The human body has multiple systems that work together to maintain normal function. But what happens when processes fail? In this eBook, we are going to look at some common human pathologies with the help of Physiology and Pathology!
Arteries carry blood away from the heart to tissues throughout the body, supplying them with oxygen and nutrients.

**Pathology:**
Atherosclerosis occurs when plaques form beneath the endothelium (innermost layer of the artery wall). These plaques are where cholesterol accumulates, causing inflammation and restricting the flow of blood in the arteries. The decrease in blood flow can lead to myocardial ischemia, a decrease in oxygen supply to heart muscle tissue. The chances of developing atherosclerosis rise with obesity, high cholesterol, and advanced age.

The first visible sign of atherosclerosis is the fatty streak, formed when excess cholesterol in the blood invades the endothelium, causing accumulation and inflammation.
As more plaques accumulate in the coronary artery, it becomes harder and more narrow, resulting in less bloodflow and oxygen to the heart. This is called coronary artery disease (CAD). CAD is the most common type of heart disease and is the leading cause of death in the United States in both men and women. CAD can lead to angina (chest pain) or a heart attack. Over time, CAD can also weaken the heart muscle and contribute to heart failure (where the heart cannot pump blood adequately) and arrhythmias (abnormal heartbeats).
Physiology of airway defense:
Receptors in the airways react to particles and toxins (irritants) by triggering short-term bronchospasm (sudden narrowing of the bronchi) or bronchoconstriction (contracting or tightening of the smooth muscle in the airways). This allows foreign particles to be expelled quickly. The airways' epithelia are lined with cilia and mucus-secreting cells. The mucus traps inhaled debris and cilia sweep it up into the pharynx to be coughed out or swallowed. This is vital to the protection of the lungs and alveoli and to the restoration of normal airflow.

Pathology:
Asthma is characterized by an overreaction of the airways' defenses. Currently, more than 25 million people in America have asthma. It can be triggered by inhalation of certain particles like dust and/or allergens. During an attack, excess mucus production, caused by irritation, can lead to bronchoconstriction and edema (fluid trapped in the body's tissues that causes swelling), which makes pulmonary ventilation (breathing) difficult.
The lungs have a spongy, light, and elastic texture that allows them to expand and contract during breathing. Air fills the lungs as we breathe. Oxygen is then transported from the lungs into the bloodstream and then to the body’s cells. As cells take in oxygen, they exchange it for carbon dioxide (a waste gas). The carbon dioxide is then transported back to the lungs through the bloodstream and breathed out.

Tuberculosis is an infection of lung tissue by *Mycobacterium tuberculosis*. It is transmitted by droplets that spread through the air when an infected person coughs or sneezes. The initial infection causes inflammation of the alveoli and surrounding capillaries. Immune cells ingest the bacteria, and *tubercles* (nodules) form around the immune cells to help stop the infection. However, if the tubercles rupture, the infection reactivates, spreading through the lungs. This causes the affected tissue to become *caseous* (soft, dry, crumbly masses resembling cheese). Lung capacity is reduced. Fibrosis may also occur, causing a reduction of the lung’s elasticity and compliance.
Lung cancer is a leading cause of cancer-related death worldwide. The usual cause is smoking, or long-term exposure to another carcinogen (any substance that can cause cancer). Carcinogen exposure wears down airway defenses, paralyzes cilia, and creates a pathogenic environment in which epithelial cells can become cancerous.

Lung cancers are classified into two main types: small cell lung cancer (SCLC) or non-small cell cancer (NSCLC). NSCLC accounts for about 80% of lung cancers. The three main subtypes are:

- **Adenocarcinomas**: the most common subtype and usually form in the outer region of the lung.
- **Squamous cell carcinomas**: usually found toward the interior of the lungs, near the main airways.
- **Large cell carcinomas**: can occur anywhere in the lungs.
KIDNEY STONES

Physiology of the kidney:
The kidneys filter the blood and produce urine. Urine creation occurs within nephrons, the functional units of the kidneys, in three steps: filtration, reabsorption, and secretion. The finished urine drains into the renal calyces at the tips of the renal pyramids, then into the renal pelvis and out through the ureter.

Pathology:
Kidney stones are undissolved mineral or acid salts in urine that have crystallized, forming stones. Kidney stones can form anywhere in the urinary tract, but typically originate in the renal calyces or pelvis. Stones larger than 5 mm significantly obstruct urine flow and can lead to infection or a buildup of fluid pressure. If the stones are not broken up or surgically removed, infection or pressure can cause hydronephrosis (swelling), damage to functional tissue, and eventually postrenal failure. Kidney stones can also cause excruciating back and side pain. About 1 in 10 people will experience a kidney stone in their life.
Swallowed food, referred to as a bolus, is pushed down the esophagus by peristalsis (involuntary muscle contractions that come in waves every eight seconds or so). The bolus enters the stomach through the cardiac sphincter, a muscle at the end of the esophagus. Within the stomach, gastric juice and the contractions of the smooth muscle in the stomach wall turn the bolus into a liquid called chyme. Chyme passes from the stomach, through the pyloric sphincter (functions like a one-way valve that directs food and waste through the digestive tract), and into the small intestine.

Gastroesophageal reflux disease (GERD) happens when the cardiac sphincter does not close properly. This allows stomach contents to leak back into the esophagus and irritate it. One of the symptoms of GERD is heartburn (feeling burning in the chest or throat). Around 2 in 10 people in America are affected by GERD.
LIVER CIRRHOSIS

The liver, an accessory organ of the digestive system, is the largest gland in the body, serving multiple exocrine and endocrine functions. Endocrine functions of the liver include the metabolism of carbohydrates, proteins, and fats. Exocrine functions include the secretion of bile into the small intestine.

Pathology:
Ongoing exposure to high levels of alcohol, or other absorbed toxins from the GI tract, can damage liver tissue irreparably, causing a condition known as cirrhosis (scarving of the liver). About 1 in 400 adults in America have cirrhosis. The decline of the liver’s ability to regulate and detoxify the blood can lead to serious complications in every body system.
GALLSTONES

Physiology of the gallbladder:
The gallbladder stores and concentrates bile after it is secreted by the liver. Bile facilitates the digestion of fats and the removal of excess cholesterol from the blood. When the sphincter of Oddi (around the opening of the duodenal papilla) is closed, bile flows back up to the gallbladder for storage.

Pathology:
Gallstones form when substances in the bile harden. These stones may stay in the gallbladder and can block flow of bile. The stones can also get stuck in different ducts. A stone in the cystic duct can block gall bladder excretion (A). A stone in the bile duct can block the flow from both the liver and gallbladder (B). A stone stuck in the duodenal papilla (C) can block both bile and pancreatic enzymes from entering the duodenum. Around 1 in 10 Americans are affected by gallstones.
OSTEOPOROSIS

Physiology of bone tissue:
Bones are remodeled in response to physical activity and mechanical stressors. Cells called osteoclasts reabsorb old or unhealthy bone tissue. Cells called osteoblasts deposit new osteoid (the bone matrix that forms prior to the maturation of the bone tissue). Mature bones include a periosteum (outer tissue layer), which houses blood vessels and layers of compact and spongy bone. Compact bone is made up of rings of calcified tissue arranged in structures called osteons, which also include vessels, nerves, and osteocytes (former osteoblasts that maintain bone health). Spongy bone contains larger vessels and marrow.

Pathology:
Osteoporosis occurs when bone tissue is lost faster than it is replaced it is causing overall tissue loss. This leads to bone pain, and weakened and brittle bones that are more likely to break. Anyone can develop osteoporosis, but it is most common in older women. As many as half of all women and a quarter of men older than 50 will break a bone due to osteoporosis.
The lumbar region of the vertebral column includes the L01–L05 vertebrae and the intervertebral discs between them. Vertebrae are weight-bearing bones consisting of an anterior body and a posterior arch. The sciatic nerve is one of the lower branches of the lumbosacral plexus (spinal nerves that are responsible for cutaneous and muscular innervation of the lower limbs and parts of the abdomen and pelvis).

**Physiology of the lumbar region:**

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**Pathology:**

Sciatica refers to pain and discomfort along the pathway of the sciatic nerve, often originating at the spinal nerves in the lower back and radiating down to the buttock and the back of the thigh. Lumbar spinal stenosis (narrowing of the spinal canal in the lumbar region) can also lead to sciatica. Compression of any of the spinal nerve roots (L04–S03) that branch to the sciatic nerve can cause this condition. Sciatica typically affects one side of the body, with mild to severe pain, muscle weakness, or numbness felt anywhere along the nerve pathway.
**Physiology of the flexor digitorum superficialis:**

The *flexor digitorum superficialis* is a superficial muscle of the anterior compartment of the forearm innervated by the median nerve. Near the wrist, the muscle ends in four tendons that pass through the carpal tunnel under the transverse carpal ligament. The tendons insert onto the middle phalanges of digits 2–5, and the muscle acts to flex those digits and the wrist.

**Pathology:**

*Carpal tunnel syndrome* may occur when inflamed tendons, or another impingement, compress the median nerve. It often results from a combination of factors. For example, wrist fracture, arthritis, or repetitive motion can irritate and inflame the tendons of the flexor muscles around the median nerve. Some possible symptoms of carpal tunnel include numbness, pain, and/or weakness in the regions of the hand and fingers served by the median nerve and its branches. The nerve compression can also cause “electric shock,” burning, or other sensations.
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