BASICS OF PATHOPHYSIOLOGY I

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Abstract

Pathophysiology, the study of disease function and processes, enables medical professionals to understand diagnosis, treatment, and management options to achieve a best-case scenario for their patients. Recognizing disease and disorder manifestations will assist nurses and nurse practitioners with early diagnosis to improve patient outcomes. This course provides a brief overview of pathophysiology principles, including a cellular biology review, before delving in-depth into the pathophysiology of disorders affecting the cardiovascular, circulatory, pulmonary, gastrointestinal, reproductive, urinary, renal, and musculoskeletal systems, in addition to fluid, electrolyte, and acid/base imbalance disorders.
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This educational activity is credited for 2.5 hours. Nurses may only claim credit commensurate with the credit awarded for completion of this course activity.

**Statement of Learning Need**
Nurses at all levels of professional development need an enhanced understanding of pathophysiology in order to understand patient treatment and care for certain medical conditions.

**Course Purpose**
To provide nursing professionals with knowledge of the basic principles of pathophysiology and associated medical conditions.
Target Audience
Advanced Practice Registered Nurses and Registered Nurses
(Interdisciplinary Health Team Members, including Vocational Nurses and Medical Assistants may obtain a Certificate of Completion)

Course Author & Planning Team Conflict of Interest Disclosures
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Please take time to complete a self-assessment of knowledge, on page 4, sample questions before reading the article.

Opportunity to complete a self-assessment of knowledge learned will be provided at the end of the course.
1. **Which of the following is the name for the process by which the cell produces energy through the breakdown of complex molecules?**
   a. Catabolism
   b. Replication
   c. Synthesis
   d. Anabolism

2. **Which of the following is NOT one of the chemicals that DNA is comprised of?**
   a. Adenine
   b. Thymine
   c. Bromine
   d. Cytosine

3. **This branch of pathology is the study of chemical and biochemical mechanisms of the body in relation to disease.**
   a. Anatomical Pathology
   b. Chemical Pathology
   c. Biological Pathology
   d. Immunology

4. **Which of the following is NOT one of the classifications for kidney infections:**
   a. Complex
   b. Uncomplicated
   c. Complicated
   d. Chronic

5. **The body is comprised of _____________ percent fluids.**
   a. 12 – 18
   b. 24 – 30
   c. 52 - 60
   d. 72 - 80
Introduction

Pathophysiology, the study of disease function and processes, enables medical professionals to understand diagnosis, treatment, and management options to achieve a best-case scenario for their patients. The ultimate goal of pathophysiology is to be able to answer the following questions:¹

- What is the cause or causes of the disease, and why the disease is developing?
- What are the mechanisms responsible for disease onset, progression, and recovery?
- What are the mechanisms responsible for development of symptoms and signs of disease?

Recognizing disease and disorder manifestations will assist nurses and nurse practitioners with early diagnosis to improve patient outcomes. This course provides a brief overview of pathophysiology principles, including a cellular biology review, before delving in-depth into the pathophysiology of disorders affecting the cardiovascular, circulatory, pulmonary, gastrointestinal, reproductive, urinary, renal, and musculoskeletal systems, in addition to fluid, electrolyte, and acid or base imbalance disorders.

Cellular Biology Review

Cells are the basic building blocks of all living things. Humans are multicellular, meaning that they are comprised of more than one cell. In fact, the human body contains approximately 100,000,000,000,000 cells.² The cells are supported and sustained by the body’s organ systems.³

There are a number of specialized cells in the body, which perform different functions. For example, some cells combine together to create tissue and
organs, while other cells carry out the body’s functions. In total, there are approximately 200 specialized cells within the body carrying out these special functions.4

The following table provides information on each of the types of specialized cells:5

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve Cells</td>
<td>Also called Neurons, these cells are in the nervous system and function to process and transmit information (it is hypothesized). They are the core components of the brain, spinal cord and peripheral nerves. They use chemical synapses that can evoke electrical signals, called action potentials, to relay signals throughout the body.</td>
</tr>
<tr>
<td>Epithelial cells</td>
<td>Functions of epithelial cells include secretion, absorption, protection, transcellular transport, sensation detection, and selective permeability. Epithelium lines both the outside (skin) and the inside cavities and lumen of bodies.</td>
</tr>
<tr>
<td>Exocrine cells</td>
<td>These cells secrete products through ducts, such as mucus, sweat, or digestive enzymes. The products of these cells go directly to the target organ through the ducts. For example, the bile from the gall bladder is carried directly into the duodenum via the bile duct.</td>
</tr>
<tr>
<td>Endocrine cells</td>
<td>These cells are similar to exocrine cells, but secrete their products directly into the bloodstream instead of through a duct. Endocrine cells are found throughout the body but are concentrated in hormone-secreting glands such as the pituitary. The products of the endocrine cells go throughout the body in the blood stream but act on specific organs by receptors on the cells of the target organs. For example, the hormone estrogen acts specifically on the uterus and breasts of females because there are estrogen receptors in the cells of these target organs.</td>
</tr>
</tbody>
</table>
**Blood Cells**

The most common types of blood cells are: red blood cells (erythrocytes). The main function of red blood cells is to collect oxygen in the lungs and deliver it through the blood to the body tissues. Gas exchange is carried out by simple diffusion.

**White Blood Cells (leukocytes)**

Leukocytes are produced in the bone marrow and help the body to fight infectious disease and foreign objects in the immune system. White cells are found in the circulatory system, lymphatic system, spleen, and other body tissues.

Although cells will differ in their structure and function, they all have similar needs and a similar structural organization.

**Cellular Function**

Cellular function can be broken into four distinct categories, each of which is essential to the development and maintenance of the cells and the body as a whole. The following table provides information on each of the categories of cellular function:

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
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</table>
| Growth and metabolism  | Cell growth occurs as the result of functional cell metabolism, which is the process that occurs when cells create nutrient molecules. There are two components of metabolism:  
  - Catabolism – the cell produces energy through the breakdown of complex molecules.  
  - Anabolism – The cell constructs complex molecules by using energy and reducing its power. These molecules are used for other biological processes. |
### Replication

Cell division occurs when the mother cell, which is a single cell, divides into two individual cells. These newly formed cells are called daughter cells. Cell division (replication) is what enables growth within the organism.²

### Protein synthesis

The synthesis of protein is necessary for the maintenance of cellular activities. The protein synthesis process utilizes DNA and RNA amino acids to form new protein molecules through a two-step process:³

- Transcription
- Translation

### Movement or motility

Human cells are capable of moving during specific cellular processes, including immune responses and cancer mastitis. Cellular movement occurs in three steps:³

- Protrusion of the leading edge of the cell
- Adhesion of the leading edge and de-adhesion at the cell body and rear
- Cytoskeletal contraction that pulls the cell forward

### Genes and Genetic Disorders

Deoxyribonucleic acid (DNA) is comprised of four primary chemicals:

- Adenine
- Thymine
- Cytosine
- Guanine

These chemicals bind together to create genetic patterns within the cell. The DNA, which contains the genetic material, binds together to form chromosomes. Typically, a cell contains 23 pairs of chromosomes. When cells replicate, the genetic material is transferred to the new cells.⁶
Genetic disorders occur when an individual experiences a mutation in one or more genes. These mutations can occur at conception, or they can occur at some point during the individual’s lifetime. When mutations occur during an individual’s lifetime, they are typically caused by the aging of cells or exposure to external factors such as chemicals or radiation. In many instances, these mutations will be repaired by the cells and will cause no damage. However, in some instances, these mutations cannot be repaired. In these instances, the patient will experience adverse effects such as illness or disability.

When a gene mutation occurs at conception, the mutation becomes part of the individual’s genetic make up. In these instances, the mutation cannot be repaired by the cell.

There are more than 4000 diseases that can be caused by gene mutations. When an individual experiences a mutation in a dominant gene, he or she will typically experience the condition and/or symptoms associated with the mutation.

Examples of common conditions caused by dominant gene mutations include:

- Achondroplasia
- Marfan syndrome
- Huntington disease

When an individual experiences a mutation in a recessive gene, he or she will not typically develop the condition associated with the mutation. The individual will be a carrier of the mutation, but will not develop the condition because one of the two genes in the pair will still be healthy. However, if
an individual receives mutated genes from both the X chromosome and the Y chromosome, he or she will develop the condition associated with the recessive gene. These common conditions caused by mutated recessive genes include:

- Cystic fibrosis
- Sickle cell anemia
- Tay-Sachs disease

**Pathology And Physiology Medicine**

Pathology is the branch of medicine that studies changes in the structure and function of the tissues and organs that either cause disease or are caused by disease. Pathologists focus on the basic nature of disease and attempt to understand how disease affects, and is affected, by the body. Through the examination of blood, bodily fluids, and tissue, pathologists identify the causes and severity of an illness and the impact it is having on the patient. The results from a pathologist’s analysis are used to develop a treatment plan for the patient. Pathologists will study disease using the following parts of the body:

- Whole bodies
- Organs
- Tissues
- Bodily fluids

The above list provides information regarding the parts of the body that are studied. However, pathology is also broken into a number of categories based on how the body is studied and what parts of the body are studied. The categories are defined as specialty areas and a description of each is provided in the table below:
<table>
<thead>
<tr>
<th>Specialty</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomical Pathology</td>
<td>Anatomical Pathology is the microscopic study of organs and tissues to determine the causes and effects of particular diseases. Specialist pathologists, Anatomical Pathologists, examine tissue to aid in the diagnosis of disease and the determination of a treatment plan.</td>
</tr>
</tbody>
</table>
| Chemical Pathology      | Chemical Pathology is the study of chemical and biochemical mechanisms of the body in relation to disease. A chemical pathology department within a hospital provides a link between medicine and the basic sciences employing analytical and interpretative skills to aid the clinician in the prevention, diagnosis and treatment of disease.  

In many diseases there are significant changes in the chemical composition of body fluids. Testing is aimed at detecting these changes quantitatively compared to results from *Healthy People*. |
| Cytogenetics     | This involves the analysis of abnormalities at a chromosomal level. Techniques have been developed using high-powered microscopes, which are used to look at the number and structure of chromosomes so that genetic conditions such as Downs Syndrome can be diagnosed. |
| Hematology       | Hematology is the study of diseases that affect blood. Investigations that take place in the Hematology laboratory include:  

- Routine hematological testing  
- Clotting and bleeding studies  
- Transfusion services |
| Immunology       | Clinical Immunology is concerned with the diagnosis and management of diseases arising from abnormal immune responses. In broad terms, these abnormalities may be the result of either under-activity (immunodeficiency) or over-activity (autoimmunity and allergy) of the immune system. |
| Microbiology     | Microbiology deals with isolation and identification of infectious agents such as bacteria, viruses, fungi and parasites that cause disease. |
| Molecular Pathology | Molecular pathology is a term commonly used to encompass all forms of diagnostic DNA and RNA tests (also referred to as nucleic acid tests). |
Physiology is the branch of medicine that focuses on the functions of the body. Specifically, physiologists are concerned with how the organs and the systems of the body function in both normal situations and abnormal situations. Physiologists focus on four aspects of function: 8

- Physical
- Mechanical
- Biochemical
- Bioelectric

**Circulatory Disease**

**Coagulation Disorders**

Coagulation disorders occur when the body is unable to control blood clotting. When an individual has a coagulation disorder, he or she is at risk of hemorrhaging or developing thrombosis. 17 Hemorrhaging occurs when the patient is unable to produce significant clotting to sustain basic blood flow. Thrombosis occurs when a patient has too much clotting agent present. 18

Coagulation disorders can be caused by a variety of factors, the most common being: 19

- Vitamin K deficiency
- Liver disease
- Disseminated intravascular coagulation
- Development of circulating anticoagulants

Individuals may inherit the disorder, or it can be acquired or develop at some point in the individual’s life. The most common hemorrhagic condition is hemophilia, which is a hereditary disease. The most common form of thrombophilia is Factor V Leiden Mutation. 17
Vascular Disorders

A vascular disorder is any disease that affects the blood vessels (arteries, lymphatics, veins). There are a number of vascular disorders.

Disorders of the veins and arteries

- Carotid Artery Disease:
  The carotid arteries in the neck that deliver blood to the brain can become blocked by a build up of plaque. This can cause a variety of symptoms and lead to a stroke.

- Mesenteric Artery Disease:
  The blood flow to the intestine (belly area) can be blocked by atherosclerosis. This blockage can lead to malnutrition, weight loss, even death if left untreated.

- Renal Artery Disease:
  A blockage of the renal (kidney) arteries can lead to poor kidney function and high blood pressure.

- Peripheral Artery Disease:
  Deposits of plaque on the walls of the arteries that take the blood to the legs and arms can lead to the hardening of the arteries and can cause leg pain.

- Venous Disease:
  Veins can become inflamed, dilated and blocked, particularly those in the legs.
• **Stroke:**
  A stroke occurs when a blood vessel (artery) that supplies blood to the brain bursts or is blocked by a blood clot. Within minutes, the nerve cells in that area of the brain are damaged, and they die within a few hours.

• **Varicose Veins:**
  Varicose veins are twisted, enlarged veins near the surface of the skin. They most commonly develop in the legs and ankles.

• **Venous Skin Ulcer:**
  A venous skin ulcer, also called a stasis leg ulcer, is a shallow wound that develops when the leg veins do not move blood back toward the heart normally.

*Thrombosis and Emboli*

Thrombosis is caused by an obstruction in the veins or arteries. There are two types of thrombosis, depending on where the obstruction is located. Venous thrombosis is an obstruction that occurs in a vein, while arterial thrombosis is an obstruction that occurs in an artery. Thrombi, which are the clots that form, remain in one region of the body without traveling through the bloodstream.

An embolism occurs when a blood clot forms in an artery or vein, and then breaks free from the region and travels to a new location in the body. Once the clot breaks free, it can cause a blockage to different regions of the body and it has the potential to cause significant damage to the region. There are a number of different types of embolism:
• Brain embolism - a clot that can prevent blood flow to the brain and can cause an ischemic stroke

• Retinal embolism - small clots that can block blood flow to the retina of the eye and can cause sudden blindness in an eye

• Amniotic embolism - amniotic fluid during pregnancy that can form clots and reach the lungs, resulting in pulmonary amniotic embolism

• Air embolism - air bubbles that form clots in the arteries and block blood flow, often seen in scuba divers rising to the surface too quickly

• Thromboembolism - a blood clot (thrombus) that breaks free to form an embolus, capable of causing a heart attack

• Cholesterol embolism - cholesterol from plaques in a blood vessel break free and form a blockage

• Fat embolism - fat droplets enter the blood stream and block blood flow, usually a side-effect of certain surgeries or bone fractures

• Septic embolism - embolism infected with bacteria containing pus

• Foreign body embolism - any other small particle or object that enters the circulatory system and manages to block the flow of blood.
Cardiovascular Disease

Congenital Heart Disease

Congenital heart disease is a form of heart disease that is caused by abnormalities that form in the cardiovascular system prior to birth. The abnormalities occur while the fetus is developing and can cause significant problems. The symptoms of congenital heart disease may be present at birth, or they may develop over time. In some instances, the individual will never show signs of the disease.

In most instances, the cause of the disorder is unknown. However, there are a number of factors that may contribute to the development of congenital heart disease:

- Genetic or chromosomal abnormalities in the child, such as Down syndrome
- Taking certain medications or alcohol or drug abuse during pregnancy
- Maternal viral infection, such as rubella (German measles) in the first trimester of pregnancy
- A parent or sibling with congenital heart disease.

Valvular Disorders

There are a number of different valve disorders ranging in severity from mild to severe. While there are many different types of valvular disorders, they all produce similar symptoms, which include:

- Dizziness
- Shortness of breath
- Fatigue
- Irregular pulse
Valve disorders are broken into the categories of stenosis (narrowing), pulmonary valve stenosis, prolapse (slipping out of place), and regurgitation (backward flow), as described in the table below.\(^{31}\)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stenosis (narrowing)</strong></td>
<td>The narrowing of heart valves is known as stenosis. When the opening narrows, the heart cannot push the required amount of blood through the valve. Stenosis makes the heart work harder to pump the same volume of blood and may also lead to an increase in the size of the heart muscle. Enlargement of the heart muscle may lead to serious complications.</td>
</tr>
<tr>
<td><strong>Pulmonary valve stenosis</strong></td>
<td>Pulmonary valve stenosis is a narrowing or obstruction that partly or completely blocks the flow of blood. Obstructions can occur in heart valves, arteries or veins. This condition results in the narrowing of the pulmonary valve (which lets blood flow from the right lower chamber of the heart to the lungs). As a result, the right lower chamber (right ventricle) must pump harder than normal to overcome the obstruction. This may cause stress on, and enlargement of, the right ventricle.</td>
</tr>
<tr>
<td><strong>Prolapse (slipping out of place)</strong></td>
<td>In valve prolapse, the valve flaps do not close smoothly or evenly. Instead, they collapse backwards into the heart chamber they are supposed to be sealing off. This sometimes makes a clicking noise and allows a small amount of blood to leak backward through the valve. This group of conditions may be called mitral valve prolapse, click-murmur syndrome, Barlow's syndrome, balloon mitral valve and floppy valve syndrome.</td>
</tr>
<tr>
<td><strong>Regurgitation (backward flow)</strong></td>
<td>Regurgitation occurs when a heart valve doesn't close securely. This condition reduces the heart's pumping efficiency. When the heart contracts, blood is pumped forward in the proper direction and is also forced backwards through the damaged valve. This not only limits the heart's ability to supply the body with blood, but may also cause lung problems.</td>
</tr>
</tbody>
</table>
**Coronary Heart Disease**

Coronary heart disease occurs when plaque builds up in the coronary arteries, thereby causing blockages. The blockages prevent adequate flow of blood to the heart.\(^{32}\) When this occurs, the heart does not receive the appropriate amount of oxygen or the nutrients necessary for proper function.\(^{33}\) In many instances, the disorder will not produce immediate symptoms.

Most patients who have coronary heart disease will experience symptoms and complications during times of increased stress and exertion, when the oxygen supply to the heart is further reduced.\(^{34}\) In some instances, the patient may develop a blood clot that will block the blood supply to the heart, thereby resulting in a myocardial infarction.\(^{32}\) In other instances, the blood clot will block a vessel to the brain, which can cause an ischemic stroke. In some situations, the clot in the brain may burst, which will cause a hemorrhagic stroke.\(^{34}\)

**Congestive Heart Failure**

Congestive heart failure occurs when the pumping power of the heart has been reduced and the blood moves through the circulatory system at a slower rate. When this occurs, the amount of pressure in the heart increases and the heart is unable to pump an appropriate amount of oxygen and nutrients to adequately meet the needs of the body.\(^{35}\)

In some instances, the chambers of the heart will become stiff and thickened, or they may stretch to hold more blood. In either instance, the muscle walls will eventually weaken and will not be able to pump efficiently.\(^{36}\) In response, the kidneys will send a signal for the body to retain
fluid and salt in different regions of the body, such as the arms, legs, lungs and other organs.\textsuperscript{37}

**Pulmonary Disease**

**Respiratory Diseases**

Respiratory disease is a term that is used to describe a number of different conditions that affect the organs and tissues involved in respiration, which include: \textsuperscript{38}

- Upper respiratory tract
- Trachea
- Bronchi
- Bronchioles
- Alveoli
- Pleura
- Pleural cavity
- Nerves and muscles involved in respiration

Respiratory diseases can be mild, moderate or severe and include conditions such as colds and viruses, as well as bacterial pneumonia and lung cancer.\textsuperscript{39}

The following is a list of the most common respiratory diseases: \textsuperscript{38}

- Inflammatory lung disease
- Obstructive lung diseases
- Chronic obstructive pulmonary disease (COPD)
- Restrictive lung diseases
- Respiratory tract infections
- Upper respiratory tract infection
- Lower respiratory tract infection
- Malignant tumors
The major histological types of respiratory system cancer are:
- Small cell lung cancer
- Non-small cell lung cancer
- Adenocarcinoma of the lung
- Squamous cell carcinoma of the lung
- Large cell lung carcinoma
- Other lung cancers (carcinoid, Kaposi’s sarcoma, melanoma)
- Lymphoma
- Head and neck cancer
- Pleural Mesothelioma, almost always caused by exposure to asbestos dust
- Benign tumors

- Pulmonary hematoma
- Congenital malformations such as pulmonary sequestration and congenital cystic adenomatoid malformation (CCAM).
- Pleural cavity diseases
- Pulmonary vascular disease
- Neonatal diseases

**Bronchial Disorders and Diseases**

Bronchial disorders occur when the airways become inflamed or damaged. There are a number of different bronchial disorders, ranging in severity from mild to severe.

Bronchitis is the most common bronchial disorder. It occurs when the tubes become inflamed and can be acute or chronic. In addition to bronchitis, the following conditions are also included in the category of bronchial disorders and diseases.
• Bronchiectasis:
  A condition in which damage to the airways causes them to widen and become flabby and scarred

• Exercise-induced bronchospasm:
  Occurs when the airways shrink while an individual is exercising

• Bronchiolitis:
  An inflammation of the small airways that branch off from the bronchi

• Bronchopulmonary dysplasia:
  A condition that affects infants

**Restrictive Pulmonary Diseases**

Restrictive pulmonary diseases are characterized by a reduction in the total lung capacity. They occur as the result of a number of conditions, such as:

- Alteration in lung parenchyma
- Disease of the pleura
- Disease of the chest wall
- Disease of the neuromuscular apparatus

**Gastrointestinal Disease**

**Hepatic Disorders**

Hepatic disorders are any disease that affects the liver. There are a number of hepatic disorders that can range in severity and duration. However, while there are a number of diseases that affect the liver, it is typically less prone to diseases than other organs due to the nature of the organ. It is able to regenerate itself through the repair and replacement of injured tissue. In addition, the liver is comprised of a number of cell units that all perform the same duties. If one part of the liver suffers damage, the remaining cells will maintain the functions of the injured area. These defense mechanisms limit
the number and type of disorders that can affect the liver.\textsuperscript{44} The most common liver disorders include:\textsuperscript{44}

- Hepatitis
- Cirrhosis
- Liver tumors
- Liver abscess

**Gallbladder Disorders**

There are a number of different gallbladder disorders that can develop, ranging in severity from mild to severe. Depending on the cause of the disorder, the patient may need extensive treatment. The following is a list of the most common gallbladder disorders:\textsuperscript{45}

- Gallstones (cholelithiasis)
- Cholecystitis
- Gallbladder cancer
- Gallstone pancreatitis

**Gastric Disorders**

Gastric disorders are defined as any disease or disorder that occurs in the stomach. Many of the disorders affecting the stomach are mild to moderate and can be treated without long-term ramifications. However, there are some gastric disorders that cause long term complications, even when treated. Gastric disorders can be caused by a variety of factors, including exposure to bacteria, perforation, inflammation, poor motility, and cancerous cell growth.

The specific needs of the patient will depend on the type of disorder he or she has.\textsuperscript{46} The following is a list of the most common gastric disorders:\textsuperscript{47}
Intestinal Disorders

Intestinal disorders are defined as any conditions that affect the large intestine, small intestine or bowels. These conditions are typically caused by infections, autoimmune disorders, and physiological states. Intestinal disorders can be either acute or chronic, and will range in severity from mild to severe. Most intestinal disorders will cause changes in stool (constipation or diarrhea, and/or the presence of blood), vomiting, and abdominal discomfort. In acute disorders, the cause is often impaction or obstruction, or an infectious agent. These conditions can be treated and often resolve quickly.

Chronic disorders are typically caused by malabsorption, autoimmune conditions, structural changes in the intestines, or lifestyle choices. Most chronic disorders can be treated and minimized, but they will not be resolved. The following is a list of the most common intestinal disorders:

- Angiodysplasia of the colon
- Appendicitis
- Bowel twist
- Chronic functional abdominal pain
- Celiac disease
- Colitis
- Colorectal cancer
- Constipation
- Crohn's disease
- Diarrhea
- Diverticular disease
- Enteroviruses
- Gastroenteritis
- Hirschsprung's disease (aganglionosis)
- Ileitis (inflammation of the ileum)
- Ileus (blockage of the intestines)
- Intussusception
- Irritable bowel syndrome (IBS)
- Polyp
- Pseudomembranous colitis
- Ulcerative colitis and toxic megacolon

**Reproductive System Disease**

**Male Reproductive System Disorders**

The male reproductive system is a complex system, which makes it prone to a variety of disorders. The male reproductive system is comprised of the following organs:\(^{53}\)

- Testicles
- Epididymis
- Vas deferens
- Seminal vesicles
- Prostate gland
- Urethra
- Penis
There are a number of conditions that affect the organs that comprise the male reproductive system. They can range in severity from mild to severe, and some will impact a patient’s fertility. These conditions will produce a range of symptoms, depending on the area affected. Typically symptoms range from mild to severe pain, difficulty urinating, impotence, discharge, and swelling. The most common male reproductive disorders include:

- Tumors
- Lack of testicular descent
- Hydrocele
- Infection and inflammation of the epididymis
- Varicocele
- Inflammation and development of small calculi
- Benign overgrowth of prostrate gland
- Prostrate cancer
- Inflammation of the urethra
- Inflammation (balanitis) or narrowing (phimosis) of the foreskin
- Growths and ulcers
- Sexually transmitted infections
- Disorders of erectile capability

**Female Reproductive System Disorders**

The female reproductive system is also quite complex and prone to a number of disorders. The female reproductive system is comprised of the following components:

- Ovaries
- Fallopian tubes
- Uterus
- Cervix
- Vagina
• Vulva

There are a number of conditions that affect the organs that comprise the female reproductive system. They can range in severity from mild to severe, and some will impact the patient’s fertility. These conditions will produce a range of symptoms, depending on the area affected. Typically symptoms range from mild to severe pain, difficulty urinating, discharge, delayed or discontinued menstruation, abnormal menstruation, infertility and swelling.\textsuperscript{55}

The most common female reproductive disorders include:\textsuperscript{56}

• Failure of the ovaries to form normally
• Destruction of the ovaries
• Neoplastic enlargement of the ovary
• Ovarian tumors
• Endometriosis
• Inflammation of the fallopian tubes
• Ectopic pregnancy
• Benign tumors of the myometrium (fibroids)
• Hormonal abnormalities
• Infection of the endocervical glands with gonococcus or chlamydia trachomatis agent
• Cervical cancer
• Developmental abnormalities of the vagina
• Inflammation of the lining of the vagina
• Atrophy or shrinkage of the vagina and mucosa secondary to estrogen deprivation
• Weakened vaginal support
• Vaginismus
• Infection of the female external genitalia
Pregnancy disorders can affect both the pregnant woman and the fetus, or they can affect one or the other. In some instances, the condition will primarily affect the mother, but will pose a risk to the fetus if untreated, and vice versa. The following is a list of the most common pregnancy and prenatal disorders:

Maternal Problems

- Hyperemesis gravidarum
- Diabetes Mellitus, Type I
- Gestational Diabetes
- Thyroid Disease
- Hyperparathyroidism
- Pelvic girdle pain (PGP)
- Severe hypertensive states:
  - Preeclampsia = gestational hypertension, proteinuria (>300 mg), and edema. Severe preeclampsia involves a blood pressure over 160/110 (with additional signs)
  - Eclampsia = seizures in a preeclamptic patient
  - HELLP syndrome = Hemolytic anemia, Elevated liver enzymes and low platelet count
  - Acute fatty liver of pregnancy is sometimes included in the preeclamptic spectrum.
- Deep vein thrombosis
- Anemia
- Pituitary Adenomas

Fetal Problems

- Ectopic pregnancy (implantation of the embryo outside the uterus)
- Placental abruption (separation of the placenta from the uterus)
- Monochorionic Multiples
- Twin-to-twin transfusion syndrome
- Monoamniotic multiples
- Umbilical cord compression
- Prenatal infection

**Urinary And Renal System Disease**

Urinary and renal system disease affects a number of individuals and range in severity from minor infections to complete kidney failure. The most common forms of urinary and renal disease include:61,62

- Kidney stones
- Urinary incontinence
- Benign hyperplasia
- Interstitial cystitis
- Urinary tract infection
- Polycystic kidney disease
- End-stage renal disease

**Infections**

The most common form of urinary and renal disorders is infections. These infections can affect any part of the urinary or renal system and can range in severity from mild to severe.

*Urinary Tract Infections*

Most urinary tract infections are caused by Escherichia coli (E. coli) bacteria, which normally live in the colon. Women are more prone to urinary tract
infections than men. The following is a list of the most common forms of urinary tract infection:

- Urethritis
- Cystitis
- Pyelonephritis

**Kidney Infections**

Kidney infections can be caused by a variety of conditions and bacteria, and will range in severity from mild to severe. There are three classifications for kidney infections:

- Uncomplicated
- Complicated
- Chronic

Of the three classifications, complicated kidney infection is the most severe and typically involves abscess formation, enlarged kidney, or gas in the kidney. A chronic infection is less severe than other forms of kidney infection, but it typically lasts longer than other infections, and is often recurring.

Bacteria cause kidney infections. The most common forms of bacteria associated with kidney infections include:

- Escherichia coli (E. coli) (accounts for 80% of infections)
- Klebsiella
- Proteus
- Pseudomonas
- Enterococcus
- Staphylococcus saprophyticus
Cysts and Tumors

Cysts and tumors can form in many areas of the urinary and renal system. Cysts are quite common and can cause complications depending on their location and size. In some instances, a cyst may resolve by itself. However, many patients will require surgery to remove a cyst or cysts. Tumors can be benign or malignant and typically require treatment. Tumors will not resolve on their own.

The causes of cysts and tumors vary depending on the area affected and the type of cyst or tumor that has developed. In some instances, the patient will only develop one cyst or tumor. However, some patients will develop multiple cysts or tumors in the same region or throughout the urinary and renal system.

Renal Failure

Renal failure is a severe complication that occurs as the result of extensive damage to the kidneys. The onset of renal failure may be sudden, or it can develop over time. Acute renal failure occurs suddenly, typically caused immediate damage to the kidneys through injury or infection. Chronic renal failure typically develops over a prolonged period and is often the result of long-term damage to the kidneys.

Patients with renal failure will display an elevated level of blood creatinine, which is excreted from the damaged muscle tissue. Patients will also experience passing of proteins and blood in the urine and abnormal fluid and electrolyte levels, abnormal blood acid levels, and abnormal mineral levels.
Musculoskeletal Disease

Arthritis
Arthritis is an inflammatory joint disorder that can affect one or more joints throughout the body. There are more than 100 forms of arthritis that affect individuals. These different forms of arthritis affect the body differently, and they range in severity from mild to severe. The most common forms of arthritis include:
- Osteoarthritis
- Rheumatoid arthritis
- Psoriatic arthritis
- Septic arthritis
- Autoimmune disorders

Arthritis causes pain in the joints, which is a result of the following factors:
- Inflammation that occurs around the joint
- Damage to the joint from disease
- Daily wear and tear of joint muscle strains caused by forceful movements against stiff painful joints
- Fatigue

Fractures
A fracture is an area of the bone that is broken. However, there are different types and severity levels of fractures. Depending on the cause and the impact, a patient may experience any level and type of fracture.

There are two categories of fractures: closed fractures and compound fractures. A closed fracture is one in which there is a clean break to the bone. With this type of fracture, there is no damage to the surrounding...
tissue and the bone does not tear through the skin.\textsuperscript{78} A compound fracture is more complex. With this type of fracture, the surrounding tissue and skin can be damaged, resulting in significant bruising. A compound fracture may also involve the bone tearing through the skin.\textsuperscript{79} Within these two categories of fractures, there are many different types. The areas they affect, the damage they inflict, and the cause of the fracture define these fracture types.

Types of Fractures:\textsuperscript{80}
- Avulsion fracture
- Comminuted fracture
- Compression (crush) fracture
- Fracture dislocation
- Greenstick fracture
- Hairline fracture
- Impacted fracture
- Longitudinal fracture
- Oblique fracture
- Pathological fracture
- Spiral fracture
- Stress fracture
- Torus (buckle) fracture
- Transverse fracture

\textbf{Atrophy and Dystrophy}

Spinal muscular atrophy is a disorder that affects the region of the nervous system that is responsible for controlling voluntary muscle movement. The disorder is genetic and cannot be repaired.\textsuperscript{81} While the disorder affects the nervous system, its primary impact is on the muscles. When the nerves are
unable to transmit the appropriate signals to the muscles, the muscles do not perform properly, which leads to shrinkage. This is directly caused by the loss of the nerve cells that transmit the information.\textsuperscript{82}

Spinal muscular atrophy is present at birth. However, many individuals will not display signs of the disorder until their later childhood or teenage years. The age of onset is directly correlated to the degree in which motor function will be impaired. Early onset atrophy has a greater impact on motor function, while late onset has a reduced impact.\textsuperscript{83}

Muscular dystrophy is a term used to describe approximately thirty different genetic diseases. While the diseases differ in terms of age of onset, whom they affect, and which muscles they affect, all of the diseases cause some level of muscle weakness and muscle loss.\textsuperscript{84} In addition, all forms of the disorder are degenerative, with the loss of the ability to walk as a common outcome. The major types of muscular dystrophy are:\textsuperscript{85}

- Becker
- Congenital
- Distal
- Duchenne
- Emery-Dreifuss
- Facioscapulohumeral
- Limb–girdle
- Myotonic
- Oculopharyngeal

**Abnormal Bone Formations**

Abnormal bone formations can occur throughout the body and are the result of a number of different factors, including:\textsuperscript{79}
• Genetic conditions (such as fibrodysplasia ossificans progressiva and progressive osseous heteroplasia)
• Surgical procedures (including total hip replacement and elbow fracture and forearm fracture surgery)
• Brain or spinal cord injury (traumatic brain injury and spinal cord injury)
• Sports injuries (myositis ossificans)
• Fractures

In some instances, the bone formations will occur in regions such as the muscles, ligaments, or other soft tissue. This type of abnormal bone formation is called heterotopic ossification, and it is common in the above situations.\textsuperscript{86} Other abnormal formations will occur in bony regions. The most common type of abnormal bone formation is the bone spur.\textsuperscript{87}

\textbf{Fluid, Electrolyte, And Acid/Base Imbalance Disorders}

\textbf{Fluid Imbalance}

The body is comprised of approximately 52% - 60% fluids (male to females, respectively).\textsuperscript{88} Therefore, an increase or reduction in body fluids can have a significant impact on an individual. Hypovolemia is a loss of fluid and hypervolemia is an overload of fluid.\textsuperscript{89} Fluid imbalance can be caused by any of the factors listed below due to fluid loss or gain.\textsuperscript{88}

\textbf{Fluid Loss:}

• Diarrhea
• Vomiting
• Sweating/fever
• Hemorrhage
• Diuretics
• Excessive urination

Fluid Gain:
• Congestive cardiac failure
• Renal failure
• High sodium intake
• Cirrhosis of the liver
• Over infusion of intravenous fluids

Electrolyte Imbalance
An electrolyte imbalance can be caused by a variety of factors and will range in severity. The most common forms of electrolyte imbalance occur due to an altered level of magnesium, sodium, potassium, or calcium. The most common causes of electrolyte imbalance include:
• Kidney disease
• Vomiting for prolonged periods
• Severe dehydration
• Heatwaves (a report found that the number of cases of electrolyte imbalances increases significantly during heatwaves)
• Acid/base (pH) imbalance (acid and alkaline balance in the body is disproportionate)
• Congestive heart failure
• Cancer treatment
• Some drugs, such as diuretics or ACE inhibitors.
• Bulimia (eating and purging meals, an eating disorder)
• Severe and persistent vomiting and nausea during pregnancy
Acid-Base Imbalance

An acid-base imbalance occurs when the normal levels of acids and bases deviate from the appropriate range. Acidosis is the excess of acid, while alkalosis is the excess of bases. Many different processes can cause an acid-base imbalance, and the level of abnormality will range in severity depending on the cause. Individuals can experience a simple acid-base disorder, or they may experience a mixed disorder.

Acid-base imbalance disorders are classified depending on the derangement that the patient experiences. The most common causes of acid gain and acid loss are listed below.

Sources of acid gain include:

- Retention of carbon dioxide
- Production of nonvolatile acids from the metabolism of proteins and other organic molecules
- Loss of bicarbonate in feces or urine
- Intake of acids or acid precursors

Sources of acid loss include:

- Use of hydrogen ions in the metabolism of various organic anions
- Loss of acid in the vomitus or urine
- Gastric aspiration in hospital
- Severe diarrhea
Summary

Pathophysiology is the study of disease function and processes. It enables healthcare professionals to understand diagnosis, treatment, and management options to achieve a best-case scenario for patients.

Recognizing disease and disorder manifestations will assist nurses and nurse practitioners with early diagnosis to improve patient outcomes. This course provided a brief overview of pathophysiology principles, including a cellular biology review, before delving in-depth into the pathophysiology of disease processes and disorders affecting the cardiovascular, circulatory, pulmonary, gastrointestinal, reproductive, urinary, renal, and musculoskeletal systems, in addition to fluid, electrolyte, and acid-base imbalance disorders.

Please take time to help NurseCe4Less.com course planners evaluate the nursing knowledge needs met by completing the self-assessment of Knowledge Questions after reading the article, and providing feedback in the online course evaluation.

Completing the study questions is optional and is NOT a course requirement.
1. **Which of the following is the name for the process by which the cell produces energy through the breakdown of complex molecules?**
   a. Catabolism  
   b. Replication  
   c. Synthesis  
   d. Anabolism  

2. **Which of the following is NOT one of the chemicals that DNA is comprised of?**
   a. Adenine  
   b. Thymine  
   c. Bromine  
   d. Cytosine  

3. **This branch of pathology is the study of chemical and biochemical mechanisms of the body in relation to disease.**
   a. Anatomical Pathology  
   b. Chemical Pathology  
   c. Biological Pathology  
   d. Immunology  

4. **Which of the following is NOT one of the classifications for kidney infections:**
   a. Complex  
   b. Uncomplicated  
   c. Complicated  
   d. Chronic
5. **The body is comprised of ________________ percent fluids.**
   a. 12 – 18
   b. 24 – 30
   c. 52 – 60
   d. 72 – 80

6. **Genetic disorders occur when an individual experiences a mutation in one or more genes**
   a. at conception
   b. associated with gender
   c. at some point during a lifetime
   d. *Answers a and c above

7. **The most common forms of electrolyte imbalance occur due to an altered level of the following EXCEPT:**
   a. Magnesium
   b. Sodium,
   c. Potassium
   d. *Phosphorus

8. True or False. HELLP syndrome is an acronym for Hemolytic anemia, Elevated Liver enzymes and Low Platelet count.
   a. *True
   b. False
9. Abnormal bone formation is called ____________________.
   a. trophic calcification
   b. *heterotopic ossification
   c. heterotropic calcification
   d. none of the above

10. ___________________ is the most common bronchial disorder.
    a. pneumonia
    b. asthma
    c. *bronchitis
    d. fluid congestion

11. A number of different cells in the body perform different functions. There are approximately _____ specialized cells within the body.
    a. *200
    b. 100
    c. 300
    d. 500

12. Most urinary tract infections are caused by ____________________.
    a. Pseudomonas
    b. *E. Coli
    c. Staph
    d. None of the above

13. Spinal muscular atrophy is a disorder that affects the region of the ____________________.
    a. *nervous system
    b. skeletal system
    c. spinal and muscular system
    d. skeletal and spinal system
14. Patients with renal failure will display an elevated level of blood creatinine, which is excreted from ____________
   a. the kidneys
   b. *damaged muscle tissue
   c. renal tubules
   d. answers a and c above

15. The mesenteric artery involves blood flow to the:
   a. *intestine
   b. kidneys
   c. lungs
   d. liver

16. Valve disorders are broken into categories that include
   a. stenosis (narrowing)
   b. prolapse (slipping out of place)
   c. regurgitation (backward flow)
   d. *all of the above

17. The most common form of urinary and renal disorders is ____________.
   a. calculi
   b. *infections
   c. genetic
   d. incontinence

18. True or False. A most common female reproductive disorder does NOT include hormonal abnormalities.
   a. True
   b. *False
19. The most common gastric disorders may include:
   a. Gastritis
   b. Gastric ulceration
   c. Gastric cancer
   d. *All of the above

20. Preeclampsia involves the following factors:
   a. gestational hypotension
   b. proteinuria (>300 mg)
   c. edema
   d. *answers b and c above

**CORRECT ANSWERS:**

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References Section

The reference section of in-text citations include published works intended as helpful material for further reading. Unpublished works and personal communications are not included in this section, although may appear within the study text.


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40. Bronchial Disorders. National Library of Medicine;


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