essential to life today could have formed under early Earth conditions.

D. The molecules essential to life today were initially self- replicating proteins that were synthesized approximately four billion years ago.

Answer: C.

Example #2.

When DNA replicates, each strand of the original DNA molecule is used as a template for the synthesis of a second, complementary strand. Which of the following figures most accurately illustrates enzyme-mediated synthesis of new DNA at a replication fork?

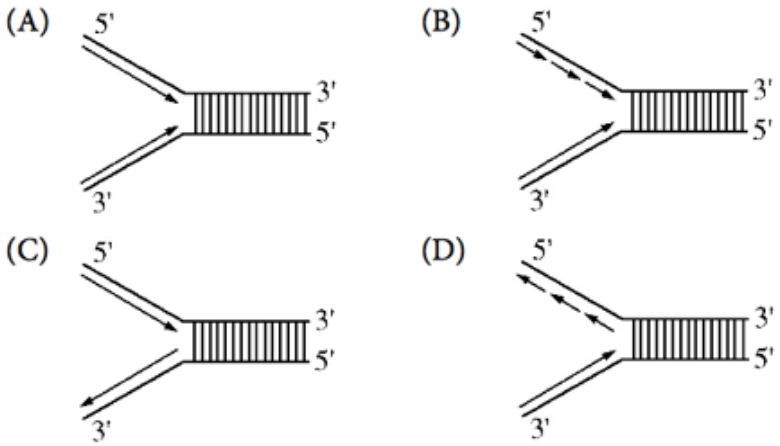


Image Source: CollegeBoard

Answer: D.

As you can see from these two example questions, there is more to think about than just simply recalling facts. Often, several questions will be based on the same data sets and diagrams. For more questions like these, check out **Albert.io**.

The Ultimate List of AP Biology Tips Cont.

2. Find and read the question first. Lab-set questions and diagram questions can be tedious since you'll have to do so much reading and analyzing. Skip the diagram or any long paragraph at first, find the question they're asking you, and then go back to the data to find the answer to that question. It's a simple technique, but when you have 63 long multiple-choice questions to read, analyze, and answer in such a short time, pinpointing the actual question first can be helpful.

3. Use standard multiple-choice strategies. Using multiple-choice techniques, such as process of elimination, making educated guesses, and budgeting your time are important for any multiple-choice test. Let's look at how these apply to the AP Bio exam. On the multiple-choice section, you will have four options, rather than five. This means that if you can eliminate two choices, you have a 50% chance of getting the answer correct. When it comes to budgeting your time, it's important to remember that you have about 45 seconds to 1 min for each multiple-choice question. Try and stick to that time limit for each question, otherwise you may run out of time and have to leave some questions unanswered. You should also watch out for reverse questions, such as "EXCEPT," since all the data and information they're throwing at you can be distracting and you may miss important keywords.

4. Practice! The only way to get better at answering complicated AP Bio multiple-choice questions is to practice as much as possible. Practicing gets you familiar with the format of the questions and gives you some much-needed confidence. You can find practice questions online, in review books, and in the CollegeBoard's **AP Biology Course and Exam Description**. Make sure you're practicing questions from 2013 and later, because exams before that follow the old, fact-recalling multiple-choice format and won't help you for future AP Bio exams.

The Ultimate List of AP Biology Tips Cont.

AP Biology Grid-in Response Tips

1. Know these quick tips:

- Your answer can start in any column
- Extra columns should be left blank
- Units are not required
- Fill in only one bubble per column
- Use decimals and other symbols if necessary
- The grid is machine-scored so fill in the bubbles correctly
- Mixed numbers need to be gridded as a decimal or improper fraction

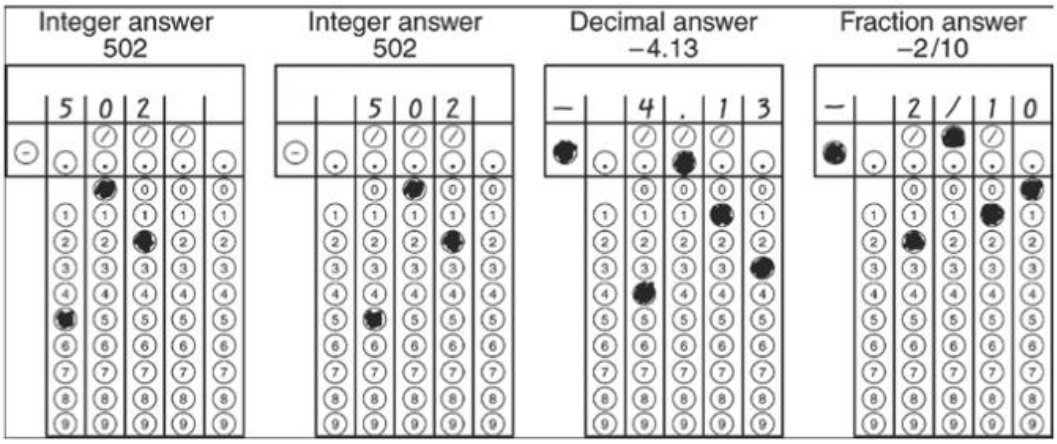


Image Source: CollegeBoard

2. Pay attention to the instructions. The directions will specify how to round your answers and whether or not your fractions should be reduced. Pay close attention to these instructions because even if your answer is correct, you won't get any points if it's not in the proper form and not bubbled in correctly.

The Ultimate List of AP Biology Tips Cont.

3. Don't memorize formulas. For the AP Bio exam, there is no need to memorize formulas since you will be given a **formula list** to use during the exam. Look over this list to see what kinds of formulas you need to be practicing. It's important to remember, though, that while you don't have to *memorize* formulas, you still need to be familiar with them.

4. Know how to apply mathematical formulas. The most important thing you need to know for the grid-in questions is how to apply a formula to reach the correct answer. You need to know how to work with **Chi Squares**, surface area and volume, water potential, **Hardy-Weinberg**, probability, and standard deviation. This comprehensive **AP Biology Math Review** has everything you need to know math-wise for the grid-in section of the exam. Remember that you are allowed to use a basic four-function calculator (with square root), but NOT a graphing calculator, on the exam.

Start your AP Biology prep today

AP Biology Free Response Tips

1. Know the FRQ format. At the start of the AP Bio free-response section of the exam, you will be given a 10-minute reading and planning period. After that, you'll have 80 minutes to answer 8 essay questions, broken down like this:

	Long Free-Response	Short Free-Response
How many?	2	6
How much time?	20 minutes for each	6 minutes for each
How much value?	10-point scale for each 25% of final exam score	10-point scale for each 25% of final exam score

The Ultimate List of AP Biology Tips Cont.

2. Use the entire 10-minute reading period. Don't underestimate the importance of the planning period! It's given to you for a reason. You should read through all 8 of the questions, re-read them, and use the "planning space" to start putting your thoughts on paper. Draw diagrams, underline keywords, make notes, outline your responses, or whatever else you need to do to start formulating your answers. Ten minutes will feel like a long time, but use the entire time. Make sure you really know what the question is asking you; take the time to fully digest the question.

3. Define your terms. Never write down a biological term without defining it. For example, you probably won't get the point if you just write *osmosis*, without mentioning "movement of water down a gradient across a semipermeable membrane." Always incorporate a definition of some shape or form to show the AP readers that you know what you're talking about. In other words, don't just inject fancy vocab words into your essays if you don't know what they mean; the AP readers will know.

4. Connect biological concepts to larger big ideas. Your main focus in studying for the AP Biology exam should be making connections. Knowing your vocabulary and labs is not useful if you can't connect them to larger big ideas. On the FRQs, you'll have to make claims and defend them, providing evidence to support your reasoning. How can you do this, while still making insightful connections across big ideas? The **CollegeBoard** has a few suggestions:

Strategy	Example Question
Relate a proposed cause to a particular biological effect.	*What is the evidence that a single mutation caused the phenotypic change seen in an organism?*
Identify assumptions and limitations of a conclusion	*If a nutrient has a positive effect on one plant, can you appropriately conclude that it is effective on all plants?*

The Ultimate List of AP Biology Tips Cont.

Strategy	Example Question
Connect technique/strategy with its stated purpose/function in an investigation	*Identify the control from a list of experimental treatments.*
Identify patterns or relationships (and anomalies) from observations or a data set	*Is the behavior of an organism the same in different environments?*
Rationalize one choice over another, including selection and exclusion	*Which question from this list of questions can best be investigated scientifically?*

5. Be aware of the free-response booklet instructions. It's helpful to know the actual AP Bio FRQ exam instructions:

- Each answer should be written out in paragraph form; outline form is not acceptable.
- Do not restate questions or provide more than the number of examples called for.
- Diagrams alone will not receive credit, unless called for in the question.
- Write clearly and legibly.
- Begin each answer on a new page.
- Do not skip lines.
- Cross out any errors you make.

The Ultimate List of AP Biology Tips Cont.

6. Know the types of questions. The table below outlines some of the most common free-response question types, how to answer them, and real example questions from past AP Bio exams.

**Click on the links included in the example questions to see sample responses.*

Question Type	What To Do	Example Question
Predict and Justify/Predict and	State what you think will happen in a certain circumstance and prove this reasoning using examples.	*Predict the effects of the mutation on the structure and function of the resulting protein in species IV. Justify your prediction.* (2014 AP Bio exam)
Propose	Come up with an improvement, solution, or idea that answers the prompt. Be specific.	*Propose an evolutionary mechanism that explains the change in average number of spots between 6 and 20 months in the presence of the predator.* (2014 AP Bio exam)
Identify	Name one or more items, list the parts, and give an example.	*Identify TWO environmental factors that can change the rate of an enzyme-mediated reaction.* (2010 AP Bio exam)

The Ultimate List of AP Biology Tips Cont.

Question Type	What To Do	Example Question
Explain	Make something understandable. Give reasons and examples, instead of just descriptions.	*Explain how paper chromatography can be used to separate pigments based on their chemical and physical properties.* (2010 AP Bio exam)
Compare/Contrast	Point out what is similar and what is different between two or more concepts. Do not explain or describe the objects separately.	*Compare and contrast reproduction in nonvascular plants with that in flowering plants.* (2009 AP Bio Exam)
Discuss	Think of this question as an "all of the above" type question. You need to consider different theories, points of view, and ideas, implementing the identify, describe, and explain strategies.	*Discuss THREE ways that an invasive species can affect its new ecosystem.* (2011 AP Bio Exam)
Describe	Provide the characteristics/properties of a term or concept.	*Describe THREE different factors that contribute to the success of invasive species in an ecosystem.* (2011 AP Bio Exam)

The Ultimate List of AP Biology Tips Cont.

Many times, a single free-response question on the AP Bio exam will include several of these key terms, while some only include one key term. Pay attention to exactly what the question is asking you to do and be sure to answer every part. An example of a question that asks you to do several things in one would look like this:

*"Based on the data in the table below, **draw** a phylogenetic tree that reflects the evolutionary relationships of the organisms based on the differences in their cytochrome c amino-acid sequences and **explain** the relationships of the organisms. Based on the data, **identify** which organism is most closely related to the chicken and **explain** your choice."*

7. Claim + Evidence + Reasoning. This model of scientific argumentation can be helpful to keep in mind when writing your FRQs. Essentially, you have to read and understand the question you're being asked, directly answer this question with a claim statement, back up your claim with detailed examples of evidence, then use reasoning to explain how this evidence justifies your claim. Just remember *claim, evidence, reasoning* when you're writing your essays.

8. Answer the parts of the question in the order called for. Try not to skip around too much when answering your FRQs. If you do, you might accidentally miss a part of a question. Instead, use the question's labels (a, b, c, d, etc.) to stay organized and clear. Make it as easy as possible for the AP readers to follow your answer.

9. Know how to answer "Design an Experiment" questions. Sometimes, you'll be asked to design an experiment as part of your FRQ. This is where your knowledge of the "Dirty Dozen" labs comes in. You need to be familiar with lab procedures and terms. In your response, make sure to include:

- Hypothesis (using the "if…then" structure)
- Independent and dependent variables
- Control, stating directly, "Controls are…"
- Explanation of the data you will collect and how you will measure it

The Ultimate List of AP Biology Tips Cont.

- Materials list
- Procedure list (what you will actually do)
- Description of how the data will be graphed and analyzed
- Conclusion (what you expect to happen and why, compare your results to your hypothesis)

Remember that your experiment should be at least theoretically possible and that your conclusions should stay consistent with the way you set up your experiment.

10. Know how to answer "Draw a Graph" questions. If you're asked to draw a graph based on data, be sure to include the following in your response:

- Labeled x-axis (independent variable) and y-axis (dependent variable)
- Equal and proportional increments
- Name and units
- Smooth curve
- Appropriate title
- If more than one curve is plotted, label on each curve instead of using a legend

Hint: Most of the points for a graphing question come from proper setup!

11. Be specific and thorough. Avoid flowery and vague language in your essays. You don't want to say something like: "Many parts of a cell are important in cell respiration." This sentence is way too general and doesn't really say anything at all. Whenever you use a biology term in your essay, offer specific examples of that term. Remember that your goal is to convince an AP reader that you know what you're talking about.

The Ultimate List of AP Biology Tips Cont.

12. Manage your time. It can be easy to get carried away when writing your FRQs. Just remember that you have to write *8* essays in only *80* minutes. You need to spend more time on the two long free-response questions than on the six short free-response questions. You should be spending 20 minutes on each long FRQ and only 6 minutes for each short FRQ. Use a watch and time yourself during the exam. You don't want to end up with no time to answer a question and miss out on 10 points.

Tips by AP Biology Teachers

1. Look for "real life" examples of what you're learning. Go to websites like ***Biology News***, ***Science Daily***, and ***The Chemical Heritage Foundation***. Search for articles in the subject you're learning. The more ways you learn something the better!

2. Watch Bozeman Biology videos. Mr. Anderson, the teacher behind ***Bozeman Biology,*** has a wide variety of videos for AP Bio. Watch them before you start a unit to get a general idea of what you'll be learning and before tests so you can review. Thanks to Ms. Lorie X. from Riverdale High for the tips!

3. Underline important terms in the question. Such as: "OR" and "CHOOSE TWO" and the power verbs such as: 'DESCRIBE,' 'IDENTIFY,' 'LABEL,' 'CONSTRUCT,' 'DESIGN,' or 'EXPLAIN.'

4. Find the core biology topic. Even if you don't understand the question or you draw a blank, find the 'core biology topic' being asked about and elaborate on it. Thanks to Mrs. S. from North High School for the tips!

5. Write! Write! Write! For the free-response questions, usually, the longer your answer to the question, the more points you will earn! That being said, don't just do a mind dump.

The Ultimate List of AP Biology Tips Cont.

6. Apply the language of science. FRQs require that you show depth, elaboration, and give examples. You need to loop together your ideas and show how they connect. Don't just rely on factual regurgitation. Thanks to Mr. Jeremy M. from Blue Valley Northwest High School for the tips!

7. Know how to set up your essays. When you're planning your essays, follow this structure:

1. Introductory sentence
2. Several broad points
3. Examples to prove your points
4. Closing sentence to summarize

Fill in this general structure with details and specifics. Write in short, declarative sentences. Thanks to Mr. C. from Alliance Cindy & Bill Simon Technology Academy High School for the tip!

8. Answer the question as concisely as possible. Avoid writing down everything you know about a certain topic. If you do, you might contradict yourself or write down something which is wrong. You can be penalized for this. Thanks to Mr. F. from Dauphin Regional Comprehensive Secondary School for the tip!

9. Remember that the AP graders are looking for certain statements to award points. If a FRQ asks you describe mutualism, for example, you need to both define it *and* elaborate on it to receive full points. As a general rule, always support your definitions with at least one example. Thanks to Dr. L. from Framingham High School for the tip!

10. Answer something for every question. If you don't know how to answer a free-response question, don't panic. Begin with defining some terms related to the topic. Elaborate with an example or more detailed explanation of the things you can remember. Thanks to Ms. Kelly O. from Colleyville Heritage High School for the tip!

The Ultimate List of AP Biology Tips Cont.

Tips from Past AP Biology Students

1. Do lots of genetics practice problems. Practice working with **Hardy-Weinberg formulas**, Punnett Squares, and Chi-Square tests. Also, memorize the common crosses, like **dihybrid monocross**.

2. For test prep, use the released exams! I worked through all the available FRQs on the CollegeBoard website. Those went a long way in helping me figure out the type of questions they ask, the common material they test, and how to manage my time. I would also recommend checking out the student answers to released FRQs, as well as the FRQ answer keys to get an idea of what kind and how much information are needed to get the points.

3. It helps to memorize things. AP Bio is less memorization than it used to be, but it still helps to memorize things. You should still be able to recall things at the drop of a hat, but you don't need to know all 12 of the reactions involved in glycolysis like you once did.

4. The human body is important. It's important to know your anatomy and human body systems. Focus on the nervous, immune, and **endocrine systems**. Don't just memorize the parts, but *understand* the processes. For example, know how an antibody attacking postsynaptic receptors leads to certain responses.

5. When in doubt, focus on these topics:

- Evolution (as a whole)
- Genetics/genetic regulation (transcription, translation, etc.)
- **Population ecology**
- Animal function/physiology
- **Muscular System**
- Nervous System
- **Endocrine System**
- **Immune System**

The Ultimate List of AP Biology Tips Cont.

6. Understand the concepts, functions, processes and relationships between subjects. The AP Bio test isn't simply just recalling facts anymore. You need to analyze information rather than just recall information from your studies.

7. Make sure you know all about DNA/RNA (transcription/translation), cellular respiration/photosynthesis, and evolution. Make sure you have a great detailed and conceptual understanding of these topics!

8. Know the "how" and "why" of a topic. If you can't explain how something works, knowing it is pointless. Stop and quiz yourself about something you just learned. How does that process work? If you can't explain it in your own words, you need a better understanding of it.

9. Know all about anatomy/physiology. This includes both humans and plants. Know the basics of plant transport systems and focus on the nervous and **endocrine systems**.

10. Make study sheets or chapter outlines. Making study sheets requires more active work than flashcards, which helps the information stick in your head. It also refreshes your memory on the definitions *in context*, which is important for AP Biology.

Start your AP Biology prep today

Are you a teacher or student? Do you have an awesome tip? Let us know!

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