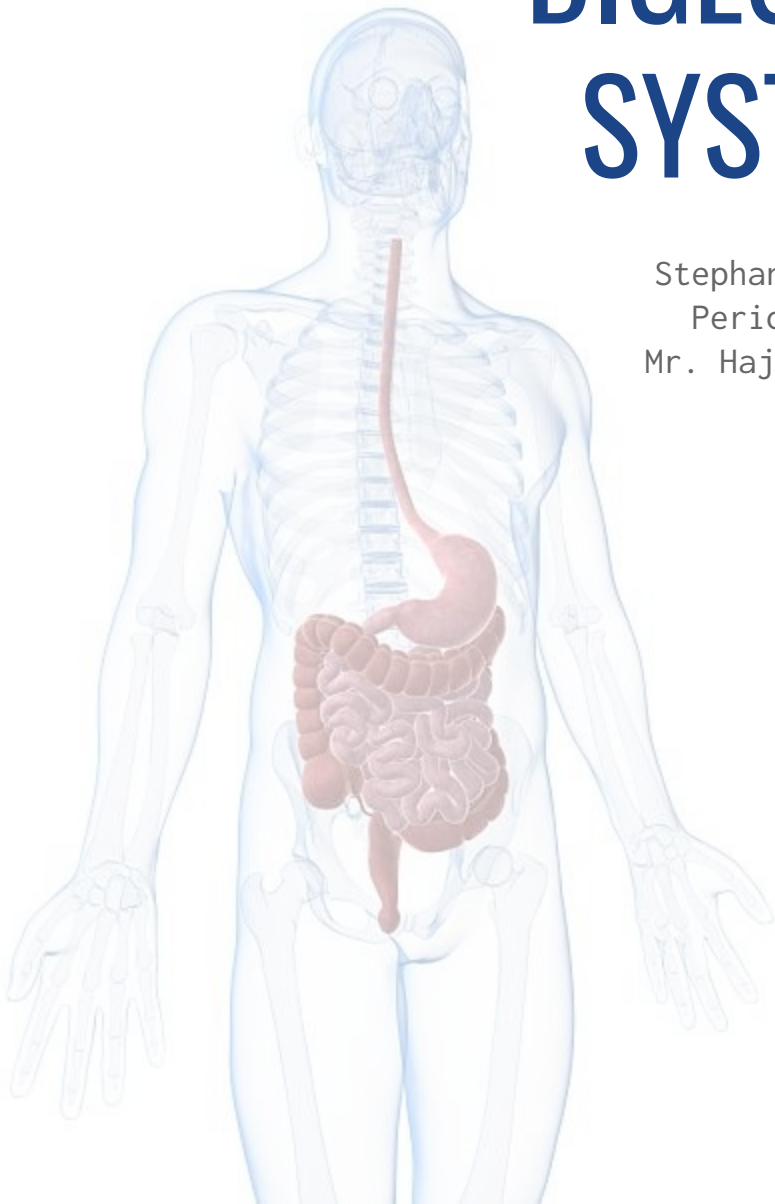




Biology ABCs:

DIGESTIVE SYSTEM

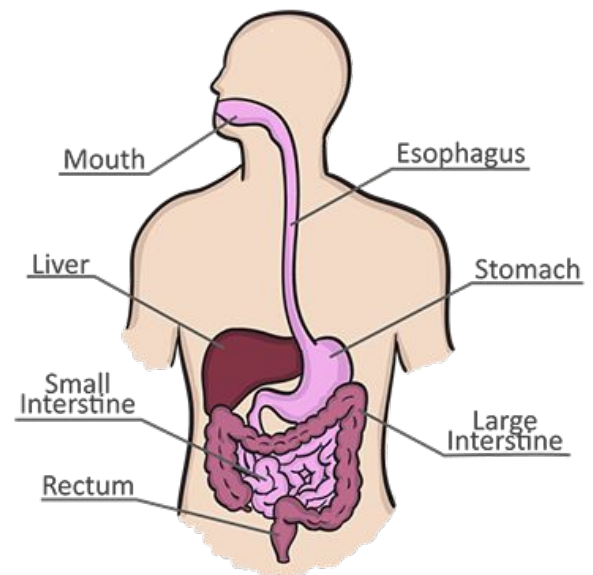
Stephanie Wu
Period 4
Mr. Hajjarian



An introduction to the Digestive System

When we eat, where does our food go? It turns out that we have a collection of organs that work together to digest our food, absorb nutrients, and form our waste, all belonging to our beloved digestive system. In the most rudimentary form, the digestive system is a long tube passing through your body, starting with your mouth and ending with your rectum (where you poop!). This tube is known as the gastrointestinal tract. The main organs of the digestive system are the mouth, esophagus, liver, gallbladder, stomach, pancreas, small intestine, and large intestine.

Organs of the Digestive System



<https://www.selfmanagescleroderma.com/lessons/introduction-to-the-digestive-system.html>

I chose the digestive system because I found it to be one of the most intuitive systems, and as a result the most approachable system. The way the organs function together to process food, almost like a factory, is quite appealing. Despite being relatively easier to grasp conceptually, the digestive system still has the breadth and complexity of other systems like the immune or nervous system.





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Agriculture:

What is agriculture?

Agriculture is the science of raising livestock and crops for food and other products. The practice of agriculture is practically as old as human civilization itself.



An agricultural farm

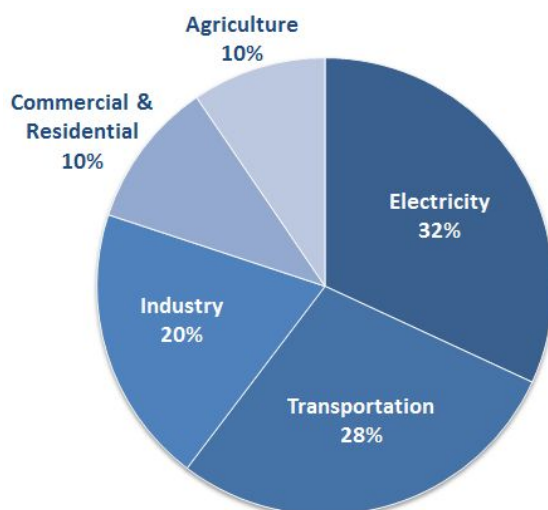
<https://blog.biolinked.com/organic-farming/>

Agriculture fueling our digestion from Day 1

Agriculture alone provides us with all necessary nutrients. For example, we can get our protein from eggs, our carbohydrates from wheat products, lipids from butter, and nucleic acids from beans. All these food products come directly from agriculture.

The Dark Side of Agriculture

However, despite its benefits, agriculture comes with several severe drawbacks. Livestock, most notably cattle, release a gas called methane as a result of their digestive cycle. Methane is a compound made of carbon and hydrogen, and is therefore a powerful greenhouse gas that traps heat in the atmosphere, furthering global warming, and in the grand scheme of things, climate change.



<https://advocacy.consumerreports.org/>

On the pie chart graph at right, agriculture alone is depicted to contribute 10% of all total greenhouse emissions in the United States. Commercial & Residential contribute 10% as well, while electricity contributes 32%, transportation contributing 28%, and industry contributing 20%.

Did you know?

A cow must give birth to a calf in order to produce milk!

One pound of wool produces 10 miles of yarn!

Bacteria:

Specifically what are bacteria?

Bacteria are unicellular, or single-celled organisms found nearly everywhere. They are classified as prokaryotes, meaning they lack a nucleus, and instead have DNA floating freely in the cell. Bacteria were one of the first life forms on Earth, and function in countless ways, such as recycling nutrients, providing nutrients, or causing diseases.

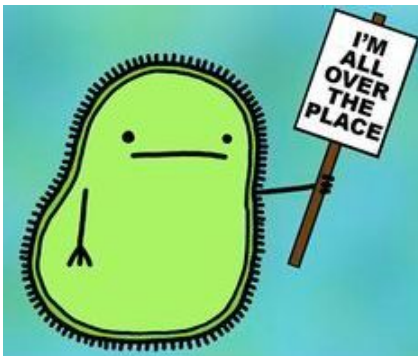


An artistic render of bacteria

<https://www.abc.net.au/radional/programs/greatmomentsinscience/the-microscopic-high-tech-wizardry-of-bacteria/7752152>

Bacteria in our Digestive System

There are trillions of “good” bacteria in our large and small intestine, known as gut flora. These bacteria help produce vitamin B12 and vitamin K in our large intestine, which help blood clotting. They also help regulate the “bad” bacteria in our system, or break down poison. About a third of the bacteria in our gut are bacteroides, which help us digest plant material. The symbiotic relationship between us and digestive bacteria is known as a mutualism, as we provide a safe environment for the bacteria, and in return the bacteria performs many functions for our digestive system.



<https://www.pinterest.com/pin/270145677620932768/?lp=true>

Antibiotics vs Bacteria Evolution

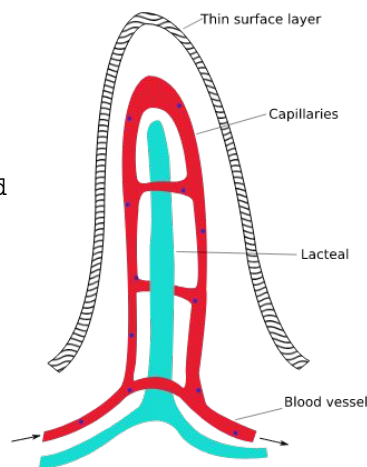
Antibiotics are a specific mold (penicillium) used to treat bacterial infection. However, when bacteria evolve to become antibiotic resistant, antibiotics become useless against them. While evolution is inevitable, we are speeding the evolution of bacteria at an alarming rate due to careless use of antibiotics, making common diseases exponentially harder to treat.

Capillaries:

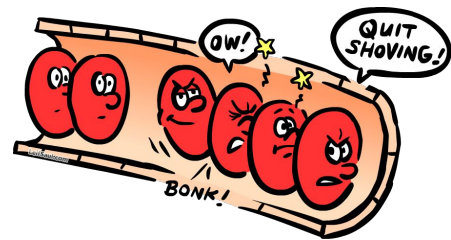
What are capillaries?

Capillaries are extremely thin blood vessels that deliver oxygenated blood from arteries to tissue, and return deoxygenated blood from the tissue to the veins. The oxygenated blood contains nutrients and oxygen, and the deoxygenated blood helps remove waste products.

A single villus and its components, which collectively form villi



<https://courses.lumenlearning.com/boundless-ap/chapter/absorption/>



<https://leifsaal.com/2019/02/25/your-crowded-capillaries/>

Capillaries in the Digestive System

In the small intestine, villi are fingerlike projections which have microvilli lining the thin surface layer. Villi are meant to increase the surface area for nutrient absorption in the digestive system. Nutrients are absorbed by the capillaries in the villi, which are part of the circulatory system. Lacteals also absorb nutrients in the small intestine, but are part of the lymphatic system, which is a subset of the immune system that fights diseases.

Capillaries in the Digestive System

There are three types of capillaries: continuous, fenestrated, and discontinuous. Continuous capillaries are generally found in skin and muscles. Fenestrated is the one that absorbs nutrients, which are found in the intestinal villi among other places. Discontinuous provides greater movement in the liver and spleen.

Diabetes:

What is Diabetes?

Diabetes is the name of the disease in which our blood sugar level is too high. Our blood sugar level is raised by glucose.

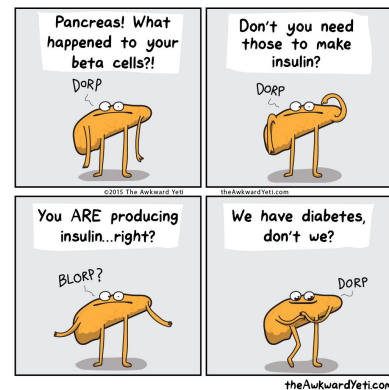


The finger prick test used by diabetics to check blood sugar level

<https://www.niddk.nih.gov/health-information/diabetes>

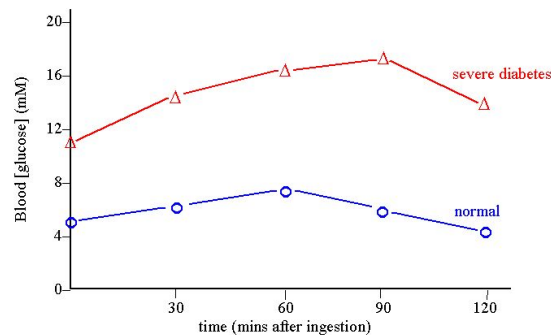
Digestion causing Diabetes?

Diabetes is generally attributed to digesting too much glucose, a starch found mainly in carbohydrates. There are two types of diabetes: type 1 diabetes is caused when the pancreas, an organ of the digestive and endocrine system, does not produce enough of insulin. Insulin is a hormone that lowers the amount of glucose in blood. Type 2 diabetes is caused by insulin resistance: your cells does not use insulin effectively, causing the pancreas to overwork and eventually stop functioning as well.



<http://theawkwardyeti.com/comic/seriously-pancreas/>

The graph to the right shows a normal person's blood sugar level after ingesting food. The normal person's pancreas produces and uses insulin effectively to keep the blood sugar under control. The person with severe diabetes has more glucose in their blood to begin with, and is unable to keep glucose level under control effectively.



<http://www2.gvsu.edu/chm463/diabetes/diabetes-mellitus-good.htm>

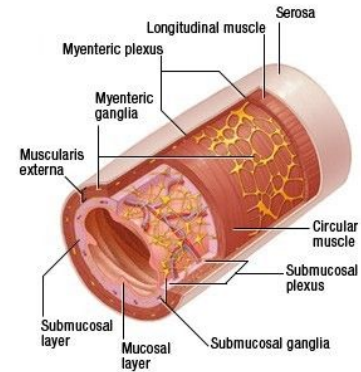
Diabetes Treatment

If someone has type 1 diabetes, they must inject insulin doses into themselves throughout the day, or use an insulin pump that constantly monitors blood glucose levels and pumps accordingly. If someone has type 2 diabetes, they often treat it with weight loss, healthy eating, and exercise. However, current developments in biotechnology are working to advance treatments for diabetes.

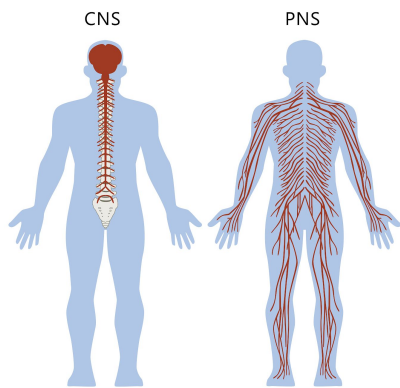
Enteric Nervous System:

What is the Enteric Nervous System?

The enteric nervous system is a part of the nervous system that contains circuits which control immune and endocrine functions. This “second brain,” which is not actually located in the brain, oversees many important functions of the digestive system.



Organization of the ENS in the gut wall of small intestine
<https://www.researchgate.net/figure/Organization-of-the-enteric-nervous-system->



Central Nervous System (left)
and Peripheral Nervous System
(Right)

<https://www.thepartnershipineducation.com/resources/nervous-system>

Different Nervous Systems

The nervous system is a system of nerves that communicate throughout the body. The central nervous system is located in the brain, and neurons in it integrate and coordinate all information received by the nerves. The peripheral nervous system is the collection of all the nerves throughout the body.

Digestive System and ENS Interactions

The neurons of the enteric nervous system interacts with muscles of the digestive system to perform the digestive system’s near-perfectly coordinated movements like a factory. It ensures the digestion, absorption, and the excretion parts of the digestive system runs appropriately. For example, functions such as the muscle movement peristalsis in the esophagus, stomach, and large intestine, the absorption of nutrients in the small intestine, and the forming of feces in the large intestine are all controlled by neurons in the enteric system.

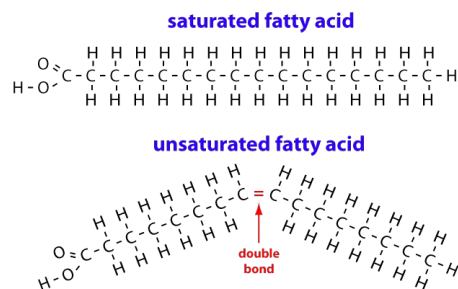
Did you know?

- There are over 100 billion neurons in the brain alone!
- Different neurons look different from each other due to having different functions

Fatty acids:

What are fatty acids?

Fatty acids are the building blocks of fat, and the primary component of lipids. They are a chain of carbon and hydrogen molecules. Those with a double bond are known as unsaturated fatty acid, and those with a single bond are known as saturated fatty acid.



Saturated (top) and unsaturated (bottom) fatty acid molecular structure

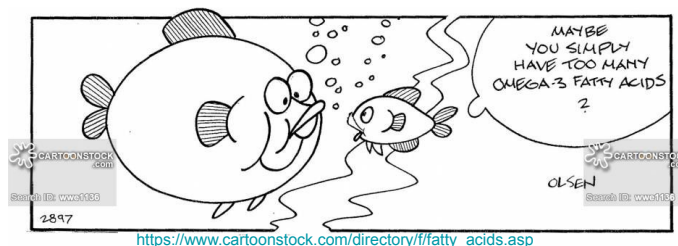
<https://www.creative-proteomics.com/application/unsaturated-fatty-acids-analysis-service.htm>

Fatty Acids in Digestion

Fatty acids are waxy and oily in food products. They are generally present in fish, avocados, milk, cheese, and meat. The fat in fatty acids from these foods are not digested until they reach the small intestine until bile produced by the liver and stored in the gallbladder breaks down the fat. The bile breaks down the fat into smaller droplets, which increase surface area and help pancreatic lipase, a fat-digesting enzyme, digest fats.

Omega-3 Fatty Acids

In particular, the omega-3 fatty acid, the fatty acid found in fish, vegetable oils, nuts, and other food products are an essential fat, as our body cannot produce them. Omega-3 fats are unique because they have so many important functions throughout our body, such as helping produce hormones, helping maintain heartbeat rhythm, and lowering blood pressure. Omega-3 fats are polyunsaturated fats, meaning they have multiple double bonds.



https://www.cartoonstock.com/directory/f/fatty_acids.asp

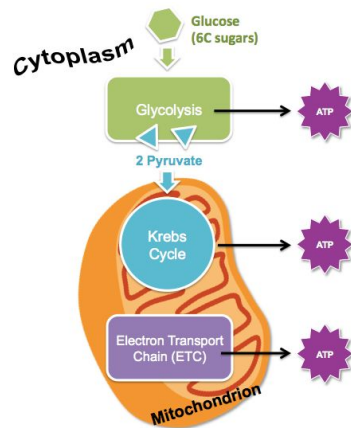
Glycolysis:

What is glycolysis?

Glycolysis is name of the process in which one glucose molecule is broken down to release energy and two pyruvate molecules. Glycolysis is a step in cellular respiration.

Glycolysis and Digestion

During digestion, glucose from carbohydrates are broken down by the digestive system, and are turned into monosaccharides (the most simple sugar). The monosaccharide is absorbed by the villi in the small intestine. Then, cellular respiration begins, starting with glycolysis, to produce adenosine triphosphate. Adenosine triphosphate, or ATP, is a high energy molecule that stores energy and powers us.



Cellular respiration processes, involving glycolysis, Krebs Cycle, and ETC

<https://allinonehighschool.com/aerobic-cellular-respiration/>

Did you know?

- Glyco = glucose, lysis = split from latin roots
- The process of glycolysis is so ancient, it was probably around before *oxygen* appeared on Earth!
- Glycolysis was discovered by Gustav Embden, Otto Meyerhof and Jakub Karol Parnas

In-depth Cellular Respiration

Cellular respiration main purpose is to produce ATP in a cell. To do so, the process glycolysis splits glucose into two pyruvate molecules and some ATP. The pyruvate molecules then enter Kreb's Cycle, in which the molecules are broken down into carbon dioxide, and turned into Acetyl Co-A and then to citric acid. Kreb's Cycle also releases some ATP. Through the Electron Transport Chain, a large amount of ATP is made. In total, the Kreb's Cycle and Electron Transport Chain produce 36 ATP molecules for every 1 glucose molecule.

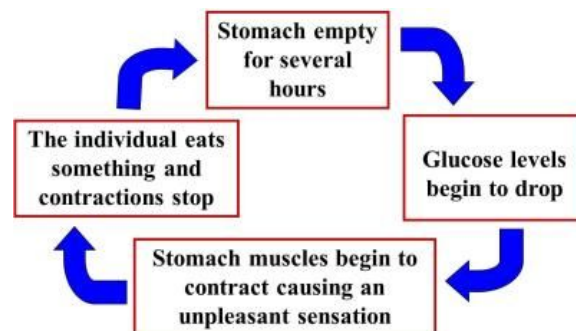
Homeostasis:

What is homeostasis?

Homeostasis is the ability to maintain steady internal conditions after external changes. In other words, it refers to keeping a balance, or equilibrium.

Digestive System Maintaining Homeostasis?

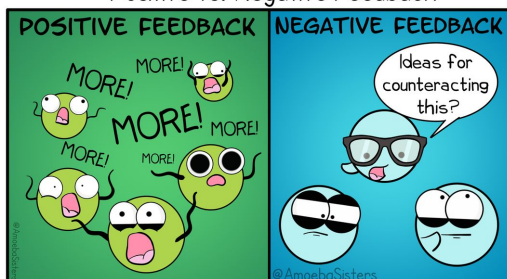
The digestive system is constantly maintaining homeostasis. For example, the small intestine does not have a mucus lining to protect itself from acidic chyme from the hydrochloric acid in the stomach, so the pancreas secretes sodium bicarbonate and neutralizes out the acid in order to maintain homeostasis. In a wider scope of things, the digestive system breaks down food for the body to use for nutrients to keep you from starving, which is another example of homeostasis.



Graphic organizer of the digestive system maintaining homeostasis

<http://humanbiologylab.pbworks.com/w/page/128623443/Homeostasis>

Positive vs. Negative Feedback



<https://www.amoebasisters.com/parameciumparlorcomics/positive-and-negative-feedback>

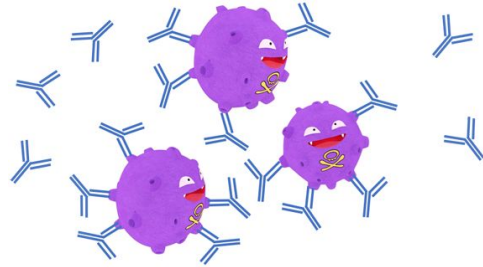
Feedback Loops

In homeostasis, a positive feedback loop is a cycle in which the outcome of the loop amplifies the system. If the outcome obstructs the system, it causes a negative feedback loop. For example, cattle running and level of panic is a classical positive feedback loop because cattle running raise the overall level of panic, which causes more cattle to run. Homeostasis generally involves negative feedback loops that counteract changes.

Immune System:

What is the Immune System?

The immune system consists of cells, tissues, and organs that work together to defend the body from pathogens. Pathogens are foreign organisms that are invasive and dangerous to us.



Pathogens attacking your immune system!

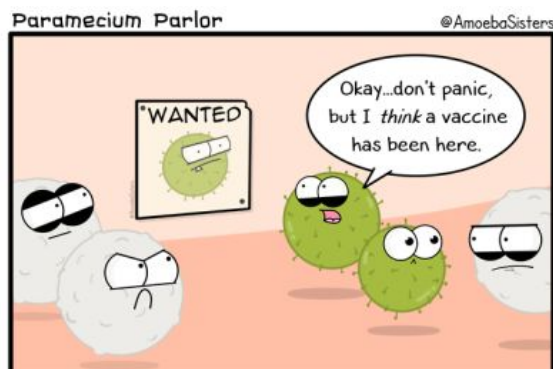
The Immune System At Work!

<https://www.sciencebuddies.org/teacher-resources/lesson-plans/antibodies-immune-system>

If pathogens enter your body through physical barriers, such as an open cut, the immune system kicks in. White blood cells work together to eat the pathogen and display antigens, pieces of the pathogen, for T-cells. This is when your body temperature increases and you begin to notice a fever arising. Antibodies are then created which bind to the antigens and kills it, while T-cells kill infected cells. If the immune system encounters the antigen again, the immune system will have remembered the antigen and destroy it much faster.

Immune and Digestive System

The immune system and digestive system are interlinked in many ways. A large amount of your immune system is located in the intestines of the digestive system. If your digestive system is unhealthy, that heavily compromises your immune system. For example, food allergies can cause problems for your gastrointestinal tract because the immune system recognizes it as a pathogen.



<https://www.tumblr.com/tagged/flu-shot>

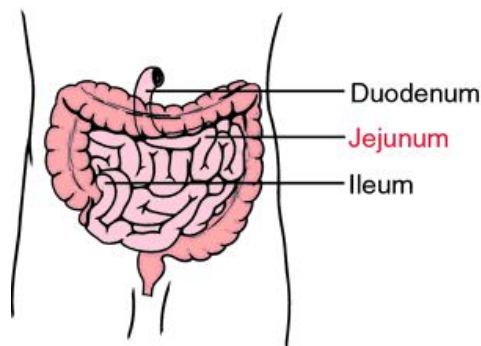
Vaccinations

However painful getting your flu shot or vaccination is, it's extremely crucial for our survival. When you get a vaccine, you are really getting a weakened or dead antigen, so your immune system can remember the antigen if they encounter the pathogen again, while being able to defeat the weakened or dead pathogen given by the vaccine easily.

Jejunum:

What is the Jejunum?

The jejunum is the second part of the small intestine, and rests between the duodenum and ileum. Most nutrients are absorbed by the jejunum.

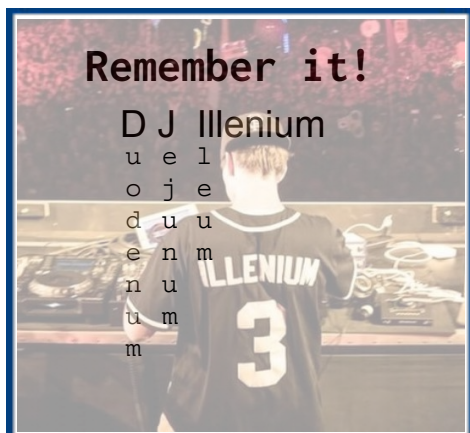


Labeled duodenum, jejunum, and ileum in the small intestine

<https://medical-dictionary.thefreedictionary.com/jejunum>

Jejunum in Digestion

The jejunum makes up roughly two-fifths of the small intestine, which is a key organ in the digestive system. While it does perform some digestion, the small intestine's main function is to absorb nutrients, which is what the jejunum does. Precisely, the jejunum absorbs important nutrients like glucose, amino acids, and fatty acids with its villi and microvilli. The nutrients diffuse through to then enter the bloodstream.



<https://www.ravejungle.com/2017/07/18/illenium-awake-tour-fractures-remix/>

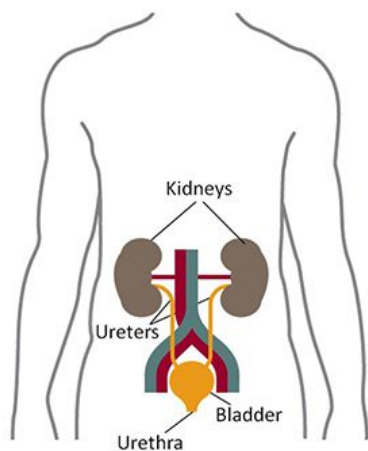
Small Intestine Parts

The duodenum connects the stomach to the small intestine, and receives chyme from the stomach. Some digestion also occurs here. Then, it is passed to the jejunum, which is held in place by the mesentery (connective tissue). The ileum, which is also held in place by the mesentery, absorbs whatever is not absorbed by the jejunum, like Vitamin B12 and bile salts.

Kidney:

What is the Kidney?

Kidneys are the organs that filter your blood for waste, and then produce urine with the waste. You have not one, but two kidneys!



Excretory system, starting with the kidney

<https://www.niddk.nih.gov/health-information/kidney-disease/kidneys-how-they-work>

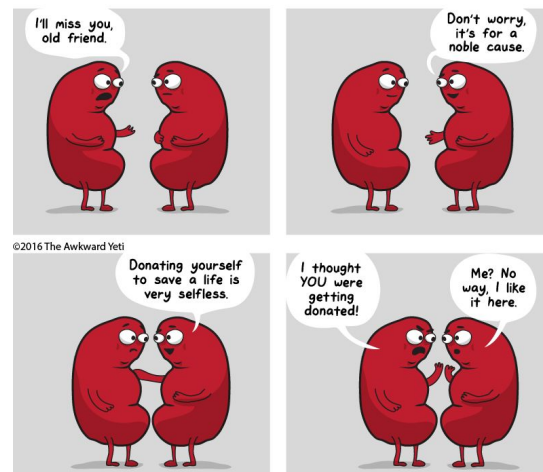
The Kidney and Digestion

After we digest foods, the small intestine transports nutrients from the food to the bloodstream so nutrients can be distributed throughout the body. Certain foods like coffee and tea can make you urinate more because they block ADH. ADH, or antidiuretic hormone, is a hormone that tells your kidney the level of water it should conserve in based on the amount of water in circulation.

More on Kidneys

Your kidneys are part of the excretory system. Each kidney is made of millions of nephrons, which filter your blood and return substances to the bloodstream, while releasing waste in the form of urine through connected ureters. Healthy kidneys typically filter half a cup of blood per minute.

If blood stops flowing to your kidney, it could lead to kidney failure. In that case, a dialysis can substitute the role of filtering. Another alternative is to receive a kidney transplant.

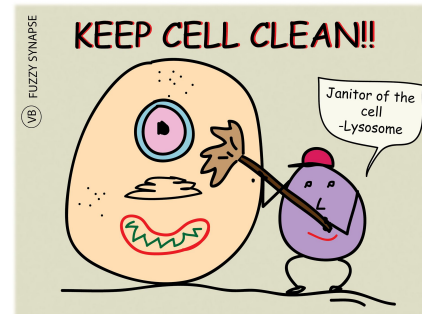


<http://theawkwardyeti.com/character/kidney-2/>

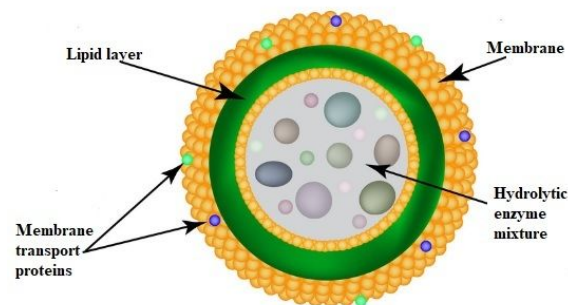
Lysosome:

What is the Lysosome?

The lysosome is an organelle in a eukaryotic cell that is responsible for digestion and waste removal. Lysosomes digest “expired” organelles, food particles, and microorganisms.



<http://fuzzysynapse.com/illustrations/>



The detailed structure of a lysosome

<https://www.studyread.com/importance-of-lysosomes/>

Lysosomes in the Cell

A lysosome is surrounded by a membrane that helps maintain an acidic environment so the enzymes in it operate at optimal pH range. Lysosomes are produced in the golgi apparatus. The enzymes in it are made by the rough ER and delivered to the golgi apparatus.

Lysosomes in Digestion

The lysosome is to the cell what the digestive system is to our body. Specifically, lysosomes contain a large variety of enzymes that break down biomolecules like nucleic acids, proteins, and polysaccharides. Once the cell absorbs food, lysosomes travel throughout the cytoplasm (the fluid in the cell excluding the nucleus) to break down the aforementioned substances. If there is no food for the cell, the lysosomes will actually digest the organelles of the cells for nutrients.

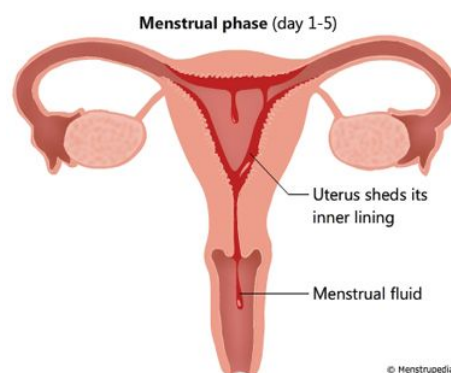
Menstruation:

What is Menstruation?

During a woman's menstrual cycle, she produces a lining in her uterus, or womb, to provide cushioning in case her egg is fertilized and a baby becomes present. If the egg does not fertilize, the lining breaks down and gets expelled through the vagina.

Digestive Issues During Menstruation

Digestive issues during periods are quite common. The two hormones that regulate a menstrual cycle are estrogen and progesterone, but a lipid called prostaglandin also acts as hormones. The prostaglandin level fluctuate wildly during a woman's period. These fluctuations of these hormones cause a change in muscle movement in the gastrointestinal tract, which causes digestive issues.



Pathway of menstruation through a female reproductive system

<https://www.menstrupedia.com/articles/physiology/cycle-phases>

Dealing with Menstruation

There are many feminine hygiene products that help women deal with the menstrual fluid being expelled, typically consisting of blood, as well as mucus and secretions. Such products include pads, which stick to underwear and work somewhat like a diaper. Tampons are plugs that are inserted into the vagina. Menstrual cups are cups in the vagina that catch the blood in a cup.

Did you know?

- A rare period disorder can cause you to bleed out of your eyes!
- On average, a woman gets around 400 periods in her lifetime!
- Hormonal imbalances causes periods, so a missed period does not *necessarily* mean one is pregnant

Nucleic Acid:

What are Nucleic Acids?

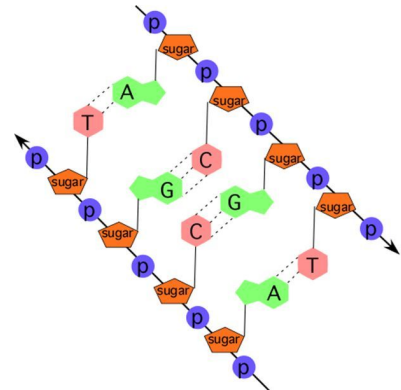
Nucleic acids are a complex biomolecule found mainly in the form of DNA and RNA. DNA controls most cellular activity, while RNA is heavily involved in protein synthesis.

Nucleic Acids and Nucleotides

The monomer, or building blocks of the polymer (large molecule) nucleic acid, is nucleotides. The nucleotide includes 3 components:

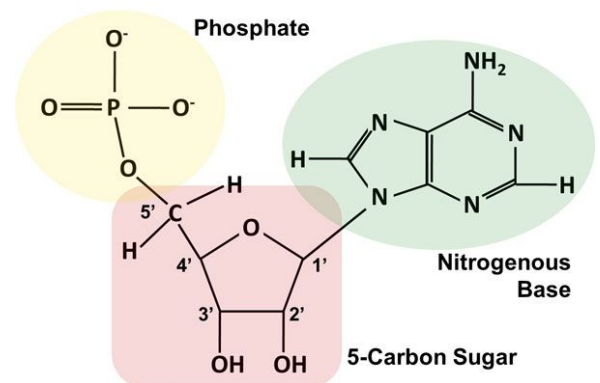
1. Phosphate group
2. 5-carbon sugar
3. Nitrogenous Base

The phosphate group makes up the backbone of DNA, denoted by the 'p's. The 5-carbon, or pentose sugar is deoxyribose in DNA and ribose in RNA. They also form the backbone and link with the nitrogenous base, which codes for the DNA / RNA.



Nucleic acid in a DNA strand

<https://slideplayer.com/slide/8234433/>



Components of a nucleotide

<https://socratic.org/questions/how-do-you-draw-a-nucleotide-and-label-its-three-basic-parts>

Did you know?

- A DNA base is called a double helix
- There are only 4 nitrogenous bases in DNA: Adenine, which solely pairs with Thymine, and Cytosine, which solely pairs with Guanine. Together, they code for all life as we know

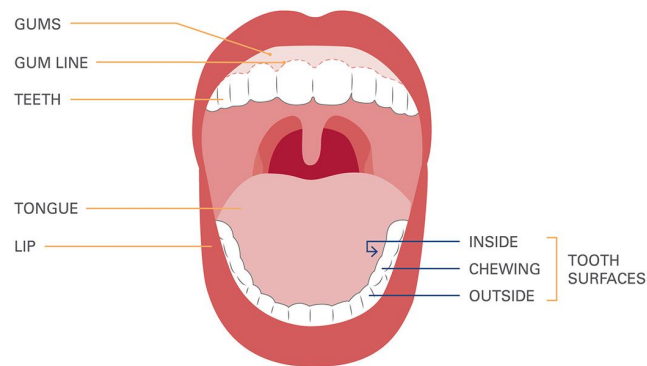
Nucleic acids in Digestion

Nucleic acids are a biomolecule that is also specifically digested. The pancreas produces a variety of digestive enzymes that also digest nucleic acids, beginning in the stomach. Nucleases are the group of enzymes that break nucleic acids into nucleotide chains. The small intestine then produces nucleases that further break down nucleotide chains into smaller units.

Oral Cavity:

What is the Oral Cavity?

The oral cavity is essentially your mouth. It helps you breath, swallow, chew, and talk amongst various other functions.



Components of the oral cavity

<https://www.therespiratorysystem.com/glossary/oral-cavity/>



<http://theawkwardyeti.com/comic/popcorn/>

A Closer Look at the Oral Cavity

The main structures of the mouth are include the lips, which line the opening of the mouth, the vestibules, the soft tissue on your cheeks, the gums, dense tissue that hold your teeth in place, your teeth, which aid with digestion, the palate, the roof of the mouth, and the tongue, which helps us taste, speak, and swallow.

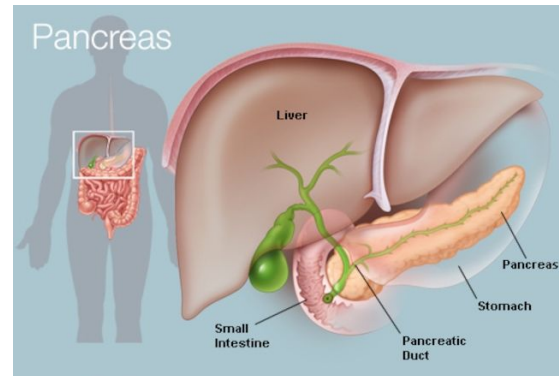
Oral Cavity in Digestion

The oral cavity is where digestion begins. Saliva glands in the mouth help moisten food, and release enzymes that produce chemical digestion on the food, turning the food into bolus - a mixture of saliva and food. The teeth in your oral cavity grind against food to soften it, performing mechanical digestion. Taste receptors on your tongue also help you taste the food you eat. After chewing, the tongue pushes the food back and it's swallowed into the esophagus.

Pancreas:

What is the Pancreas?

The pancreas is a 6-10 inch organ located next to the small intestine and liver. It has many important functions, including aiding digestion and regulating blood sugar.

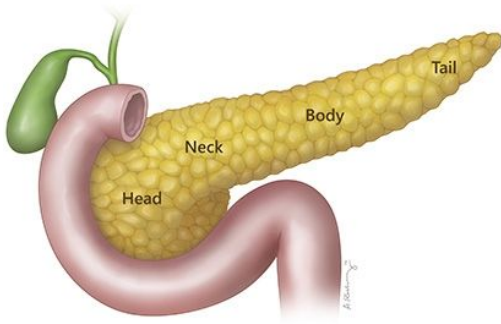


Pancreas and its surrounding organs

<https://www.webmd.com/digestive-disorders/picture-of-the-pancreas>

Pancreas in Digestion

The widest part of the pancreas, or the head, is located where the stomach meets the small intestine. The pancreas releases its digestive enzymes there. When the chyme reaches the small intestine, the digestive enzymes the pancreas provides aids the duodenum with digestion. If you have too much sugar in your bloodstream, the pancreas also produces insulin and glucagon, two blood-sugar regulating hormones.



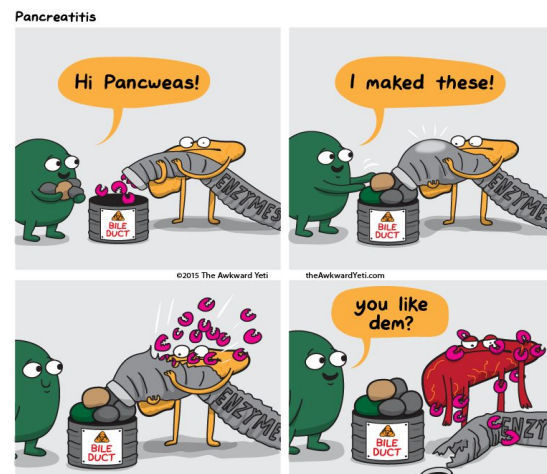
© 2016 Columbia University. All Rights Reserved.

Components of the pancreas

<https://www.webmd.com/digestive-disorders/picture-of-the-pancreas>

Pancreatitis

Pancreatitis is the disease in which the pancreas becomes inflamed because the digestive enzymes it makes are activated too early and begin digesting the pancreas. There are two types of pancreatitis: acute and chronic pancreatitis. Acute pancreatitis is generally treatable, while chronic is a long-lasting inflammation.

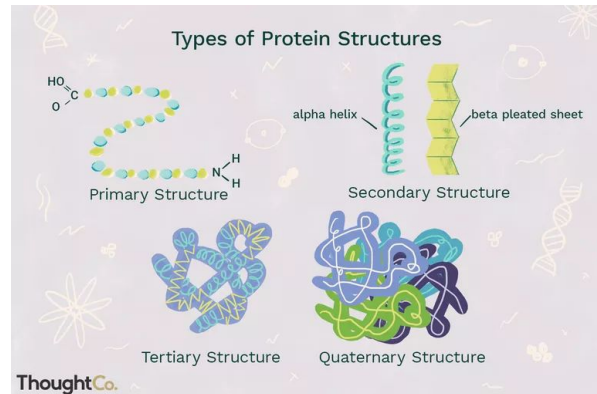


<http://theawkwardyeti.com/comic/gallbladder-pancreatitis/>

Quaternary Structure:

What is a Quaternary Structure?

When the monomer amino acid comes together to form the polymer protein, it goes through a certain folding process. There are 4 protein structure types, and quaternary structure is the most complex one.



Different protein structures, in increasing complexity

<https://www.thoughtco.com/protein-structure-373563>

Structures in Protein Synthesis

The most simple level of a protein structure is a primary structure, which is simply a sequence of amino acids in a polypeptide chain. The second level, secondary structure, are local folding structures that form due to amino acid interactions. These include the alpha helix and beta pleated sheet pictured above. Tertiary structures occur when secondary structures fold on itself, caused by R groups of the amino acids. When proteins with multiple polypeptide chains, or subunits, come together, they form a quaternary structure.

Protein and Digestion

Protein digestion begins in the stomach, where the acidic environment allows for protein denaturation, when proteins lose their native quaternary, tertiary, or secondary state. Pepsin, an enzyme in the stomach, breaks down proteins into their building blocks, amino acids. The amino acids are then transported into the bloodstream, where they are used as the building blocks of hormones, enzymes, and nucleic acids.

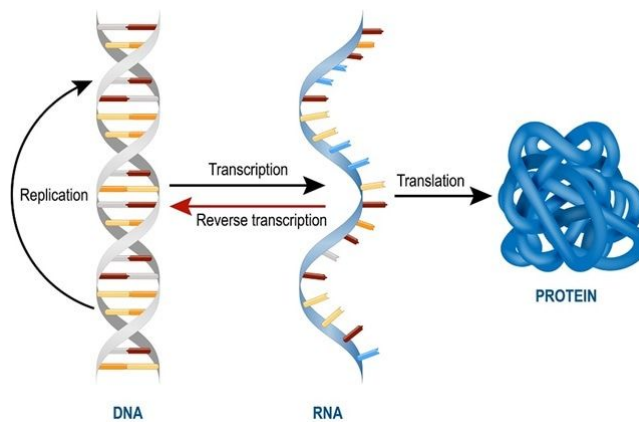
Remember it!

Primary	STate	Qualifier
R	E E	U
I	C R	A
M	O T	T
A	N I	E
R	D A	R
Y	A R	N
	R Y	A
	Y	R
		Y

RNA:

What is RNA?

RNA, or ribonucleic acid, is a complex compound made of nucleic acids. RNA is heavily involved in protein synthesis. There are 3 main types of RNA: messenger RNA, ribosomal RNA, and transcription RNA.



The process of protein synthesis

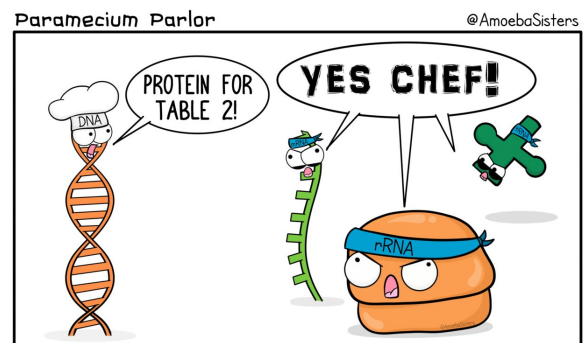
<https://www.news-medical.net/life-sciences/-Types-of-RNA-mRNA-rRNA-and-tRNA.aspx>

RNA and Beyond!

Protein synthesis begins in the nucleus, where mRNA (messenger RNA) carries genetic codes from the DNA to the ribosomes. Ribosomes are made up of rRNA (ribosomal RNA), and protein. In the cytoplasm, the mRNA is read by the rRNA 3 bases, or one amino acid, at a time. tRNA (transfer RNA) bring the specified amino acids to the ribosome, where they are compiled and linked to form a protein.

RNA and Digestion

The purpose of protein synthesis is to produce protein in the state we know it as, which is crucial for cell structure and function. It also regulates most of the body's tissue and organs. Because of this, RNA plays such an important part in the body, including the digestive system, which relies on cells to work properly. Essentially, we *run* on protein.



RNA: If you can't help make proteins, get out of the kitchen.

<https://www.pinterest.com/pin/158822324343972462/?lp=true>

Tissue:

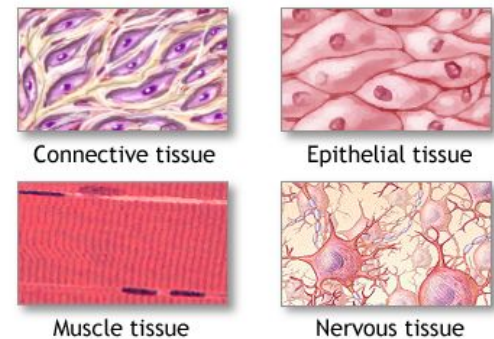
What is tissue?

Tissue is a large collection of cells that has a specific role, and make up part of an organism. For example, your muscle is a tissue.

Types of Tissue

We are made up of 4 types of tissue: muscle tissue, epithelial tissue, connective tissue, and nervous tissue. Muscle tissue is long and fibrous, making it extremely strong and durable (imagine a rubber band!). Epithelial tissue is joined tightly together, and resembles a tightly stitched quilt. Connective tissue holds our organs together, and provides structure. For visual representation, imagine a thin sac holding a marble. Nervous tissue is in the nervous system, and receives and sends impulses.

Four types of tissue



4 different types of tissue in humans

<https://medlineplus.gov/ency/imagepages/8682.htm>

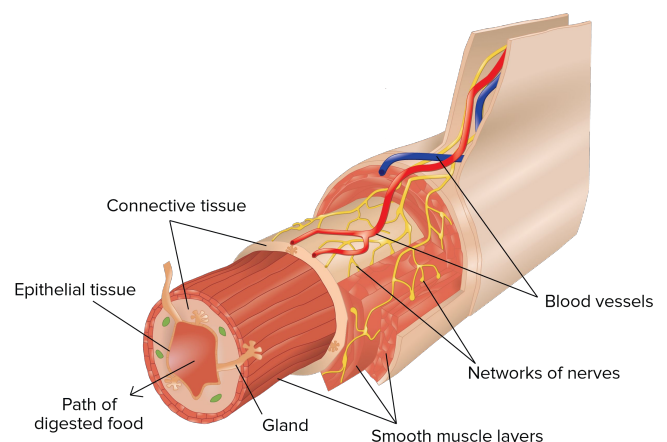
Remember it! - Cool MEN

Connective Muscle Epithelial Nervous

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O
L

Tissue in Digestion

The gastrointestinal tract is composed of multiple tissues to function properly. For example, the stomach is made up of epithelial, muscular, and connective tissue. However, the GI tract is primarily composed of epithelial tissue. This is because epithelial tissue functions in many ways optimal for the digestive system, such as secretion and absorption.

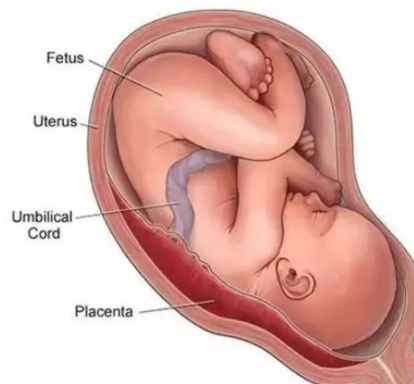


<https://courses.lumenlearning.com/suny-ap2/chapter/overview-of-the-digestive-system/>

Umbilical Cord:

What is the umbilical cord?

The umbilical cord is a cord that connects the baby to the mother's placenta, through its vein transports oxygen and nutrients to the fetus, and its two arteries that carry waste from the fetus out.



Components of the womb supporting a fetus

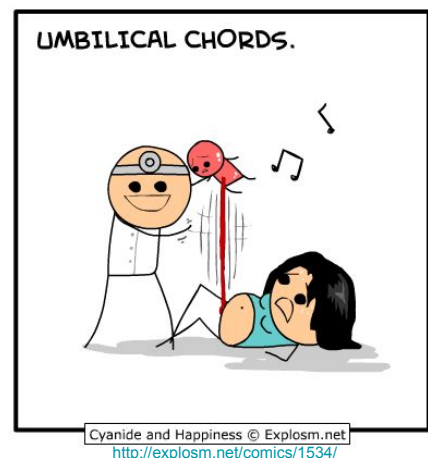
<https://www.quora.com/What-is-the-difference-between-placenta-and-umbilical-cord>

Digestion and the Placenta

Digestion plays a key role in delivering nutrients to the baby. When you digest food, the digestive system breaks the food down into small particles, which is then absorbed by the body. The nutrients travel through the mother's bloodstream, and to the placenta, where they are eventually delivered to the fetus. A few weeks into the pregnancy, the fetus also begins digesting nutrients in the form of amniotic fluid.

What happens after birth?

Shortly after birth, someone will cut the cord linking the mother and baby. Because there are no nerves on the cord, the process is painless. There will be a stump around 2-3 centimeters left on the baby's abdomen. Eventually, the stump will fall off and form our beloved belly button!



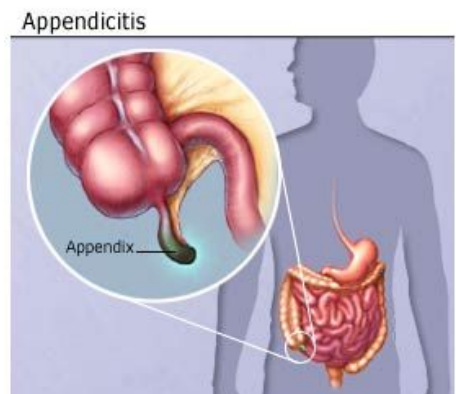
Vestigial Structure:

What is a vestigial structure?

A vestigial structure is a structure that appears to have no function or purpose, but may have in the past. Examples of such would include the tailbone and wisdom teeth.

Vestigial Structures in the Digestive System

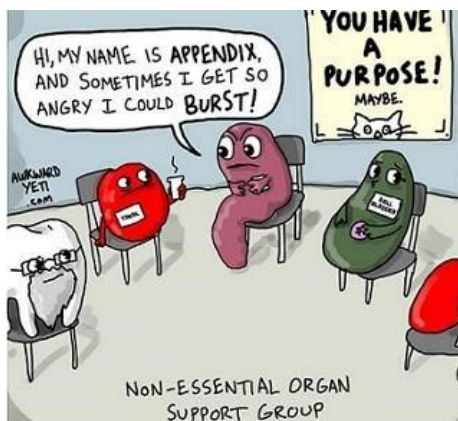
In humans, the appendix was once believed to be a vestigial structure, but played a role in digestion. In fact, 1 in 20 people got it removed. However, the appendix is revealed to be a storehouse for good bacteria to assist you in the scenario of diarrhea, making it non-vestigial. Wisdom teeth is another vestigial structure: the human jaw has become smaller throughout the generations, leaving no room for the wisdom teeth.



Where the appendix is located

<https://www.webmd.com/digestive-disorders/digestive-diseases-appendicitis>

Tracing Vestigial Structures to Evolution

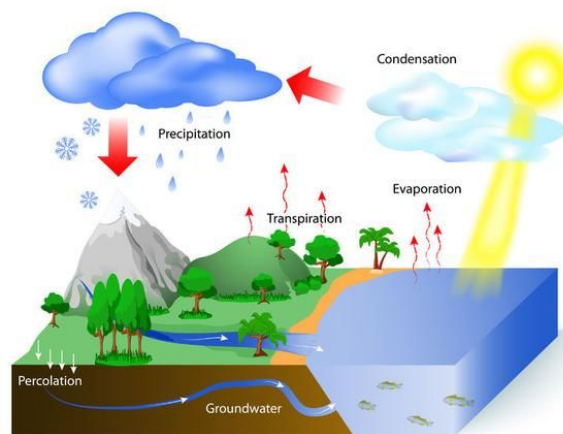


Oftentimes, vestigial structures once had an important function in the past. However, because of natural selection, or “survival of the fittest,” the now vestigial structures are rendered useless. There is also no selection pressure against the function, so it’s continually passed down. Essentially, vestigial structures are harmless remnants of our ancestors.

Water Cycle:

What is the water cycle?

The water cycle is the continuous movement of water through the Earth and atmosphere. The 3 phases of the water cycle brings together all major parts of Earth's climate, such as ocean, lakes, and plants.



The water cycle in action!

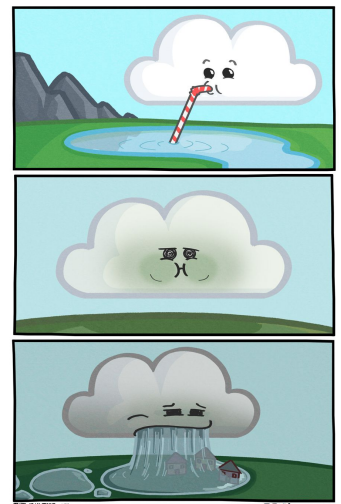
<https://theberkey.com/blogs/water-filter/the-water-cycle-the-journey-of-water-and-our-lives>

More on the water cycle:

A heavily generalized version of the water cycle is precipitation rains onto the ground, which goes through percolation of water into the ground, turning into groundwater. The groundwater could eventually be led back to a large body of water, such as a lake, river, or ocean, and evaporated back into the atmosphere. From the atmosphere, it forms a cloud through condensation, and is rained back via precipitation again.

Water Cycle and the Digestive System

Water is essential for our digestive system to run properly. Our body uses water in all cells, organs, and tissues to help regulate numerous body functions, including digestion, and flushing waste in the form of urine. The only source of water we use is freshwater, which makes up about 2.5% of the total water in the water cycle.



<https://jamesofnotrades.com/comic/water-cycle/>

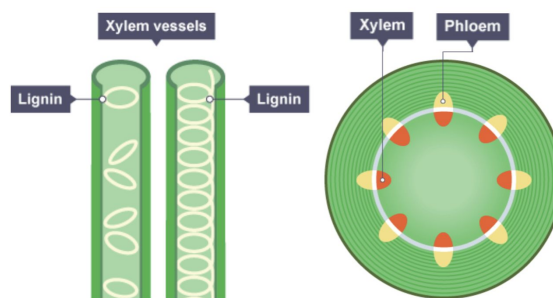
Xylem:

What is the xylem?

The xylem of the plant is a tissue that contains a variety of water conducting cells. It transports water and dissolved minerals from the roots to the rest of the plant.

Xylem and digestion

The xylem performs a very similar job for the plant as the digestive system performs for the human. However, the plant makes its own food, so in order to provide the nutrients necessary for photosynthesis, the process in which plants synthesize food, it needs carbon dioxide from the atmosphere and water from the soil. The xylem provides the water, while the stomata, microscopic holes on a leaf, provides carbon dioxide. Together, this provides the plant with the food it needs, while our digestive system digests food to provide us with the nutrients we need.



The xylem in the root, stem, or leaves

<http://igcse-biology-notes.blogspot.com/2017/06/252-describe-role-of-xylem-in.html>

An Interesting Way of Transport...

Nutrients and water is diffused through the cells of the roots via passive diffusion, movement of small molecules through a membrane that does not require energy. However, because the nutrients and water must be transported against gravity, it requires a specific transport called capillary action. Capillary action is when surface area tension causes liquid to move upwards, like a train.

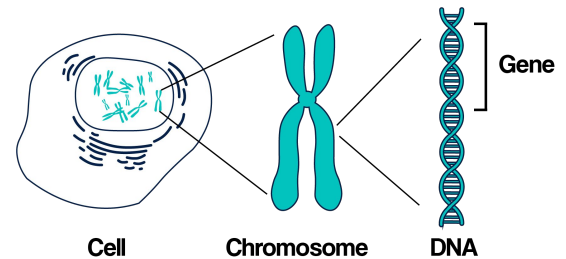
Did you know?

- The mixture of water and nutrients that flows through the xylem is called xylem sap
- Lignin (as pictured above) gives the cell walls of plants a rigid and woody structure
- Plants use carbon dioxide instead of oxygen, and "return" oxygen into the atmosphere

Y-chromosome:

What is a Y-chromosome?

Firstly, a chromosome is combined protein and DNA that carries genetic information. A Y-chromosome is one of the two sex chromosomes, the other being an X-chromosome, and determines sex.



Chromosomes in the nucleus of the cell, and the DNA in the chromosome

<https://kintalk.org/genetics-101/>

Chromosomes and digestion

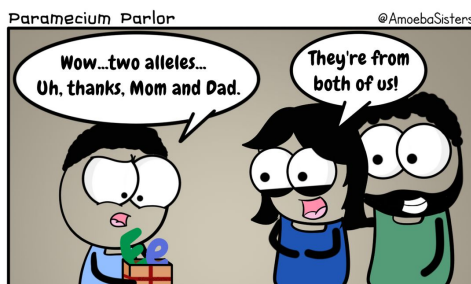
The nutrients we get from the food we digest not only power the body, but can influence our genetic information in our chromosomes! In fact, there is a section of genetic study called nutrigenomics, that studies the impact of food on our genetic information. In particular, a wrong diet can adversely affect our DNA, forming DNA mutations and thus causing our cells to not function as they should. This can cause information in our chromosomes can be damaged, including the DNA in our sex chromosomes.

How X and Y-chromosomes Determine Sex

In an XY sex-determining system, the female contributes an X chromosome always through the egg, because a female typically, save mutations, have the XX sex chromosome. Typically, males have the XY sex chromosome, and the sperm carries either X or Y. When the sperm meets the egg, they fuse to become either XX or XY.

	X	X
X	XX	XX
Y	XY	XY

<https://www.quora.com/Are-humans-more-likely-to-create-a-male-or-female-child-or-is-it-a-50-50-shot>



(Note that an allele is a variant of a trait for a given gene)

<https://www.pinterest.com/pin/500884789794257538/?lp=true>

Zinc:

What is zinc?

Zinc is a metal that is a trace element, or found in extremely small quantities in our body. However, they have a significant effect on our health.



Zinc metal in solid form

<https://www.thoughtco.com/zinc-facts-606621>

Zinc in digestion

Zinc is an essential micronutrient, vitamins and nutrients that are beneficial to health. Zinc is present in all organs, and is required to catalyze many enzymes. When your blood sugar is high, the pancreas releases insulin, which can be high in zinc. In fact, researchers have found that zinc-deficient animals require 50% more food than those without zinc-deficiencies to gain the same weight, and that humans likely react to zinc in the same way. Some foods high in zinc include liver, seafood, and eggs.

Zinc everywhere!

Outside of digestion, zinc provides numerous health benefits. In fact, zinc helps us activate T-cells, a crucial part of our immune system, including reducing diarrhea. It is likely that zinc helps heal wounds, and slows down age progression.

Did you know?

- Zinc is the 24th most abundant element on Earth
- Zinc is the 4th most consumed metal on Earth, preceded by iron, aluminum, and copper

Footnotes

A special thanks to these websites:

“How Much Does Agriculture Contribute to Global Warming?” *Planet Experts*, 14 May 2016,
www.planetexperts.com/how-much-does-agriculture-contribute-to-global-warming/.

Harwood, Jessica, et al. “Digestive System Bacteria.” CK, CK-12 Foundation, 14 Aug. 2018,
www.ck12.org/biology/digestive-system-bacteria/lesson/Bacteria-in-the-Digestive-System-MS-LS/.

Britannica, The Editors of Encyclopaedia. “Capillary.” *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 26 Aug. 2014, www.britannica.com/science/capillary.

“Type 2.” *American Diabetes Association*, www.diabetes.org/diabetes-basics/type-2/.

“Definition: Insulin (for Parents).” *KidsHealth*, The Nemours Foundation, kidshealth.org/en/parents/insulin.html.

Brookes, J H, and Hennig. “Anatomy and Physiology of the Enteric Nervous System.” *Gut*, BMJ Publishing Group, 1 Dec. 2000, gut.bmj.com/content/47/suppl_4/iv15.

Study.com, Study.com,
study.com/academy/lesson/lipids-digestion-and-absorption.html.

Biga, Lindsay M., et al. “Anatomy & Physiology.” *24.2 Carbohydrate Metabolism | Anatomy & Physiology*, Open Oregon State, Oregon State University, library.open.oregonstate.edu/aandp/chapter/24-2-carbohydrate-metabolism/.

“How Does the Digestive System Maintain Homeostasis.” *Biology Dictionary*, 15 Apr. 2018, biologydictionary.net/how-does-the-digestive-system-maintain-homeostasis/.

(continued)

Learnwithalbert. "Positive and Negative Feedback Loops in Biology." *Albert Blog*, 30 Apr. 2017, www.albert.io/blog/positive-negative-feedback-loops-biology/.

"How Digestive and Immune Systems Work Together." *MicroBiomePlus*, 30 Jan. 2018, microbiomeplus.com/digestive-immune-systems-work-together/.

"Jejunum: Definition, Function and Anatomy, Diagram, and Conditions." *Healthline*, Healthline Media, www.healthline.com/human-body-maps/jejunum#function.

"Your Kidneys & How They Work." *National Institute of Diabetes and Digestive and Kidney Diseases*, U.S. Department of Health and Human Services, 1 June 2018, www.niddk.nih.gov/health-information/kidney-disease/kidneys-how-they-work.

Britannica, The Editors of Encyclopaedia. "Lysosome." *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 16 Sept. 2018, www.britannica.com/science/lysosome.

Parenthood, Planned. "What Is Menstruation? | Get Facts About Having Your Period." *Planned Parenthood*, www.plannedparenthood.org/learn/health-and-wellness/menstruation.

Thornton, Emma. "Facts You Didn't Know about Your Period but Probably Should!" *15 Interesting Facts about Your Period*, A.vogel, www.avogel.co.uk/health/periods/15-interesting-facts-about-your-period/.

Boundless. "Boundless Biology." *Lumen*, courses.lumenlearning.com/boundless-biology/chapter/nucleic-acids/.

Human Digestive System, www.oswego.edu/~balko/bio203/Digestion.htm.

"What Are Oral Cavity and Oropharyngeal Cancers?" *American Cancer Society*, Cancer.org, 9 Mar. 2018, www.cancer.org/cancer/oral-cavity-and-oropharyngeal-cancer/about/what-is-oral-cavity-cancer.html.

(continued)

“The Pancreas and Its Functions.” *The Pancreas and Its Functions* | Columbia University Department of Surgery, columbiasurgery.org/pancreas/pancreas-and-its-functions.

“Pancreatitis: Symptoms, Causes, Diagnosis, Treatments, Tests.” *WebMD*, WebMD, www.webmd.com/digestive-disorders/digestive-diseases-pancreatitis.

“Orders of Protein Structure.” *Khan Academy*, Khan Academy, www.khanacademy.org/science/biology/macromolecules/proteins-and-amino-acids/a/orders-of-protein-structure.

Wan, Yao, and Kunal Chatterjee. “RNA.” *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 13 July 2018, www.britannica.com/science/RNA.

“What Is DNA Replication?” *Facts*, The Public Engagement Team at the Wellcome Genome Campus, 25 Jan. 2016, www.yourgenome.org/facts/what-is-dna-replication.

“What Is Human Body Tissue? - Definition, Types & Examples.” *Study.com*, The Editors of Encyclopaedia Britannica, study.com/academy/lesson/what-is-human-body-tissue-definition-types-examples.html.

NHS Choices, NHS, www.nhs.uk/common-health-questions/pregnancy/what-is-the-umbilical-cord/.

What to Expect, Editors. “Fetal Development: Baby's Digestive System.” *Whattoexpect*, WhattoExpect, 17 May 2019, www.whattoexpect.com/pregnancy/fetal-development/fetal-digestive-system/.

Scoville, Heather. “Your Appendix: Evidence of Evolution.” *ThoughtCo*, ThoughtCo, 26 Jan. 2019, www.thoughtco.com/about-vestigial-structures-1224771.

Staff, Live Science. “5 Useless Body Parts.” *LiveScience*, Purch, 11 July 2012, www.livescience.com/21513-vestigial-organs.html.



(continued)

“Water Cycle.” *Water Cycle | National Oceanic and Atmospheric Administration*,
www.noaa.gov/education/resource-collections/freshwater-education-resources/water-cycle/.

Petruzzello, Melissa. “Xylem.” *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 17 Oct. 2016, www.britannica.com/science/xylem.

“Xylem - Definition, Types and Function.” *Biology Dictionary*, 28 Mar. 2019,
biologydictionary.net/xylem/.

“Biology for Kids.” *Ducksters Educational Site*,
www.ducksters.com/science/biology/chromosomes.php.

Kahn, Joel. “How The Food You Eat Changes Your Genes.” *Mindbodygreen*,
Mindbodygreen, 10 June 2015,
www.mindbodygreen.com/0-13477/how-the-food-you-eat-changes-your-genes.html.

Nordqvist, Joseph. “Zinc: Benefits, Intake, Sources, Deficiency, and Side Effects.”
Medical News Today, Medilexicon International, 5 Dec. 2017,
www.medicalnewstoday.com/articles/263176.php.

“Zinc.” *Gastrointestinal Society*,
badgut.org/information-centre/health-nutrition/zinc/.



Stephanie Wu is a freshman at Monta Vista High School. She is an active contestant of math competitions, and is unsure of what she wants to do in the future. Other than math she enjoys programming, violin, and talking with friends.

She has several fond memories of the 2018-2019 biology class. In particular, she liked learning about biotechnology and its applications. She also liked the cell unit as it provided an in-depth look of miniscule processes at work.