MEDICAL ASSISTANT

STUDY GUIDE

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CHAPTER I

THE MEDICAL ASSISTANT

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1. HISTORY OF MEDICINE TIMELINE

2600 BC	- Imhotep (Egyptian) describes the diagnosis and treatment of 200 diseases
500 BC	- Alcmaeon of Croton characterized the difference of veins from arteries
460 BC	- Hippocrates was born, also known as the “father of medicine” - starts the scientific study of medicine and prescribes aspirin like medicine
300 BC	- Diocles has written the first known anatomy book
280 BC	- Herophilus began the study of the nervous system
130 AD	- Galen was born, a Greek physician to roman emperors and gladiators
60 AD	- “De Materia Medica” was written by Pedanius Dioscorides (between 30 – 90 AD)
910	- Rhazes identifies smallpox
1010	- “The Book of Healing” and “The Canon of Medicine” are written by Avicenna
1249	- Spectacles are invented by Roger Bacon
1489	- Dissection of corpses by Leonardo DaVinci
1543	- Findings on human anatomy are published in “De Fabrica Corporis Humani” by Versalius
1590	- Invention of the microscope by Zacharius Jannssen
1628	- “An Anatomical Study of the Motion of the Heart and of the Blood in Animals” is published by William Harvey and is the basis for future research on blood vessels, arteries and the heart
1656	- Experiments with canine blood transfusions take place by Sir Christopher Wren
1670	- Discovery of blood cells by Anton van Leeuwenhoek
1683	- Observation of bacteria by Anton van Leeuwenhoek
1701	- First smallpox inoculations given by Giacomo Pylarini

1747 - "Treatise of the Scurvy" published by James Lind, stating that citrus fruits prevent scurvy

1763 - First successful appendectomy performed by Claudius Aymand

1796 - Process development of vaccination for smallpox by Edward Jenner

1800 - Discovery of the anesthetic properties of nitrous oxide by Sir Humphry Davy

1816 - Invention of the stethoscope by Rene Laennec

1818 - First successful transfusion of human blood performed by James Blundell

1842 - Ether is used as a general anesthetic by Crawford W. Long

1844 - Nitrous oxide is used as an anesthetic by Dr. Horace Wells

1846 - Dentist William Morton is the first to publish the process of using anesthetic properties of nitrous oxide

1847 - Discovery of how to prevent transmission of puerperal fever by Ignaz Semmelweis

1849 - First woman to gain a medical degree from Geneva Medical College in NY was Elizabeth Blackwell

1853 - Development of the syringe by Charles Gabriel Pravaz and Alexander Wood

1857 - Germs are identified as cause of disease by Louis Pasteur

1867 - Joseph Lister publishes "Antiseptic Principle of the Practice of Surgery" as he develops the use of antiseptic surgical methods

1870 - Louis Pasteur and Robert Koch establish the germ theory of disease

1879 - Development of the first cholera vaccine

1881 - Louis Pasteur develops the first anthrax vaccine

1882 - Louis Pasteur develops the first rabies vaccine
- Discovery of TB bacillus by Robert Koch

1887 - Development of the first contact lenses

1890 - Discovery of antitoxins & development of tetanus and diphtheria vaccines by E. von Behring

1895 - Discovery of X-rays by Wilhelm Conrad Roentgen

1896 - Development of the first vaccine for typhoid fever

1897 - Development of the first vaccine for Bubonic plague

1899 - Development of aspirin by Felix Hoffman

1901 - Introduction of the system to classify blood types by Karl Landsteiner

1913 - Dr. Paul Dudley White explores the use of the ECG (electrocardiograph)

1921 - Discovery that lack of vitamin D causes rickets by Edward Mellanby
- Invention of Band-Aid by Earle Dickson

1926 - Development of the first vaccine for whooping cough

1927 - Development of the first vaccine for tuberculosis

1928 - Discovery of penicillin by Sir Alexander Fleming

1935 - Development of the first vaccine for yellow fever

1937 - Development of the first vaccine for typhus

1943 - Discovery of the antibiotic streptomycin by Selman A. Waksman

1945 - Development of the first vaccine for influenza

1950 - Invention of the first cardiac pacemaker by John Hopps

1952 - Development of the first vaccine for polio by Jonas Salk

1953 - Francis Crick and James Watson work on structure of the DNA molecule

1954 - First kidney transplant performed by Dr. Joseph E. Murray

1963 - Invention of the balloon embolectomy catheter by Thomas Fogarty

1964 - Development of the first vaccine for measles

1967 - First human heart transplant performed by Dr. Christiaan Barnard
- Development of the first vaccine for mumps

1970 - Development of the first vaccine for rubella

1974	- Development of the first vaccine for chicken pox
1975	- Invention of CAT-Scans by Robert S. Ledley
1977	- Development of the first vaccine for pneumonia
1978	- Birth of the first test-tube baby - Development of the first vaccine for meningitis
1980	- Smallpox is eradicated
1981	- Development of the first vaccine for hepatitis B
1983	- Identification of HIV
1984	- First genetic fingerprinting method is devised by Alex Jeffreys
1985	- Invention of the artificial kidney dialysis machine by Willem J. Kolff
1992	- Development of the first vaccine for hepatitis A
1996	- First clone is Dolly the sheep
2006	- Development of a vaccine to target a cause of cancer

2. LAW AND ETHICS

Medical Assistant is the term for health care providers that perform medical as well as administrative tasks to support other health professionals, such as doctors.
The physician may decide on the amount of appropriate aid from the medical assistant, such as directly supervised incisions, aspiration of hypodermic fat, administering local anesthesia – all of which are not considered to be duties of medical assistants.

Routine tasks for the medical assistant may include taking a patients vital signs, recording information in the form of medical record keeping, administering medications, preparation of medical supplies, sterilization (destruction of all living micro-organisms by chemical disinfectants or boiling for 20 minutes as in dishes) of medical equipment or supplies (such as dishes from patients with communicable/ contagious diseases) as well as collection and preparation of fluids and tissue for testing

Administrative duties for the medical assistant may include greeting patients, medical record keeping, answering telephones, filing insurance forms, scheduling appointments and/or arranging admission for hospitals or laboratory and billing.

Medical assistants work under the direct supervision of a physician. They perform clinical duties which are authorized by the physician, although if the situation warrants it, the medical assistant is allowed to give emergency care in the absence of the physician. If patients have more serious conditions, such as stroke, heart attack, hemorrhage or shock, the medical assistant should call for an ambulance if no doctors or nurses are present.

Medical assistants may also instruct patients about medications, administer medications, call in prescriptions to pharmacies and/ or authorize medication refills. Some medications are dangerous or habit forming and require prescription in order for a patient to obtain these medications.

The medical assistant should have basic knowledge of the laws and ethics as they apply to the medical field.

As medical assistants work with the public, they should always follow good manner by being neat and well groomed as well as following a good taste in wardrobe, when not wearing a uniform, as this can have a positive psychological effect on the patient.

A medical assistant must be able to put patients at ease and explain medical instructions and/ or procedures – although when interacting with patients, a medical assistant should not discuss a patient's complaint with them as well as giving a prognosis (prognosis is the opinion to the probable cause and outcome of a disease), as patients tend to take the medical assistants advice/ opinion as those of the physician.

Being neat also applies to the administrative field, as well as being organized, especially if the administrative working place is in view for patients and free of clutter.

3. PATIENT CARE

Patient care is very important for the medical assistant. Interacting with patients, making them feel at ease and comfortable, taking vital signs or administering medications as well as explaining medical procedures are all part of patient care.
Workplace and patient surroundings should always be sanitized as bacteria flourishes in hot and damp areas and can cause health problems.

Communication with patients is a large portion of a medical assistant's job, as the medical assistant will listen to patients concerns, answering questions, and instruct medical procedures or medications.
The medical assistant should always be friendly, well-spoken and well-mannered.

When working in a medical office setting, the medical assistant should always try to make patients feel comfortable.
Any procedures performed, such as taking vital signs, administration of medication or others, should be well explained to the patient.

When working in clinical settings, the medical assistant should as well always explain any procedures and be able to listen to any concerns a patient might have.

CARING FOR BEDRIDDEN / BED STRICKEN PATIENTS

In clinical settings where the patients are required to stay in bed (bedridden or bed stricken), the medical assistant can make patients feel more comfortable by doing a variety of things, depending on the discomfort, including:

General:

- Support should be provided for back and joints, in order to prevent strain
- Arms and legs should be in a comfortable position and if needed, supported
- During bed changes, communication with the patient is important to gain cooperation.
- Movement should be guided rather than lifting patients

Other considerations:

- offering pillows for support (such as when patient is uncomfortable lying on the side)
- bed cradle (to keep weight of upper beds off patients)
- air-rings under buttocks (if signs of pressure sore at the base of the spine show)

4. MEDICATION ADMINISTRATION

Administering medication involves providing patients with medications prescribed and intended for diagnosis, treatment or prevention of medical conditions.
Laws regarding the administration of medication can vary from state to state. Generally, physicians, doctors, nurse practitioners, nurses and physician assistants are trained and authorized to administer medications.
Certain medications are restricted by state and federal laws in their distribution and the access to them as they are controlled substances and can be abused. Responsible measures should be taken with these controlled substances, such as accountability for discarded substances, counting of medical supply at regular intervals as well as locked storage for these substances.

Prescriptions:

- in order for patients to obtain certain medications (as they are habit forming), prescriptions are written
- prescriptions should contain the patients name, date and time it was written as well as the signature of the physician or doctor ordering the prescription

TOPICAL ADMINISTRATION

- onto the skin (epicutaneous)
- inhalational
- onto the conjunctiva (eye drops)
- ear drops
- through mucous membranes in the body

ENTERAL ADMINISTRATION

- by swallowing (oral route)
- through the inner cheek or gum (buccal route)
- under the tongue (sublingual route)
- through feeding tube
- through the anus

PARENTERAL ADMINISTRATION

- into veins (intravenous)
- into arteries (intra-arterial)
- into bone marrow (intraosseous infusion)
- into muscles (intra-muscular)
- into the skin (intradermal)

Administering medication by injection beneath the skin, it is called subcutaneously administration.

COMMON TYPES OF MEDICATION

Analgesics:
- medications used to alleviate pain
- Two main types: non-narcotic for mild pain, narcotic analgesics for severe pain
- Common medications: Codeine, Vicodin, Hydrocodone, Oxycontin, Naproxen, Darvon, Aspirin, Tylenol, Morphine, Cocaine and Methadone

Antianxiety Drugs:
- medications to suppress anxiety and relax muscles
- Common medications: Zoloft, Lexapro and Effexor

Antiarrhythmics:
- medications to control irregular heartbeat
- Common medications: beta blockers (Acebutolol, Betaxolol, Esmolol, Nadolol), Sodium channel blockers (Disopyramide, Mexiletene, Flecainide, Propafenone), Potassium channel blockers (Amiodarone, Bepridil, Ibutilide, Tedisamil) and Calcium channel blockers (Diltiazim, Verapamil)

Antibiotics :
- medications used to infection caused by bacteria, such as Diphtheria
- Antibiotics stop the infection producing organisms
- Certain medications need to be refrigerated, such as Amoxicillin or Aureomycin
- Common medications: Penicillins, Cephalosporins, Macrolides, Sulfonamides

Antidepressants:
- medications used to treat depression
- Three main groups of antidepressants: tricyclic antidepressants, benzodiazepines And serotonin boosting medications
- Tricyclic antidepressants: Elavil, Flexeril, Pamelor, Sinequan, Desyrel
- Benzodiazepines: Xanax and Klonopin
- Serotonin boosting drugs: Prozac, Paxil, Effexor, Serzone, Zoloft

Antifungals:
- medications used to treat infections caused by fungus, such as Ringworm
- divided into systemic (taken by mouth or injection) and topical (applied to skin)
- Systemic drugs: Nizoral, Diflucan, Sporanex, Monistat
- Topical drugs: Ciclopirox, Econazole, Nystatin, Terconazole

Antihistamines:
- medications used to treat effects of allergic reactions
- common medications: Benadryl, Atarax, Hismanal, Chlortripalon, Claritin

Antihypertensive:
- medications used to lower blood pressure
- common medications: Diuretics, Beta Blockers, ACE inhibitors

Anti-Inflammatories:
- medications used to reduce inflammation
- divided into steroids and non-steroidal anti-inflammatory drugs (NSAIDs)
- Steroids (referred to as corticosteroids) reduce inflammation or swelling
- NSAIDs alleviate pain by counteracting the COX enzyme
- common steroids: Corticosterone, Cortisone, Aldosterone
- common NSAIDs: Aspirin, Ibuprofen, Naproxen, Celebrex

Antipsychotics:	- medications used to treat psychiatric disorders - common medications: Butyrophenones, Phenothiazines, Thioxanthenes
Antivirals:	- medications used to treat viral infections - most of antiviral nowadays are used to treat HIV - common medications: Atripla, Darunavir, Nevirapine, Truvada
Beta-Blockers:	- medications used to reduce oxygen needs of the heart - common medications: Betaxolol, Esmolol, Carteolol, Penbutolol, Labetalol
Cold Remedies:	- medications to treat common colds - common medications: aspirin, acetaminophen, decongestants
Cough Suppressants:	- medications used to relieve cough - medications may contain honey, menthol and soothe throat irritation
Decongestants:	- medications used to reduce swelling of the mucous membranes - commonly used to relief nasal stuffiness
Diuretics:	- medications used to increase quantity of urine produced by the kidneys - common medications: Aldactazide, Dyazide, Maxzide, Moduretic
Hormones:	- medications used to restore hormone deficiency, as in diabetes mellitus, where too little of a certain hormone is produced, medication restores this deficiency
Hypoglycemic:	- medications used to lower the level of glucose in blood - common medications: Thiazolidinedione, Iguanid, Sulfonylurea
Immunosuppressives:	- medications used to treat autoimmune diseases - common medications: Methotrexate,, Azathioprine, Alkylating Agents
Laxatives:	- medications used to increase frequency and ease bowel movements - common medications: Enulose, Cilium, Konsyl, Colace, Colyte
Sleeping Aids:	- medications used to help with sleeping disorders - common medications: Benzodiazepines, Barbiturates, Ambien

<u>ANESTHETICS</u>

- these medications cause the reversible loss of sensation, also called anesthesia
- categorized into local and general anesthetics
- local anesthetics include: Procaine, Amethocaine, Prilocaine, Ropivacaine, Novocaine, Dibucaine, Mepivacaine, Bupivacaine, Trimecaine, Propoxycaine, Chloroprocaine, Cocaine
- general anesthetics include: inhaled (Enflurane, Halothane, Sevoflurane, Isoflurane), and intravenous (Barbiturates, Etomidate, Ketamine, Benzodiazepines, Propofol)

<u>5. ADMINISTRATIVE DUTIES</u>

The duties of the medical assistant can be different depending on the workplace, but common administrative duties may include:

- includes the keeping, filing and updating of medical records of patients (such as vital statistics that include data relating to births, deaths and marriages)
- when obtaining medical record information, patients should be discouraged to give irrelevant (inappropriate) information
- record medical history of patients as well as test result in individual record sheets
- record bills for insurance purposes
- complete medical insurance forms
- scheduling appointments for patients (appointments should be scheduled after patient needs)
- contact other medical departments such as laboratory to schedule tests
- common office functions like filing and answering phones

<u>Methods of filing:</u>

- by subject (filed primarily by main subject)
- by numbers (numerical order)
- by letters (alphabetical order)
- by date (chronological order)
- by places (geographical order)

<u>Medical Insurance – Managed Care Systems:</u>

HMO
- patients pay fixed amount, periodic fee, for medical care from providers belonging to HMO
- offer more cost advantages when compared with traditional payment plans
- tend to offer more coverage like medical screenings and routine physical check-ups
- generally offer lower hospitalization rates

PPO
- contractual arrangements which provide services at discount to volume group of patients
- PPO providers work on a fee-for-service basis, similar to traditional payment plans
- allow the use of primary care providers outside the network (HMO does not)

CHAPTER II

VITAL SIGNS

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VITAL SIGNS

Vital signs are measurements of different physiological statistics, often taken by health professionals, in order to determine basic body functions. Taking vital signs normally means the recording of body temperature, blood pressure, respiration and pulse.

Normal vital signs can change due to different factors such age, sex, weight, exercise, and even health conditions.

For the average healthy adult, normal vitals signs are:

- Temperature: 97.8 - 99.1°F
- Blood pressure: 120/80 mm/Hg
- Respiratory Rate: 16 - 20 respirations per minute
- Heart Rate (pulse): 60 - 100 beats per minute

In order to take and record vital signs, the following equipment is needed:

- thermometer (to measure temperature)
- sphygmomanometer (to measure blood pressure)
- stethoscope (in combination with a sphygmomanometer to measure blood pressure)
- watch (to measure pulse)

1. BODY TEMPERATURE

Body Temperature refers to the amount of heat produced and sustained by the body processes.
Changes in the body temperature are usually indicators of underlying problems such as disease or other abnormal conditions.
The metabolism of nutrients generates heat within the body. This heat is lost from the surface through convection, radiation and evaporation of perspiration.
The production and loss of heat are generated and controlled in the hypothalamus and the brainstem.

Fever is usually caused by an increase in heat generation; although certain conditions (e.g. congestive heart failure) can produce small increases of the body temperature through damage of the heat loss function.
Unusual low body temperatures can be caused by the interference with regulatory centers or problems of the hypothalamus.

The average adult temperature is around 98.6°F, taken orally. The temperature taken under the arm (axillary temperature) is usually 0.5°F to 1°F lower than temperature taken orally, whereas temperatures taken via the anus (rectal temperature) can be 0.5°F to 1°F higher than oral temperature.

VARIATIONS DUE TO METHODS OF MEASUREMENT

Temperature results may vary depending on the method of measurement that is used.

In general, oral, rectal, gut and core temperature are well correlated and oral temperature being the lowest.
Oral temperatures can be affected by smoking, intake of food (drinking and chewing) as well as breathing (if the mouth is open where air can reach into the mouth).

Temperatures taken under the arm, inside the ear and other skin based temperatures correspond very poor with the core body temperature. The temperature measured orally is higher than rectal and core body temperature and temperatures taken under the arm are lower.

The body uses skin as a mechanism to increase or decrease the core body temperature, which makes temperatures taken by skin-based methods more variable than others.

VARIATIONS DUE TO OUTSIDE FACTORS

Temperature can also be affected by various outside factors.

With the intake of food or drinks that are calorie rich, the temperature will increase. Diets that are calorie restricted will reduce the temperature. The consumption of alcohol will show a small decrease in temperatures during the day but increase temperatures during the night.

Physical activity can also increase body temperatures. In adults, a high increase usually requires difficult exercise or physical workout that is sustained over time; children however can reach higher temperatures with only minimum physical activities like playing.

The emotional or mental state of mind can also interfere with temperature. A person with a higher level of excitement may also have an increased temperature.

A person's sleep patterns can also affect body temperatures. In general, temperatures drop at night and throughout the night. Higher temperatures at night will occur if short-term sleep deprivation is present and lower temperatures will occur if long-term sleep deprivation is present.

Having poor sleep quality or even insomnia can lead to a decrease in temperature. Also affecting body temperature are shift work (changes to it), waking up at unusual times or even jet lag.

METHODS OF MEASUREMENT

Sites used for temperature measurement include:

- oral temperature (in the mouth)
- rectal temperature (in the anus)
- tympanic temperature (in the ear)
- axillary temperature (under the arm)
- vaginal temperature (in the vagina)
- on the skin of the forehead
- in the gut by swallowing a small thermometer
- over the temporal artery

Temperature readings will vary depending on which body part is measured, but typical temperatures (daytime) for healthy adults are:

- rectal, vaginal and tympanic temperature about 99.7°F
- oral temperature about 98.2
- axillary temperature about 97.6°F

MEASURING DEVICES

The device used to measure temperature is called a thermometer.
A thermometer consists of two important parts: the temperature sensor (e.g. bulb on mercury thermometers), where slight physical change in temperature occurs, as well as a way of converting this physical change into a number (e.g. scale on mercury thermometers).

There are different types of thermometers:

- *LIQUID FILLED* - Traditional thermometers consist of a glass tube with a bulb at the end that contains liquid which expands with temperature in an even manner. The glass tube is narrow and has markings on it called calibration markings. The liquid is usually mercury, however in alcohol thermometers a colored alcohol is used.

  In order to use a thermometer, the bulb must be placed into the area where the temperature will be measured and left there for about three minutes, for it to reach thermal equilibrium.

- *MERCURY* - Mercury-in-glass thermometers are considered the most accurate liquid-filled thermometers. Mercury however is a toxic metal. In order to minimise the amount of mercury in a thermometer the tube must be very narrow.

As the temperature of the tube is not controlled, the mercury in it must be much less than in the bulb to minimize the effect of temperature of the tube, which makes for a more difficult reading since the mercury column is hardly visible.

With colored liquid filled thermometers visibility does not cause that much of a problem.

Since glass thermometers are designed that the temperature will not decrease once removed from a patient, the reading will remain without change until the bulb comes in contact with something that has a higher temperature or with the thermometer being shaken down.

Shaken down is the method of pushing the mercury back into the bulb from the stem. Once the thermometer reads 95°F, it was shaken down enough and is available for use again.

- *ELECTRONIC* - Electronic Thermometers (also called digital thermometers) display numeric values. Most of them show readings with good accuracy of about 0.2°F, although it should not be taken as an accuracy guarantee and specified accuracy should be checked with documenting and maintaining of periodical recalibration.

- *CONTACT* - These electronic thermometers measure temperatures by contact, where the sensor is placed in the area where the temperatures is measured and left there until it reaches equilibrium. These thermometers usually reach equilibrium faster than mercury thermometers, and in general these contact thermometers beep once equilibrium is reached.

- *REMOTE* - There are other types of electronic thermometers which work through a remote sensing, a sensor (infrared) that will respond to the radiation spectrum that is emitted from the location where the temperature is measured.

These thermometers do not come in direct contact with the location to be measured but could touch parts of the body (e.g. measuring the temperature of the eardrum that is inserted into the ear canal). To avoid the risk of cross infection of patiens these thermometers have disposable covers.

- *BASAL THERMOMETER* – These are special glass basal thermometers which are very different from usual glass fever thermometers. Digital thermometers could be used for measuring basal body temperature as they have a sufficient resolution, but there specifications should be regarded and checked for accuracy and calibrated at certain intervals.

CONCEPTS OF TEMPERATURE

FEVER	A common medical sign characterized by an increase of temperature above the normal level due to an increase in the body temperature regulatory set point is a fever. Causes for most fevers are infectious diseases, although other causes that can lead to fever include medication, immunizations, heat exhaustion and even tumors. The treatment of fever depends on what is causing the fever. Over-the-counter medications such as ibuprofen or acetaminophen can be used. Adults can also take aspirin to medicate fevers.
CORE BODY TEMPERATURE	The core body temperature is the operating temperature of an organism in deep structures of the body (like the liver). Normally the core temperature is maintained with a narrow range for essential enzymatic reactions to occur. A significant core body temperature increase (hyperthermia) or a significant decrease in core body temperature (hypothermia) that is persistant for more than just a short amount of time is incompatible with human life.
BASAL BODY TEMPERATURE	The lowest temperature attained by the body (usually during sleep) is the basal body temperature. Generally it is measured right after waking up and before any physical activity takes place – although the temperature measured then may be higher than the actual basal body temperature.
HYPOTHERMIA	The condition in which the core temperature drops below required temperature level (defined as 95°F) for normal metabolism and body functions is hypothermia.Body temperature usually is maintained at a constant leven through a biologic thermoregulation – but if exposed to cold, and the internal mechanisms being unable to replenish the heat that is lost – a drop in body temperature will occur. The treatment for hypothermia varies from noninvasive, passive external warming to external rewarming to active core rewarming. In more severe cases resuscitation begins with accompanying removal from the cold environment and simultaneous management of the airway, breathing and circulation.
HYPERTHERMIA	The condition in which the core temperature increases due to failed thermoregulation is hyperthermia. It occurs when the body produces or absorbs more heat than it can consume. When the increased body temperature is high enough, it is considered a medical emergency and requires immediate treatment to prevent disability or death. Most common causes conflicting reactions to drugs or heat stroke, an acute condition of hyperthermia caused by extended exposure to exessive heat. The treatment for hyperthermia depends much on the underlying cause that needs to be corrected. Hyperthermia caused by exertion on hot days could be treated with self care measures like resting in cooler places or drinking more water. Hyperthermia caused from drug exposure can be treated by ending the use of the causing drug or by drugs to counteract them. Fever-reducing drugs such as paracetamol and aspirin have no value in treating hyperthermia. When the body temperature reaches about 104°F, or if the affected person is unconscious or showing signs of confusion, it is considered a medical emergency that requires treatment in a proper medical facility.

2. BLOOD PRESSURE

Blood Pressure (BP) is the pressure exerted by circulating blood upon the walls of bloods vessels.

Without further specification, “blood pressure” usually refers to the arterial pressure of the systemic circulation. During each heartbeat, blood pressure varies between a systolic (maximum) and a diastolic (minimum) pressure.

Blood pressure, due to pumping by the heart and resistance to flow in blood vessels, decreases as the circulating blood moves away from the heart through arteries.

Blood pressure drops most rapidly along the small arteries and arterioles, and continually decreases as blood moves through the capillaries and back through the veins to the heart.
Valves in veins, gravity and pumping from contracting of skeletal muscles, can also influence blood pressure at different places in the body.

Blood pressure measurement without specification usually refers to the systemic arterial pressure that is measured on the inside of an elbow (at the brachial artery) at a person's upper arm.
The measurement is usually expressed as the systolic pressure over the diastolic pressure, for example 120/80 mmHg.

DEFINITION SYSTOLIC AND DIASTOLIC

Systolic: This is the blood pressure at the time when the heart is contracting, specifially the maximum arterial pressure during contraction of the left ventricle of the heart.
This time, at which ventricular contraction takes place, is called systole.

A systolic sound is a heart sound that is heard during systole, the time the heart contracts, between the normal first and second heart sound.

Diastolic: This is the blood pressure at the time when the heart is in a relaxation and dilatation (expansion) period, specifically the minimum arterial pressure during relaxation and dilatation of the ventricles of the heart when the ventricles fill with blood.

A diastolic sound is a heart sound that is heard during diastole, the time the heart relaxes.

LOW BLOOD PRESSURE

The medical term for low blood pressure is called hypotension, and is a blood pressure low enough that the blood flow to organs is insufficient and symptoms of low blood pressure can occur.

Symptoms or signs of low blood pressure can include dizziness, being lightheaded or even fainting. Such symptoms mostly occur when the person goes from a sitting or lying position to a standing position and is called orthostatic hypotension.
If the blood pressure is low enough to cause an insufficient blood flow to organs it can result in strokes, heart attacks and kidney failure, with the most severe form being shock.

To determine the cause of low blood pressure, blood test, cardiac testing for arrhythmias or radiologic studies can be taken.

The treatment of low blood pressure can be determined by its cause.

Causes for low blood pressure include:

Pregnancy:	During pregnancy, a woman's circulatory system expands very fast which can cause blood pressure to drop rapidly. After giving birth, blood pressure levels usually return to a normal level (pre-pregnancy).
Heart Problems:	Some heart problems can cause low blood pressure as they might prevent the body from circulating enough blood. These heart conditions include heart valve problems, bradycardia (extremely low heart rate), heart attack or even heart failure.
Dehydration:	Dehydration causes the body to lose more water than it is taking in. Mild dehydration may cause dizziness, feeling weak or even fatigue. Vomiting, severe diarrhea, fever, overuse of diuretics and/ or exhausting physical activity can all lead to dehydration.
Loss of Blood:	High blood loss caused by a major injury or even internal bleeding will reduce the amount of blood in the body, which will lead to a drastic drop in blood pressure.
Endocrine Problems:	Hypothyroidism (underactive thyroid) or hyperthyroidism (overactive thyroid) can cause low blood pressure. Additionally, other conditions, such as adrenal insufficiency (Addison's disease), low blood sugar (hypoglycemia) and, in some cases, diabetes, can trigger blood pressure to drop.

Severe Infection: Septicemia can happen when an infection in the body enters the bloodstream. Conditions of septicemia can lead to a life-threatening drop in blood pressure (septic shock).

Severe allergic reaction: Anaphylaxis is a severe and potentially life-threatening allergic reaction. Triggers of anaphylaxis include foods, certain medications, insect venoms and latex.
This condition can cause itching, hives, breathing problems, a swollen throat and a drop in blood pressure.

Lack of nutrients: Insufficiency of vitamins B-12 and folate can cause anemia.
Anemia is a condition in which your body doesn't produce enough red blood cells, causing low blood pressure.

Some medications can also cause low blood pressure. These medications include:

- Alpha Blockers
- Beta Blockers
- Diuretics
- Certain Antidepressants (tricyclic antidepressants)
- Drugs for Parkinson's Disease
- Sildenafil (Viagra), particularly in combination with the heart medication nitroglycerine

TYPES OF LOW BLOOD PRESSURE

Low blood pressure is often broken down into different categories, depending on the cause as well as other factors.
Types of low blood pressure include:

Postural/ Orthostatic Hypotension: Sudden drop in blood pressure when standing up from a sitting or lying position, leading to symptoms of dizziness, feeling lightheaded, blurred vision and even fainting.
It can occur for a variety of reasons, including pregnancy, dehydration, prolonged bed rest, diabetes, heart problems, burns, excessive heat, large varicose veins and certain types of neurological disorders.
Medications that can cause this type of low blood pressure include certain antidepressants, drugs to treat high blood pressure, medications for erectile dysfunction and/ or medications for Parkinson's disease.

Postprandial Hypotension:	Sudden drop in blood pressure after eating. Most likely to affect people with high blood pressure or people suffering autonomic nervous system disorders. To help reduce the symptoms a person could eat smaller portions, low carbohydrate meals or lower the dose of blood pressure medications.
Neurally Mediated Hypotension:	This form of hypotension mostly affects young people. The cause seems to be a miscommunication between heart and brain and can decrease blood pressure after standing for longer periods, with leading symptoms like nausea, dizziness and fainting.
Shy-Drager Syndrome:	(multiple system atrophy with orthostatic hypotension) This rare disorder causes progressive damage to the autonomic nervous system, which controls involuntary functions such as blood pressure, heart rate, breathing and digestion. Although this condition can be associated with muscle tremors, slowed movement, problems with coordination and speech, and incontinence, its main characteristic is severe orthostatic hypotension in combination with very high blood pressure when lying down.

<u>RISK FACTORS</u>

Hypotension can occur in anyone, though certain types of low blood pressure are more common depending on your age or other factors:

Age:	Low blood pressure on standing after eating. This type of hypotension mostly occurs in adults older than 65.
Medications:	Certain medications like high blood pressure medications (alpha blockers), have a greater risk of low blood pressure.
Certain diseases:	Diabetes, some heart conditions as well as Parkinson's disease can put a person at greater risk of developing hypotension.

TREATMENT AND DRUGS

Treatment is not required if signs and symptoms are only mild.
If low blood pressure causes symptoms, the treatment much depends on the underlying cause and this primary cause should be addressed rather than treating the low blood pressure itself.

If low blood pressure is caused by medications, treatment options would be to change the dose of medication or stopping the medication completely.

There are several medications that used alone or together, can be taken to treat orthostatic hypotension (low blood pressure when standing up). As an example, the drug fludrocortisone is commonly used to treat this type of low blood pressure as it helps to boost blood volume and therefore raises blood pressure.

The drug midodrine (Orvaten, Proamatine) is often used to raise standing blood pressure levels in people with chronic orthostatic hypotension as it works by restricting the ability of blood vessels to expand and therefore raises blood pressure.

HIGH BLOOD PRESSURE

High blood pressure (hypertension) is a medical condition where the force of blood against artery walls is high enough that it can cause health problems such as heart disease.

It typically develops over the course of many years and eventually affects nearly everyone.
However high blood pressure can easily be detected.
Leaving high blood pressure uncontrolled increases the risk of severe health problems such as heart attack and even stroke.

In most people with high blood pressure signs or symptoms are not present.
Nevertheless a few people with early stage high blood pressure can experience headaches, dizziness or even nosebleeds. These symptoms usually don't occur until hypertension has reached a severe or life threatening stage.

TYPES OF HIGH BLOOD PRESSURE

High blood pressure is put into two types:

Primary (essential) hypertension:	There is no identifiable cause of hypertension. This form of high blood pressure usually develops slowly over the course of many years.
Secondary hypertension:	Hypertension is caused by an underlying condition. This form of high blood pressure usually appears suddenly and causes a higher blood pressure than the primary hypertension.

Various conditions and medications can lead to secondary hypertension, including:

- kidney problems
- adrenal gland tumors
- defects in blood vessels born with (congenital)
- medications (birth control pills, cold remedies, decongestants, over-the-counter pain relievers and some prescription drugs)
- illegal drugs (cocaine, amphetamines)

RISK FACTORS

High blood pressure (hypertension) can have many risk factors, including:

Age:	With age the risk of high blood pressure increases. It is more common in men through early middle age. Women tend to develop hypertension after menopause.
Race:	High blood pressure is common among blacks, often developing at an earlier age in comparison to whites. Complications (stroke, heart attack) are as well more common in blacks.
Family History:	High blood pressure tends to run in families.

Physically inactive:	People that are physically inactive or not active enough tend to have higher heart rates. As the heart rate increases, the heart has to work harder with each contraction and the force on the arteries is stronger. The lack of physical activity also increases the risk of being overweight and obesity.
Overweight or obesity:	Weight plays an important role in blood pressure. The more a person weighs, more blood is need for oxygen supply and nutrients to the tissue. As the amount of blood increases that is being circulated through blood vessels, the pressure on the artery walls increases as well.
Using tobacco:	Not only does smoking or chewing tobacco immediately raise blood pressure temporarily, but the chemicals in tobacco can damage the lining on artery walls. This can cause arteries to narrow, increasing blood pressure. Secondhand smoke can also increase blood pressure.
Alcohol (too much):	Drinking too much can damage the heart over time. Consumption of more than two or three drinks in a sitting may also increase blood pressure temporarily – as it can cause the body to release hormones that raise blood flow and heart rate.
Sodium:	Too much salt in a diet can cause the body to retain fluid, which increases blood pressure.
Potassium (too little):	Potassium helps balance the amount of sodium in cells. If there is not enough sodium in a diet too much sodium can accumulate in blood.
Stress:	High levels of stress can lead to a temporary yet dramatic increase in blood pressure. If trying to relax by eating more, drinking alcohol or using tobacco, the problems with high blood pressure may only increase.
Chronic conditions:	Certain chronic conditions can also increase risk of high blood pressure, including high cholesterol, diabetes, kidney disease and sleep apnea.
Pregnancy:	Sometimes pregnancy contributes to high blood pressure.

Even though high blood pressure (hypertension) is more common in adults, children can be at risk for hypertension too, as it could be caused by kidney or heart problems.
However poor lifestyle habits like unhealthy diets or not enough exercise can also lead to hypertension.

TREATMENT AND DRUGS

The goals for the treatment of high blood pressure depend on the overall health of a person.

Changing the personal lifestyle can help toward controlling high blood pressure.
If changes in lifestyle aren't efficient enough, medications are available to lower blood pressure.

Which medication is needed depends on the stage of high blood pressure and whether there are other medical problems.

Medications used to treat high blood pressure:

THIAZIDE DIURETICS	Diuretics, also called “water pills”, act on kidneys to help the body eliminate sodium and water and reduce blood volume. Diuretics are often the first, but not the only, choice in high blood pressure medication.
BETA BLOCKERS	Reduce the workload on the heart and open blood vessels, which cause the heart to beat slower and with less force. When prescribed alone, beta blockers don't work as well in blacks or in the elderly, but when combined with a thiazide diuretic they show effectiveness.
ACE INHIBITORS (Angiotensin-Converting Enzyme Inhibitors)	Help relax blood vessels as they are blocking the formation of a natural chemical that narrows blood vessels.
ANGIOTENSIN II RECEPTOR BLOCKERS	Help relax blood vessels as they are blocking the action, not the formation, of a natural chemical that narrows blood vessels.
CALCIUM CHANNEL BLOCKERS	Help relax the muscles of blood vessels. Some can also slow the heart rate. These medications may work better for blacks and older adults than do ACE inhibitors or beta blockers alone.

RENIN INHIBITORS (Tekturna)	Slows down the production of renin, an enzyme produced by kidneys that starts a chain of chemical steps that increases blood pressure. Tekturna reduces the ability of renin to begin this process.
ALPHA BLOCKERS	Reduce nerve impulses to blood vessels and therefore reducing the effects of natural chemicals that narrow blood vessels.
ALPHA-BETA BLOCKERS	Reducing nerve impulses to blood vessels, additionally alpha-beta blockers slow the heartbeat to reduce the amount of blood that must be pumped through the vessels.
CENTRAL-ACTING AGENTS	Prevent the brain from signaling the nervous system to increase heart rate and narrow blood vessels.
VASODILATORS	Work directly on the muscles in the walls of the arteries, preventing the muscles from tightening and the arteries from narrowing.

BLOOD PRESSURE TESTING

The measurements of blood pressure are put into four general categories:

Normal Blood Pressure:	blood pressure is considered normal at 120/80 mmHg
Prehypertension:	systolic pressure ranging from 120 to 139 mmHg or diastolic pressure ranging from 80 to 89 mmHg prehypertension tends to get worse over time
Stage 1 hypertension:	systolic pressure ranging from 140 to 159 mmHg or diastolic pressure ranging from 90 to 99 mmHg.
Stage 2 hypertension:	systolic pressure of 160 mmHg or higher or diastolic pressure of 100 mmHg or higher

In a blood pressure reading both numbers are important, although after the age of 50 the systolic pressure is even more important.

DEVICES TO MEASURE BLOOD PRESSURE

Sphygmomanometer

- a medical device that is used to measure blood pressure that is made up of an inflatable cuff to restrict blood flow and a mercury (or mechanical) manometer to measure the pressure
- a sphygmomanometer is always used in combination with the means to determine at what pressure blood flow is starting and at what pressure is unblocked
- manual sphygmomanometer are used in combination with a stethoscope
- sphygmomanometers consist of an inflatable cuff, a measuring unit (e.g. the mercury manometer or aneroid gauge), an inflation bulb and valve for manual instruments
- the cuff is usually placed around the upper arm at roughly the same vertical height as the heart while the patient is in a seated position with the arm supported
- using the correct size of cuff for the patient is important as a cuff that is too small results in too high pressure and a cuff that is too large results in too low pressure
- once placed around the arm the cuff is inflated until the artery is complete occluded
- the pressure in the cuff is released while a stethoscope is used to listen to the brachial artery at the elbow
- a pounding sound is heard as the pressure in the cuff falls, when the blood flow first starts again
- the pressure that this sound happened at is recorded as the systolic blood pressure
- as the cuff is further released until the sound cannot be heard anymore, which is recorded as the diastolic pressure

Stethoscope

- an acoustic medical device used for auscultation or listening to internal sounds of the body
- often used in order to listen to the sounds of lung and heart
- also used to listen to the blood flow in arteries and veins
- in combination with a sphygmomanometer is is commonly used to measure blood pressure

3. RESPIRATORY RATE

The respiratory rate (breathing frequency) is the number of breaths a person takes within a specified time and is measured in breaths per minute.

It is usually determined through counting the amount of times a person's chest rises or falls within one minute.

There are factors that can cause the respiration rate to change such as fever or other medical conditions.

RESPIRATION RATE LEVELS

Respiration rate levels for the average person are considered to be as follows:

up to 1 yr of age:	30 – 40 breaths per minute
1 – 3 years of age:	23 – 35 breaths per minute
3 – 6 years of age:	20 – 30 breaths per minute
6 – 12 years of age:	18 – 26 breaths per minute
12 – 17 years of age:	12 – 20 breaths per minute
18 years and over:	16 – 20 breaths per minute

Respiration rate depends much on different factors, including a person's age or the level of exercise, but can be used to determine if a person's respiration rate is normal, unusually fast, unusual slow or even non existent.

TACHYPNEA: Abnormally fast respiration rates are called *tachypnea*, where the respiration rate is too fast. When a person has a breathing rate of more than 20 breaths per minute (average adult), it is considered to be tachypnea.

Causes for tachypnea can include heart or lung problems, panic attacks, anxiety, allergies (abnormal rections to substances), asthma, exercise or even labour during pregnancy.

BRADYPNEA: Abnormally low respiration rates are called *bradypnea*, where the respiration rate is too slow. When a person has a breathing rate of less than 12 breaths per minute (average adult), it is considered to be bradypnea.

Causes can include heart or lung problems, illegal drugs or certain medications.

NON-EXISTENT: Also called *apnea*, is the period of time where breathing completely stops or is significantly reduced.

There are two types of apnea, obstructive sleep apnea and central sleep apnea. In both types though, apnea takes place while sleeping, and once occuring, the person might wake up or go from a deep sleep into a lighter sleep.

RESPIRATION RATE MEASUREMENT

In order to measure the respiration rate, the patient should be in a resting position.

To get the respiration rate simply measure the amount of breaths the patient takes in one minute while breathing normal.
For the average healthy adult, a normal rate is considered to be 16 – 20 breaths per minute.

When measuring for respiration rate, it should always be considered that smaller children (newborn to 6 years) breathe much faster.

4. HEART RATE

The heart rate, also known as pulse, is the number of times that the heart beats per minute, and is usually recorded as bpm.

A person's heart rate can change during activity where the body needs to take in oxygen and discharge carbon dioxide, such as exercising or sleeping.

A person's pulse can be felt at any place that will allow an artery to be compressed against a bone, such as the radial artery (wrist), the neck (carotid artery), the elbow inside (brachial artery), behind the knee (popliteal artery) as well as around the ankle joint (posterior tibial artery).

By using a stethoscope, the pulse can also be measured by listening directly to the heart beat.

The pulse can be used to determine a person's overall level of health. In general, a lower pulse rate is better; although a condition called bradycardia (heart rate drops below 60 bpm) can be dangerous.

Normal pulse rates are considered to be:

Newborn:	120 – 160 beats per minute
1 month – 12 months:	80 – 140 beats per minute
1 – 2 years of age:	80 – 130 beats per minute
2 – 6 years of age:	75 – 120 beats per minute
6 – 12 years of age:	75 – 110 beats per minute
13 years and older:	60 – 100 beats per minute
Adult athletes:	40 – 60 beats per minute

FACTORS THAT AFFECT HEART RATE

The heart rate can be affected by many factors such as; medication, trauma, illness, temperature, exercise, stress, blood pressure and emotional stress.
Even breathing may cause slight changes in heart rate, although a person may not notice this change as it may not be significant enough.

BREATHING

- natural occurrence during respiration where heart rate changes slightly while breathing in and then returns to normal

PHYSICAL STRESS

- physical activity increases the heart rate as the heart has to beat faster and harder for more oxygen
- if heart problems are present, this increased oxygen need might burnout the heart, causing the heart rate to slow down

EMOTIONAL STRESS

- a person's natural response to psychological stress may increase heart rate
- fear and anxiety cause hormones to be released that make the heart work harder to provide muscles with sufficient energy (example: self defense or escape)

MEDICATION

- over-the-counter medications, diet aids, prescriptions, herbal supplements or even street drugs can cause changes in the heart rate
- stimulants (ephedrine, caffeine or cocaine) may cause an increase in heart rate
- digitalis preparations and beta blockers can also slow down the heart rate

VAGAL STIMULATION

- this involves special sensors that will adjust to blood pressure changes
- if a person is lifting something heavy or go through labor during pregnancy, the higher blood pressure will signal the heart to slow down

ILLNESS

- illnesses, such as a fever, will put an increased metabolic demand on the body and the heart rate increases due to oxygen requirements
- if the body can no longer fight the infection, the circulatory system crashes and heart rate drops

HEART PROBLEMS

- heart problems caused by plaque buildup in arteries (atherosclerosis) can lead to heart attack, failure of the heart or irregular heart rhythms (arrhythmias)
- arrhythmias may affect the heart rate, either increasing it or decreasing it

ABNORMAL HEART RATES

TACHYCARDIA: Defined as a resting heart rate of more than 100 bpm (number varies as small children have faster heart rates).
As the heart beats faster, it pumps less efficient and less blood flow is provided to the body, including the heart.
The increase in heart rate also causes more work and higher oxygen demand.

BRADYCARDIA: Defined as a resting heart rate of 60 or less bpm (symptoms usually don't occur until heart rate drops below 50 bpm).
This condition can be caused when not enough oxygen is pumped to the heart, and can therefore result in cardiac arrest.
Bradycardia can result in shortness of breath, fainting or even death.

ARRHYTHMIA: Abnormality of the heart rate and ryhthm.

Arrhythmias can be separated into two categories: fast and slow rates.
While some may cause few symptoms, others can cause severe symptoms of dizziness, feeling lightheaded and/ or fainting.
Some arrhythmias can be life-threatening and result in cardiac arrest or even sudden death.

CAUSES FOR ABNORMAL HEART RATES

Abnormal or irregular heart rates can be causes by many factors, including but not limited to:

- anxiety
- stress
- caffeine
- nicotine
- certain medications
- overactive thyroid
- exercise
- hyperventilation
- fever
- diet pills
- cocaine
- low oxygen levels in bloodstream
- heart valve disease

HEART RATE MEASUREMENT

A person's heart rate is defined by the pulse of the body. The pulse rate can be measured in any place where arteries can be compressed against a bone to feel the pulsation.

To feel the pulse, the index finger and middle finger are used – the thumb has a strong pulse that could interfere with the person's pulse and should therefore not be used for measurement.

Points for measurement include:

- ulnar artery
- carotid artery
- brachial artery
- femoral artery
- radial artery
- popliteal artery
- posterior tibial artery
- abdominal aorta
- facial artery
- dorsalis pedis
- superficial temporal artery
- apex of heart (chest, can be felt with fingers or by listening with stethoscope)

With the use of an EKG (electrocardiograph, also called ECG to measure heart problems or heart disease), a more precise measurement can be done.
The measurement is done by placing detectors on a person's chest in order to record the electrical impulses on the heart.
Once done, the test will produce a strip of paper (or picture) as the record of the electrical functioning of the heart. This record is called an electrocardiogram (also EKG or ECG).

COMMON PULSE SITES

UPPER LIMB:	brachial pulse, axillary pulse, ulnar pulse and radial pulse
LOWER LIMP:	popliteal pulse, tibialis posterior pulse, femoral pulse and dorsalis pedis pulse
HEAD/ NECK:	facial pulse, temporal pulse and carotid pulse
TORSO:	apical pulse

CHAPTER III

NERVOUS SYSTEM

Contents

1. ANATOMY OF THE NERVOUS SYSTEM

The nervous system is divided into several structures and systems that all work together to function.

The first division of the nervous system is between central nervous system and peripheral nervous system.

CENTRAL NERVOUS SYSTEM

The average brain of an adult weighs about 3 pounds. The brain contains about 100 billion neurons (known as brain cells) as well as trillions of glia (known as support cells).
The spinal cord measures about 17 inches and weighs about 1.3 ounces. The vertebral column: the collection of bones and host to the spinal cord, measures about 27 inches long. The spinal cord inside the vertebral column is much shorter.

The central nervous system is divided into two main parts: the spinal cord and the brain.

Spinal Cord

- located inside the vertebral column
- its function is to relay information from and to the brain
- about 16 inches long and less than 1 inch wide
- spinal cord consists of 31 segments: cervical (8), thoracic (12), lumbar (5), sacral (5) and coccygeal (1)
- spinal nerves exit from each segment of the spinal cord

Brain

- the brain is located in the skull and belongs to the nervous system
- its function is to control actions of the body
- the brain is made of a soft tissue
- meninges (connective tissue membranes) separate the brain from the skull
- the brain does not grow rather develops over time
- the brain has several functional subsystems such as the sensory system, the motor system and the neurotransmitter system

PERIPHERAL NERVOUS SYSTEM

The peripheral nervous system is divided into two main parts: the somatic nervous system and the autonomic nervous system.

The peripheral nervous system consists of 31 pairs of spinal nerves which connect the spinal cord to the body, carrying information in form of nerve impulses from the spinal cord to the body and back.

Somatic Nervous System

- consists of peripheral nerve fibers
- peripheral nerve fibers send sensory information to the central nervous system as well as motor nerve fibers which project to the skeletal muscle
- the somatic nervous systems function is the voluntary control of body movements

Autonomic Nervous System

- divided into three parts: sympathetic nervous system, parasympathetic nervous system and the enteric nervous system
- the autonomic nervous system controls smooth muscle of the internal organs (viscera) as well as glands
- main function of the sympathetic nervous system is the mobilization of the body's resources under stress
- main function of the parasympathetic nervous system is the stimulation of activities occuring while the body is under rest, including digestion, urination, lacrimation and even sexual arousal
- main function of the enteric nervous system is the control of the gastrointestinal system

BRAIN STRUCTURES

Structure	Functions
Cerebral Cortex	- voluntary movement - language - reasoning - thought - perception
Cerebellum	- movement - posture - balance
Brain Stem	- heart rate - breathing - blood pressure
Hypothalamus	- thirst - hunger - body temperature - emotions - circadian rhythmus
Thalamus	- movement - sensory processing
Limbic System	- memory - emotions
Hippocampus	- memory - learning
Basal Ganglia	- movement
Midbrain	- vision - eye movement - audition - body movement

2. SENSE ORGANS OF THE NERVOUS SYSTEM

Eye

- organ of vision (sight)
- complex structure which consists of a transparent lens which focuses light on the retina
- retina is covered with two types of light-sensitive rods and cones
- rods are sensitive to light and cones are sensitive to color
- eyes are connected to the brain through the optic nerve
- the brain takes the input of both eyes and turns it into a 3D image
- to determine a persons vision, health professionals use a Snellen Chart
- normal vision for the average person is considered to be 20/20
- in some cases, vision defects (also known as refractive errors) are caused due to abnormal shape of the lens or length of the eye
- typical vision defects are farsightedness, nearsightedness and astigmatism

Ear

- organ of hearing
- the outer ear transmits vibrations to the inner ear
- the inner ear is covered by nerve fibers that react to these vibrations and then transmit impulses to the brain
- the brain will combine the input of the ears and determine direction and distance of sounds
- in some cases, hearing problems occur
- people exposed to loud noise for long periods may be affected by tinnitus
- tinnitus is characterized by symptoms such as a constant buzzing or whistling sound

Nose

- organ of smell
- nose cavity is lined with mucous membranes with smell receptors
- smells consists of vapors of the different substances
- the receptors interact with these vapors and transmit the sensation to the brain
- in some cases the sense of smell is disturbed or damaged such as hyposmia and anosmia
- hyposmia is a condition where there is a reduced ability to smell
- anosmia is a condition of the inability to smell at all

Tongue

- organ of taste
- the tongue has receptors for taste (taste buds) that are able to detect salty, sweet, bitter and sour
- in general, taste buds close to the tip of the tongue are sensitive to sweet taste, and taste buds located in the back of the tongue are sensitive to bitter tastes
- taste buds that are located on top and sides of the tongue are sensitive to sour and salty tastes
- sense of taste works in junction with the sense of smell
- in some cases, taste disorders occur such as hypogeusia and ageusia
- hypogeusia is a condition with reduced ability to taste sweet, salty, sour and bitter tastes
- ageusia is a condition in which no sense of taste is present

Body

- organ of touch
- nerve endings in the skin as well as other body parts transmit sensations to the brain
- some body parts are more sensitive as they have more nerve endings
- the highest number of nerve endings are found at the fingertips and sexual organs
- there are four types of touch sensation: contact, heat, cold and pain
- the hair on the skin acts as an early warning sign
- for example, a child may have little or even no sense of touch, such as congenital analgesia
- in this situation, the child would have no sense of pain

3. COMMON MEDICAL CONDITIONS

CATARACT

- clouding of the eye lens
- as a person ages, the proteins inside the lens break down making the lens become cloudy
- symptoms may include sensitivity to glare, double vision, color intensity loss or blurry vision
- standard eye exams can be used to diagnose cataracts
- treatment includes eyeglasses, magnifying glasses or changes in lighting

EPILEPSY

- brain disorder that causes repeated seizures
- permanent changes in the brain tissue cause it to be "jumpy", causing the brain to send out abnormal signals, resulting in seizures
- epilepsy can be put into different types of seizures: focal (partial) seizures, petit mal (absence) seizures and grand mal (generalized tonic-clonic) seizures
- causes include brain injury, infections, dementia, brain tumor or metabolism disorders
- symptoms can vary and be as simple as staring spells or dramatic seizures
- to diagnose epilepsy an EEG (electroencephalogram) is done
- treatment for epilepsy can include medication and/ or surgery

GLAUCOMA

- group of eye conditions causing damage to the optic nerve
- glaucoma is divided into four main types: chronic (open angle) glaucoma, congenital glaucoma, acute (angle closure) glaucoma and secondary glaucoma
- glaucoma is the second most cause of blindness in the US
- in most cases of glaucoma the affected person has a high intraocular pressure (IOP)
- if the intraocular pressure is high, it damages the optic nerve
- symptoms include pain in the eye, cloudy or loss of vision, red eye, swollen eyes or tearing
- to diagnose glaucoma eye exams can be performed
- other tests to diagnose glaucoma are optic nerve imaging, gonioscopy and/ or tonometry
- treatment for glaucoma includes medication or surgery to lower the IOP

PARKINSON'S DISEASE

- neurological disease, leading to degeneration of brain cells
- in general, Parkinson's disease starts to affect people in their 50s
- motor symptoms include slowness in movement, stiffness in limb and/ or shaking
- in later stages of the disease, an impairment of balance may occur
- to diagnose Parkinson's disease, a neurologist should make a physical examination
- treatment depends on progression of the disease

TUMOR

- brain tumor consists of a group of abnormal cells
- causes are unknown, although certain factors may contribute to a higher risk of being affected
- some risk factors are exposure to radiation as well as possible inherited conditions
- symptoms include headaches, weakness, seizures, loss of balance and/ or loss of alertness
- many tests can give a diagnosis such as CT scans, MRI and/ or tissue examination
- treatment can include radiation therapy, chemotherapy and/ or surgery

CHAPTER IV

RESPIRATORY SYSTEM

Contents

1. ANATOMY OF THE RESPIRATORY SYSTEM

The term respiration refers to the act of breathing:

- inspiration (inhaling) – taking in oxygen
- expiration (exhaling) – giving off carbon dioxide

The respiratory system consists of organs that are involved in the exchange of gases. These organs are:

- nose
- oral cavity (mouth)
- throat (pharnyx)
- voice box (larynx)
- windpipe (trachea)
- bronchi
- lungs

Furthermore, the respiratory system is divided into upper and lower respiratory tract.

Upper Respiratory Tract

- nose
- nasal cavity
- frontal sinuses
- maxillary sinus
- sphenoidal sinus
- ethmoidal air cells
- larynx
- trachea

Lower Respiratory Tract

- lungs
- bronchi and bronchioles (airways)
- alveoli (air sacs)

2. ORGANS OF THE RESPIRATORY SYSTEM

NOSE
- air can enter through the external nares (nostrils)
- inside each nostril is an expanded vestibule which contains coarse hair
- the nasal cavity is divided by a midsagittal nasal septum
- nasal, frontal, maxillary, ethmoid and sphenoid bones form the cavity walls
- hard and soft palates form the nasal floor
- external part of the nose consists of cartilage, forming the bridge and nose tip
- superior, middle and inferior nasal conchae project from the cavity walls
- space between the conchae are the meatuses
- internal nares open in the nasopharynx

PHARYNX
- the pharynx is a chamber that is shared by the respiratory and the digestive system
- extends between internal nares and the entrances to the larynx and esophagus
- pharynx is lined with a stratified squamous epithelium
- the pharynx is divided into three areas: upper naso pharynx, middle oropharynx and the lower laryngopharynx
- the naso pharynx contains the pharyngeal tonsils in the posterior wall as well as the openings of the eustaquian tubes and lies above the soft palate and is a passage for airflow coming from the nasal cavity
- the oropharynx extends from the soft palate down to the base of the tongue
- the laryngopharynx includes the area between the hyoid bone and esophagus entrance

LARYNX
- joins laryngopharynx with the trachea and consists of cartilages
- three main cartilages are: throid cartilage, epiglottis and cricoid cartilage
- other cartilages in the larynx are corniculate, arytenoid and cuneiform cartilages
- the epiglottis closes while swallowing, therefore preventing food from entering the respiratory system
- coughing is a protective reflex to protect from irritants or foreign objects

TRACHEA
- extends from the larynx base and is lined with pseudostratified ciliated columnar epithelium
- tubular structure that is located before the esophagus
- along the trachea are pieces of tracheal cartilages
- tracheal muscle holds these cartilages together
- as the trachea branches it forms left and right primary bronchi
- the primary bronchi branches of into many secondary bronchi
- the smallest passages are called bronchioles

BRONCHI	- the tracheal tube once divided into two, forming the left and right bronchi - passage that allows air into the lungs - left bronchi further divides into 2 lobes - right bronchi further divides into 3 lobes
LUNGS	- pair of organs in the pleural cavities - top of the lung is called the apex - each lung has a hilus, a slit where lymphatics, nerves and bronchial tubes are reaching the lung - lung is divided into lobes, where the right lung has three and the left lung two - left lung is divided into superior and inferior lobes - right lung is divided into superior, middle and inferior lobes
PLEURAL CAVITIES	- pleural cavity is lined with a serous membrane called the pleura - parietal pleura lines the thoracic wall, mediastinum and diaphragm - visceral pleura covers the lung surface

<u>3. COMMON MEDICAL CONDITIONS</u>

APNEA

- also known as respiratory arrest
- condition where breathing has slowed or completely stopped
- common causes for apnea include asthma, choking, pneumonia, premature birth, seizures, cardiac arrest and drug overdose
- if apnea occurs, artificial respiration is required
- artificial respiration refers to the measures to cause air to flow into the lungs by expansion of the chest cavity

ASTHMA

Bronchial Asthma:
- narrowing of the airways
- this narrowing leads to difficulty breathing

Cardiac Asthma:
- occurs in left ventricular heart failure

- treatment for asthma includes bronchodilators, usually on form of aerosol inhalers

BRONCHITIS

Acute Bronchitis - condition is caused by bacteria or virus

Chronic Bronchitis - associated with smoking and emphysema

- symptoms include coughing and/ or coughing up excessive mucus
- may be treated with bronchodilator drugs

DIPTHERIA

- acute infectious disease
- spreads through respiratory drops of coughing or sneezing
- symptoms may include coloration of the skin, heavy cough, drooling, difficulties breathing or rapid breathing
- the Schick test can be used to determine immunity for diptheria
- treatment may include bed rest, heart monitoring or breathing tubes

MEASLES

- contagious viral infection

- spreads by contact with drops from the nose, throat or mouth from a person infected
- most infectious stage is the coryzal stage
- incubation period for measles is between 8 to 12 days
- symptoms include cough, fever/ chills, runny nose and/ or muscle pain as well as light sensitivity
- diagnosis can be made by measles serology
- when caring for children affected by measles, it is best to protect the eyes from direct exposure to light
- treatment in general is done by medication to treat the symptoms

PNEUMONIA

- common infection of the lung
- causes for pneumonia include breathing in germs directly into the lungs, bacteria and viruses, with bacteria being the most common cause
- symptoms include fever, chills, cough and/ or shortness of breath
- pneumonia can be diagnosed through physical examination by using a stethoscope to hear abnormal sounds and/ or X-ray of the chest
- antibiotics may be used to treat pneumonia

SCARLET FEVER

- infection caused by the bacteria streptococcus ("strep throat")
- symptoms include fever, rash, sore throat and/ or swollen tongue
- physical examination or throat cultures can diagnose Scarlet Fever
- the Dick test may be used to determine susceptibility to Scarlet Fever
- treatment usually involves antibiotics

SINUSITIS

- inflammation of the sinuses due to viral, bacterial or fungal infection
- sinusitis can be acute, sub-acute or chronic
- most common causes are colds and allergies
- symptoms include nasal congestion and discharge, fever, sore throat and/ or cough
- a physical examination may be done to diagnose sinusitis
- treatment may include allergy shot or nasal sprays
- argyrol is often used to drain sinuses

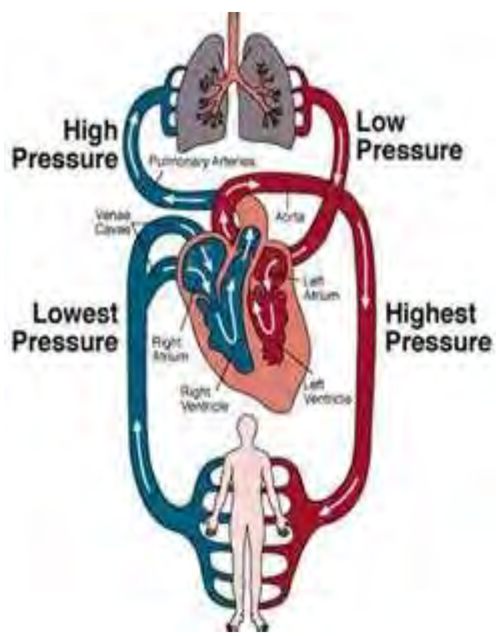
TUBERCULOSIS

- contagious infection of the lung caused by bacteria
- highest incidence of tuberculosis occurs between the ages of 15 – 30 yrs
- symptoms may include cough, fatigue, fever and/ or coughing up blood
- tests for tuberculosis include biopsy, the use of a bronchoscope to examine the lung, CT scans of the chest and/ or X-ray of the chest
- treatment is done by medications, including isoniazid or rifampin

CHAPTER V

CIRCULATORY SYSTEM

Contents



1. ANATOMY OF THE CIRCULATORY SYSTEM

The circulatory system passes nutrients (like electrolytes and amino acids), hormones, gases, blood cells to and from the cells within the body, in order to fight disease, maintain homeostatis, and stabilize pH and body temperature.

The circulatory system consists of the pulmonary circulation, systemic circulation, coronary circulation, closed cardiavascular system and the heart.

PULMONARY CIRCULATION

- the pulmonary circulation carries oxygen-depleted blood from the heart to the lungs and returns oxygen enriched blood to the heart
- blood (oxygen deprived) enters the right atrium
- this blood (now taking on oxygen travels through the tricuspid valve into the right ventricle and from there pumped into the pulmonary arteries that go to the lungs
- pulmonary veins return the blood (now oxygen rich) to the heart, entering the left atrium
- from the left atrium this oxygen rich blood flows through the mitral valve into the left ventricle
- the aorta (artery) now pumps oxygen rich blood from the left ventricle out into the body

SYSTEMIC CIRCULATION

- the systemic circulation carries oxygen rich blood from the heart to the body and returns oxygen deprived blood back to the heart
- if measured in length, the systemic circulation is much longer than pulmonary circulation, as it is transporting blood to every part of the body

CORONARY CIRCULATION

- the coronary circulation provides the blood supply to the heart

CLOSED CARDIOVASCULAR SYSTEM

- this system is called closed as the blood does not leave this structure of blood vessels
- oxygen and nutrients in the closed cardiovascular system spread out across the layers of blood vessels and enter the so called interstitial fluid, which carries that oxygen and the nutrients to the target cells and waste and carbon dioxide the opposite way

HEART

- the heart is the organ that pumps oxygen deprived blood to the lungs and oxygen rich blood to the body
- for each circulation, the heart has one atrium and one ventricle
- right atrium is the upper chamber of the hearts right side
- blood that is moved into the right atrium is oxygen deprived and moved into the right ventricle in order to be pumped by the pulmonary artery to the lungs in order to be oxygen enriched
- the left atrium receives this oxygen enriched blood from the lungs and the pulmonary veins and is then moved into the left ventricle in order to be pumped by the aorta to other body organs

BLOOD VESSELS

- blood vessels transport blood throughout the body and are divided into three types: arteries, capillaries, and veins
- arteries: carry blood away from the heart
- capillaries: enable exchange of water as well as chemicals between blood and tissues
- veins: carry blood from the capillaries back to the heart

2. BLOOD-OXYGEN TRANSPORT

- the lungs are the organs where the exchanges of oxygen and carbon dioxide between the air and blood take place
- oxygen enters the lungs through each inhalation (breathing in)
- carbon dioxide exits the lungs through each exhalation (breathing out)
- this exchange takes place within the lungs alveoli (air sacs)
- each of the alveoli is surrounded by pulmonary capillaries
- alveoli walls and pulmonary capillaries walls are lined with semi-permeable membranes
- the membranes allow the circulation of oxygen gas into the capillary bloodstream and for the circulation of carbon dioxide gas out of the pulmonary capillary bloodstream
- each inhalation brings a new supply of oxygen to the lungs, whereas the blood flowing through the lungs is oxygen deprived
- for that reason, an increased concentration of oxygen is inside the alveoli and a decreased concentration of oxygen is in the bloodstream
- the increased concentration of oxygen in the alveoli is circulated into the bloodstream
- each red blood cell contains the substance that carries oxygen, called hemaglobin
- each hemaglobin carries four oxygen molecules
- blood takes on oxygen as it passes the alveoli
- the oxygen then binds to the hemaglobin within the red blood cells
- as blood passes through the lungs it increases its oxygen concentration
- the oxygen enriched blood passes through the circulatory system to supply other organs
- in the systemic capillaries the oxygen spreads from the blood into the tissues
- the tissues then use this oxygen for metabolic activities
- pheripheral tissues release carbon dioxide
- in the pheripheral tissues the carbon dioxide level is high but decreases in the blood
- a small part of the carbon dioxide stays in its form in the blood
- a larger part of the carbon dioxide enters the red blood cells where it bonds with hemaglobin
- once bonded the carbon dioxide is turned into bicarbonate
- blood has now decreased levels of oxygen and increased levels of carbon dioxide
- the blood now moves from the systemic capillaries to the pulmonary capillaries
- in the pulmonary capillaries, the carbon dioxide levels are increased in blood and lower in the alveolar air space
- carbon dioxide spreads from the blood into the air space
- the bicarbonate is is turned into carbon dioxide at the lungs and spreads into the air space
- the carbon dioxide molecules now separate from hemaglobin and enter the alveolar space

3. DEVELOPMENT

Arterial and venous systems develop from different areas. The arterial system mainly develops from aortic arches, whereas the venous system develops from three bilateral veins between 4 to 8 weeks of the development of a human.

Arterial Development

- the arterial system develops from the aortic arches as well as the dorsal aortae at 4 weeks of human development
- aortic arch 1 mostly moves back and forms the maxillary arteries
- aortic arch 2 mostly moves back as well and forms the stapedial arteries
- aortic arch 5 completely moves back
- the formation of the arterial system comes from the aortic arches 3, 4 and 6
- the dorsal aortae first are bilateral and later fuse to form the definitive dorsal aorta
- there are about 30 posterolateral branches that branch off the aorta and form the intercostal arteries, the lumbar arteries, the upper and lower extremity arteries and the lateral sacral arteries
- the lateral branches from the aorta form the suprarrenal arteries, gonadal arteries and renal arteries
- the ventral branches from the aorta are the vitelline and the umbilical arteries
- the vitelline arteries form the superior arteries, inferior mesenteric arteries and the celiac arteries of the GI tract (gastrointestinal tract)
- the umbilical arteries form the internal iliac arteries after birth

Venous Development

- the venous system mainly develops from the umbilical veins, the cardinal veins as well as the vitelline veins
- umbilical veins, vitelline veins and cardinal veins empty into the sinus venosus

4. COMMON MEDICAL CONDITIONS

ATHEROSCLEROSIS

- disorder of arteries characterized by buildup of fatty deposits (such as cholesterol, cellular debris or lipids) on the arteries inner wall
- as these fatty deposits may harden, they can eventually block the arteries
- causes may include diabetes (non-communicable disease where the blood has high levels of sugar), high fat diet, obesity, high blood pressure or family history
- symptoms can include chest pain, slurred speech and/ or numbness in arms or legs
- diagnosis can be made upon physical examination or intravascular ultrasound and/ or CT scans
- treatment may include cholesterol medications, beta blocker medications or anti-platelet drugs

EDEMA

- edema is a condition of swelling which is caused by too much fluid in body tissue
- appears most commonly in feet and legs
- edema can be a result of other medical conditions such as heart failure or kidney disease
- symptoms include swelling of the tissue and/ or stretched skin
- chest X-ray, blood and urine tests can help identify this condition
- treatment usually involves treating the underlying cause and can include medications

HEMORRHAGE

- condition of blood loss from blood vessels
- causes may be traumatic or medical
- traumatic causes may include abrasion, puncture wound or incision
- medical causes may include intravascular changes and/ or extravascular changes
- treatment may include direct pressure to wounds or cold applications to reduce blood flow

THROMBOPHLEBITIS

- swelling or inflammation of vein/ or veins caused by a blood clot
- blood clots are clumps that occur as blood hardens from liquid to solid and coagulate (form clot)
- causes may include major surgery or sitting for long periods of time
- symptoms include inflammation/ swelling of the affected region, pain in the affected region, tenderness of the vein or skin redness
- a physician may be able to diagnose the condition by examining the affected area
- treatment may include antibiotics, analgesics and/ or NSAIDs

<u>**CHAPTER VI**</u>

MUSCULAR SYSTEM

Contents

1. ANATOMY OF THE MUSCULAR SYSTEM

The muscular system is the system of the body that allows for movement. Muscles provide balance, strength and posture to the human body.

The muscular system is divided into three groups of muscles: cardiac (heart) muscles, smooth (non striated) muscles and skeletal muscles.

There are over 600 muscles in the human body, each of which is aided by nerves in order to link the muscle to the brain as well as the spinal cord.

MUSCLE TYPES

Skeletal:
- skeletal muscles are the most abundant in the human body and produce movement
- skeletal muscles are controlled by the SNS (somatic nervous system)
- skeletal muscle fiber is somewhat cylindrical and contains nuclei
- skeletal muscle fiber is crossed by alternating dark and light bands (striations)
- fibers bind together by a connective tissue into bundles - these bundles form muscles
- composed of many muscle fibers, blood vessels, nerves and connective tissue

Smooth:
- smooth muscles are controlled by the ANS (autonomic nervous system)
- smooth muscles form the muscle layers in the walls of the bladder, digestive tract, arteries and veins, various ducts and other internal organs
- smooth muscles have only one nucleus, are elongated and thin, and they interlate to form sheets of muscles (instead of bundles)

Cardiac:
- cardiac muscles are controlled by the ANS (autonomic nervous system)
- cardiac muscles are a cross between smooth and skeletal muscles
- cardiac muscles are comprising the heart tissue

MUSCULOSKELETAL SYSTEM

In order to provide basic function to the human body, the skeletal system (bones and joints) and the skeletal muscle system (skeletal muscles) work together, called the musculoskeletal system.
Basic functions are essential to life and include:

- support (maintaining upright posture)
- blood cell formation (hematopoiesis)
- mineral homeostasis
- protection (protecting of vital organs)
- storage (of fat and minerals)
- leverage (lever is a machine that enlarges speed of movement and/ or force)

TISSUES

The musculoskeletal system is made up of 5 basic tissues:

- bones
- ligaments (which are attaching bone to bone)
- cartilage (gel like substance that is lining the joints and is protective)
- skeletal muscles
- tendons (fibrous connective tissue band)

Each one of these basic tissues contain different combinations of 4 connective tissue (building blocks).

fibroblasts - referred to as the “mother” cell which is producing the other three connective tissues
collagen - a principal protein that is produced by fibroblast, forming strong but non-stretchable fibers
elastic fibers - these are highly elastic and especially abundant in the walls of arteries
proteoglycans - referred to as the “matrix”, where fibroblasts, elastic fibers and collagen reside

2. FUNCTIONS OF THE MUSCULAR SYSTEM

The muscular system has very important functions in the human body.
These functions are:

STABILITY AND POSTURE

- skeletal muscles are responsibible for the stability and posture of the human body
- weak joints require support of the muscular system to reach this stability

MOVEMENTS OF BODYPARTS

- skeletal muscles have the responsibility for voluntary movement
- skeletal muscles provide the force by actively contracting at the expense of energy

CIRCULATION

- cardiac muscles are the main force for blood circulation through the body
- the regular pumping keeps blood in motion, and therefore nutrients are available to all tissue

HEAT PRODUCTION

- a large amount of the body's energy is being used by the muscular system
- high metabolic rate results in muscles producing heat in the human body
- the heat produced by muscles is very important, especially in cold climates

DIGESTION HELP

- smooth muscles of vital organs such as the stomach help in the process of food digestion

3. MUSCLES

FACIAL
frontalis and temporalis muscles – moving the forehead and sides of the head
orbicularis muscle – moving the eyes
zygomaticus and masseter muscles – moving jaw and upper lip
orbicularis oris muscle – moving lips

NECK
sternohyoid and sternocleidomastoid muscles – moving most of the neck
trapezius muscle – moving head up and down

ARM
bicep brachii muscle – moving forearm close to body
tricep brachii and brachialis muscles – allow for pushing

FOREARM
berachiodialis, flexor carpi radialis and palmaris longus muscles – controlling part of the arm

SHOULDER
trapezius, infraspinatus, teres major, deltoid and rhomboid muscles – moving shoulder
in junction with joint, these muscles allow for throwing, picking up and stretching

THORAX
trapezius and latissimus dorsi muscles – carrying arms, stomach head and other upper body parts

ABDOMEN
internal oblique and external oblique muscles – allow for body movement left to right
transversus abdominus and rectus abdominus muscles – allows the bending down and moving waist

HIP
gluteus maximus and gluteus medius muscles – allow for sitting down

PELVIS / THIGH
illiopsoas and pectineus muscles – help support upper leg and therefore support the body
gracilis, abductor longus, sartorius and tensor fasciae latea muscles -upper thigh muscles
vastus lateralis, rectus femoris and medialis muscles – lower thigh muscles
upper and lower thigh muscles allow for walking, running and jumping

LEG
soleus, porenius longus, tibialis anterior and gastocnemius muscles – allow for coordination for moving
these muscles also can absorb the impacts from walking or running

4. COMMON MEDICAL CONDITIONS

ATONY
- muscles are floppy and lacking their normal elasticity
- atony can have many possible causes

ATROPHY
- degeneration of muscle tissue
- can be caused lack of muscle use or ceasing of muscle's nerve impulses

CRAMP
- involuntary contractions of skeletal muscles, usually painful
- possible causes are imperfect posture, fatigue, stress or imbalance of salts

FIBROSITIS
- inflammation of fibrous connective tissues that often affects muscles of the back
- in most cases the cause for fibrositis is unknow

FATIGUE
- occurs after longer periods of activity

MYOSITIS
- inflammation of muscle fibers that can lead to degenerative changes
- in some cases it is caused by parasitic or bacterial infections

SPASM
- involuntary muscular contraction (sustained)
- can occur as part of an disorder like spastic paralysis, or as response to painful condition

SPASTICITY
- rising of the state of readiness of muscle fibers to contract
- cause is generally damage to the cortiscospinal tracts in the brain or spinal cord

SPRAIN
- sprains are injuries to ligaments
- caused by overstretching of the ligaments

STRAIN
- strain refers to the overstretching and excessive work of muscles
- strains cause swelling of the muscles and pain

CHAPTER VII

SKELETAL SYSTEM

Contents

1. ANATOMY OF THE SKELETAL SYSTEM

The skeletal system consists of fused as well as individual bones that are supported by tendons, ligaments, muscles and cartilage.

The skeletal system serves as a scaffold that supports other organs, protects organs like the heart, lungs and brain, and that anchors muscles.

BONES

- dense type of connective tissue that is impregnated with inorganic salts
- organic portion of the bone make up 1/3 and inorganic salt components make up 2/3
- inorganic salts mainly responsible for hardness, making the bone resistant against compression that are caused by forces of impact or weight
- organic connective tissue makes bones resilient and therefore bones have resistance to tensile forces
- the strength of bones can be compared to steel and iron
- bones form an important part of the skeleton, which provides strength and form that is necessary to keep the human body in its shape
- bones also protect vital organs, such as the skull protecting the brain, and the ribcage protecting the lungs and the heart

There are different types of bones. These types can be categorized by:

Basis of shape:
- long and short bones, flat bones, irregular bones, pneumatic bones, sesamoid bones

Basis of development:
- membranous bones, carilaginous bones, membro-cartilaginous bones

Basis of structure:
- compact bone, spongy bone

Basis of region:
- according to macroscopic approach
  (bones of axial skeleton, bones of appendicular skeleton)
- according to microscopic approach
  (fibrous bone, lamellar bone)

BASIC STRUCTURE OF BONES

A typical bone (long bone) of an adult consists of these two important parts:

Shaft:

- long middle part of a long bone that is composed of periosteum, cortex and a medullary cavity from outside to inside
- periosteum is a thick fibrous membrane that is covering the bone surface and is composed of two layers, the outer fibrous layer and the inner osteogenic cellular layer
- this attachment of bone and periosteum is especially strong over attachments of tendons and ligaments
- the cortex is the compact part of the long bone – the bone strength is mainly due to this cortex
- the ratio of bone substance to bone spaces is in a large quantity in the cortex
- the medullary cavity is the central part of a long bone, and is filled with yellow or red bone marrow
- at the time of birth, bone marrow is red and blood cell production is active, but with age, the red marrow is replaced by yellow marrow, which is fatty in nature, and has no power of blood cell production

Ends:

- the ends of a long bone are not compact as the shaft
- bone ends consist of cancellous (spongy) bone
- bone substance to bone spaces ratio is in smaller quantities in cancellous bone

BLOOD SUPPLY OF BONES

Although bones are not an active growing tissue, they require a constant blood supply.
The blood supply to bones happens through a variety of sources.

Nutrient Artery:

- the artery enters the shaft through the nutrient foramen and runs through the cortex
- the artery divides in the medullary cavity into ascending and descending branches
- each one of these branches divides into parallel channels that go towards the end of the bone
- in adults, at the place of metaphyses, these branches anastomose with epiphyseal, metaphyseal and periosteal arteries
- in this way the artery nourishes the whole medullary cavity, 2/3 of the inner cortex as well as metaphyses

Periosteal Arteries:

- defined as the arteries of periosteum being especially numerous under the muscular and ligamentous attachments
- beneath the periosteum they divide into branches, thereby entering the Volkmann's canals to supply 1/3 of the outer cortex

Epiphyseal Arteries:

- the arteries of epiphyses that are derived from the peri-articular vascular arcades, found on the non-articular bony surface
- this area has numerous foramina of which only few are entrance points of these arteries, while the remaining are the venous exits

Metaphyseal Arteries:

- arteries derived from the neighboring systemic vessels
- they go directly into the metaphyses and reinforce the metaphyseal branches of the nutrient artery

NERVE SUPPLY OF BONES

Bones are innervated by peripheral nerves, just like other living tissue, so that bones can coordinate with the nervous system.
This coordination is formed by the sensory signals that are coming from the bones.
The brain requires these signals in order to make changes that are necessary to avoid damage to bones and other tissue.

According to Hilton's Law, which explains the pattern of innervation of bones by peripheral nerves, the nerve that is supplying a muscle is also supplying the underlying bone.

The innervation of nerves have the following characteristics:

- nerves accompany the blood vessels – if needing to find the specific nerve supplying a specific bone, it is needed to look for the nerves which accompany the arteries and veins of a bone
- most of the nerves that are coming to a bone are sympathetic and vasomotor in function
- some of the nerves are sensory and these nerves are spread to the articular ends and periosteum of the bones

CELL TYPES IN BONES

A bone is formed by three main cell types:

Osteoblasts:
- bone-forming cells that descend from osteoprogenitor cells
- osteoblasts form a protein mixture (osteoid) which mineralizes to turn into bone
- osteoid is mainly composed of type 1 collagen
- osteoblasts also produce hormones such as prostaglandins to act on the bone itself
- produce alkaline phosphatase (enzyme that plays part in mineralization of bone) and many matrix proteins
- osteoblasts are immature bone cells that eventually become caught in the bone matrix and become osteocytes which are mature bone cells
- bone lining cells are all osteoblasts

Osteocytes:
- mature bone cells that originate from osteoblasts that have moved into and become caught by bone matrix
- the areas they fill are known as lacunae
- osteocytes have many processes that reach out to meet osteoblasts as well as other osteoc for the purpose of communication
- functions include the formation of bones, maintenance of matrix and homeostasis of calcium

Osteoclasts:
- cells responsible for bone resorption and remodelling
- large, multinucleated cells that are located on the bone surfaces in resorption pits
- resorption pits are left behind after breakdown of the bone surface
- osteoclasts are derived from a monocyte stem-cell lineage, osteoclasts are equipped with phagocytic-like mechanisms that are similar to circulating macrophages

OSSIFICATION OF BONES

Ossification is the process by which a bone is formed.

Intra-membranous:
Also known as mesenchymal ossification. Here the bone is ossified from mesenchymal condensations and the bones formed are known as membranous bones or dermal bones.

Intra-cartilaginous:
The mesenchyme has been converted to cartilaginous models where the process of ossification starts. The process of converting mesenchymal condensations in cartilage is known as chondrification.

FUNCTIONS OF BONES

Bones have a wide range of functions which can be categorized into three groups:

Mechanical Functions:

- protection (skull protecting the brain, ribcage protecting the heart)
- movement (bones form a moving mechanism by working with muscles, tendons, joints and ligaments)
- shape (bones are responsible for the shape and form of a human body)

Synthetic Functions:

- synthesis of blood cells (main synthetic role of bones is to produce blood cells, although bones are unable to produce blood, but bones store bone marrow which is able to produce blood cells)

Metabolic Functions:

- fat storage (yellow bone marrow of long bones act as storage of fat)
- mineral storage (bones store minerals like calcium and phosphorus)
- acid-base balance (bones buffer blood against too much pH changes, by taking in or releasing alkaline salts)

CARTILAGE

Cartilage is a connective tissue which is composed of cells known as chondrocytes together with collagen or yellow elastis fibers.
Fibers and cells are embedded in a gel like form (matrix) that is rich in mucopolysaccharides.
Cartilage itself is not hard as bones are, it is more flexible.

There are three types of cartilage: fibrous, hyaline and elastic cartilage.

Characteristics of cartilage:

- no blood vessels or lymphatics
- nutrition of cells spread out through the matrix, which explains slow healing process
- no nerves and therefore insensitive
- surrounded by fibrous membrane (perichondrium)
- this membrane is similar to periosteum as far as structure and function
- articular cartilage has no perichondrium, therefore regeneration after damage is insufficient
- as a cartilage calcifies, the chondrocytes die and the cartilage is being replaced by bone like tissue
- calcium salts are not present in cartilage matrix, but chondroitin (flexible material) is present

JOINTS

A joint is defined as a junction between two or more bones or cartilages.
Joints permit the movements in the hard skeleton structure of the human body.
In the way joints are formed, they are able to keep a balance between stability, movement and strength.
Some joints although sacrifice movements for stability, where others sacrifice stability for movements.
Immovable joints. These joints are mainly for growth as they permit molding during childbirth.

TYPES OF JOINTS

Joints are categorized into three types: functional, structural and regional.

Functional:

- Immovable Joints
  - fixed joints with no movement
  - surface joint by fibrous tissue
  - edges of bones are dovetailed into one another

- Partially movable joints
  - slight movement is present
  - pad of cartilage lies between bone surface
  - fibrous capsule holds bone and cartilage in place

- Freely movable joints:
  - also called synovial joints
  - free movement although some may have restricted movement caused by the ligaments holding them and the shape of the articulating surface
  - ligaments are an elastic connective tissue

Structural:

- Fibrous Joints
  - joint together by fibrous tissue
  - joints are either restricted to movement or immovable
  - further divided into subtypes (sutures, syndesmosis and gomphosis)

- Cartilaginous Joints
  - piece of cartilage between the bones to hold them together in order to make a joint
  - further divided into primary cartilaginous joints (bones are united by a plate of hyaline cartilage and are immovable and strong) and the secondary cartilaginous joints (also known as fibro-cartilaginous joints) and these joints generally allow restricted movements

Regional:

- Skull Type
  - joints of the skull
  - immovable

- Vertebral Type
  - joints of the vertebral colomn
  - slightly movable

- Limb Type
  - joints of upper and lower limb
  - freely movable

CONNECTIVE TISSUE

Defined as wide spread type of tissue that supports and protects special tissue of the human body.
It consists of cellular and extracellular components.
The cellular component serves as active defense, where the extracellular component serves as a support and protection against mechanical strains.
Connective tissue is spread all over the body but a special type of connective tissue forms other tissue, such as bones and cartilages.

Cells:	- fibroblast, macrophage, plasma cell, mast cell, fat cell and pigment cell
Extracellular Matrix:	- fibrous and non-fibrous element - fibrous element has three types of fibers, collagen, elastin and reticulin - non-fibrous element is formed by ground substance

LIGAMENTS

Ligaments are fibrous bands that connect adjacent bones and form integral parts of joints.
Even though they are sturdy they are flexible and normal movements can happen without resistance, although abnormal movements are prevented.

Types of Ligaments:

- According to composition:
  - most made up of collagen fibers
  - inelastic and unstretchable
  - few made up of elastin fibers
  - these are elastic and stretchable

- According to relation to joint:
  - intrinsic ligaments that surround the joint
  - may be extracapsular or intracapsular
  - extrinsic ligaments are independent
  - these ligaments lie away from joints

2. DIVISIONS OF THE SKELETAL SYSTEM

The human skeleton can be divided into two groups: the axial skeleton and the appendicular skeleton.

AXIAL SKELETON	APPENDICULAR SKELETON
- the axial skeleton forms the axis of the body - consists of skull, vertebral column and thoracic cage	- skeleton of appendages of the human body - consists of shoulder girdle, skeleton of upper limp, pelvic girdle and skeleton of lower limb
• *Skull* - forms framework of the head - consists of 22 different bones - bones are divided into groups - group 1: bones of cranium - group 2: bones of face • *Vertebral Column* - flexible colum of vertebrae - connects trunk to skull - consists of 33 vertebrae - divided into five regions (cervical, thoracic, lumbar, sacral and coccygeal region) • *Thoracic Cage* - bony cage enclosing organs - located within the chest - 12 pairs of ribs - ribs are divided into groups (groups are true ribs, false ribs and floating ribs)	• *Shoulder Girdle* - attaches upper limp to trunk - formed by two bones (clavicle & scapula) • *Skeleton of Upper Limb* - consists of 30 bones - bones are: humerus, ulna, radius, capals (8), metacarpals (5), phalanges (14) • *Pelvic Girdle* - one pelvic girdle for each lower limb - joint with each other at symphysis pubis - pelvic girdle is a single bone - made up of ileum, ischium and pubis • *Skeleton of Lower Limb* - consists of 30 bones - bones are: femur, tibia, tarsals (7), metatarsals (5), phalanges (14)

3. FUNCTIONS OF THE SKELETAL SYSTEM

The human skeletal system has several important functions for the survival of the human body.

- STRENGTH, SUPPORT AND SHAPE

  - the skeleton gives the body strength, support and shape
  - without a skeleton, the body could not stand upright, being just soft tissue without shape

- PROTECTION FOR VITAL ORGANS

  - examples like the skull protecting the brain show this protection
  - as damage to vital organs like the brain could be fatal, the protection of them is important

- LEVERAGE FOR MOVEMENT

  - bones in all parts of the human body provide an attachment to the muscles
  - muscles provide motor skills to produce movement
  - in these movements, parts of the skeleton act like levers and therefore providing movement according to the body's needs

- PRODUCTION OF RED BLOOD CELLS

  - bones like the sternum or heads of tibia have hemopoeitic activity, which is blood cell production
  - these are places where new blood cells are being produced

4. BONES AND JOINTS OF THE SKELETAL SYSTEM

UPPER LIMB

BONES	*JOINTS*
Clavicle (collar bone) Scapula (shoulder bone) Humerus (arm bone) Radius Ulna Carpal Bones (wrist bones) Metacarpal Bones Phalanges (finger bones)	Pectoral Girdle Sternoclavicular Joint Acromioclavicular Joint Shoulder Joint – Elbow Joint – Wrist Joint Carpometacarpal Joint of thumb Carpometacarpal Joints Intermetacarpal Joints Metacarpophalangeal Joints Interphalangeal Joints

LOWER LIMB

BONES	*JOINTS*
Hip Bone Femur Tibia (Shinbone) Fibula Talus Calcaneus Navicular Cuboid Cuneiform Bones Medial Cuneiform Intermediate Cuneiform Lateral Cuneiform Metatarsals Phalanges of Foot	Pubic Symphysis Sacroiliac Joint Hip Joint Knee Joint Superior Tibiofibular Joint Inferior Tibiofibular Joint Ankle Joint Subtalar Joint Talocalcaneonavicular Joint Calcaneocuboid Joint Cuneonavicular Joint

THORAX

BONES	*JOINTS*
Manubrium Sternum (Chest Bone) Ribs and Costal Cartilages Xiphoid Bones	Rib Joints Nanubriosternal Joint Xiphisternal Joint

5. RADIOGRAPHY

This technology is often used to determine medical conditions regarding bones and joints within the human body.
Diagnostic radiography refers to the radiography where both ionizing radiation and non-ionizing radiation are used, in order to create images for medical diagnoses.
The X-ray is the most common used test, and the X-rays are the second most common used test.
As the body is made up of different substances with different densities, X-rays can be used to see the internal structure of the body on film, by using attenuation (highlighting differences on the film).
In order to prevent X-ray film from exposure to stray X-rays, X-ray film should always be stored in lead containers.

Diagnostic Radiography includes several sub-categories:

Projection Radiography:

- creation of images by exposing an object to X-rays and capturing the shadow (remnant beam) as a latent image
- the shadow can be converted to light by using a fluorescent screen, captured by a phosphor screen to be read by laser
- X-rays of different amounts and strengths are used depending on what image is being taken
- hard tissue such as bone require high energy photon source, generally a tungsten anode is used with high voltage on a high-frequency machine to generate braking radiation
- soft tissue is seen with the same machine as hard tissue but with a less penetrating X-ray beam
- dental radiography uses small radiation doses with high penetration as teeth are very dense
- mammography is the examination of breasts and other soft tissue and is mainly used in women to screen for breast cancer

Fluoroscopy:

- technique that provides moving projection radiographs with lower quality
- mainly performed to view movement, or to guide a medical intervention like joint repair or replacement, angioplasty, or pacemakermaker insertion
- fluoroscopy is used to view the cardiovascular system, this process is called angiography

Dual Energy X-ray absorptionetry:

- primarily used for osteoporosis testing
- X-rays are emitted in two narrow beams that are scanned across the patient
- areas imaged are usually lower back, hip and/ or heel to determine the bone density
- dual energy X-ray is not used for bone imaging

Computed Tomography:

- also known as CT scan that uses high amount of ionizing radiation with a computer to create images
- in general the examination is short
-

6. COMMON MEDICAL CONDITIONS

OSTEOPOROSIS

- disease of bones that leads to an increased risk of fracture
- osteoporosis is the reduction of bone mineral density, disruption of bone microarchitecture and the alteration of amount and variety of non-collagenous proteins in bone
- it is most common in women after menopause, called postmenopausal osteoporosis
- it can also develop in men and women (before menopause) due to particular hormonal disorders or other chronic disease, or even as a result of smoking or medications such as glucocorticoids
- can be treated with bisphosphonates and other medical treatments

OSTEOGENESIS IMPERFECTA

- genetic disorder also known as brittle bone disease
- people are born with defect connective tissue or without ability to produce it
- symptoms include weak bones, causing them to be more susceptible to fractures
- other classic symptoms include: multiple bone fractures, blue tint to whites in the eyes, early hearing loss, bowed arms and legs, kyphosis and/ or scoliosis
- definite diagnosis can be done using skin punch biopsy
- there is no cure for osteogenesis imperfecta, although specific therapies can reduce pain and complications that are associated with this disease
- medications like bisphosphonates can be used to treat osteogenesis imperfecta

BONE FRACTURES

- medical condition where a break in the continuity of the bone is present
- can be the result of high force impact or injury, even certain medical condition can cause bones to weaken
- fractures can be described as either closed fractures (skin is intact) or open fractures (wounds are present, causing the bone to be exposed to contamination, leaving risk of infection)
- symptoms of bone fracture can include swelling, bruising, pain, deformation and/ or the inability to use the limb
- bone fractures can be diagnosed by physical examination or by imaging technology
- treatments for bone fracture can be classified into conservative or surgical
- conservative treatment include pain management, immobilization and other non-surgical stabilization
- surgical treatment is usually done when conservative treatment fails

DISLOCATION OF JOINT

- the articular surface of the joint is abnormally displaced so that one surface loses its contact with the other
- commonly caused by trauma
- symptoms include deformation, pain and loss of function
- x-rays can be used to confirm diagnosis
- treatment is generally done by health professionals by forcing the joint back into its normal location

SPRAIN

- condition caused by overstretching joints beyond their capacity
- symptoms include bruising, swelling and/ or decrease in ability to move
- diagnosis is made by physical examination
- x-rays can also be done to ensure there are no fractures
- treatment depends on the level of injury and the joint affected
- medications such as non-steroidal anti-inflammatory drugs can be used to ease pain
- other treatment options include ice, compression, rest and/ or elevation

ARTHRITIS

- inflammation of one or more joints
- can be caused by a variety of diseases
- most common types of arthritis include osteoarthritis, theumatoid, psoriatic and septic arthritis
- regardless of arthritis type, symptoms include pain, joint stiffness, swelling, muscle ache, weight loss, inability to use the hand or foot and/ or tenderness
- diagnosis is made by clinical examination
- diagnosis can be supported by tests such as blood tests or radiology
- there is no cure for this condition
- treatment can include physical therapy or medications such as acetaminophen or ibuprofen, depending on the type of arthritis
- diathermy, therepeutic generation of heat in body tissue, is also commonly used to treat arthritis

NEUROPATHIC JOINT

- progressive degeneration of a weight bearing joint that can result in loss of function and reflexes
- commonly caused by tabes dorsalis, leprosy and syringomyelia
- symptoms may include swelling, excessive mobility and/ or bony destruction
- treatment can include immobilization with total contact cast, pneumatic walking braces and/ or surgical correction of the joint (rarely successful in long-term)

CHAPTER VIII

REPRODUCTIVE SYSTEM

Contents

1. FEMALE REPRODUCTIVE SYSTEM

There are two main parts to the reproductive system of women. The ovaries produce the eggs, and the uterus passes a males sperm through to the tubes and carries the fetus.
The conception (fertilization) of eggs occurs in the fallopian tubes. Once fertilization takes place, the egg is implanted into the uterus walls where the initial stages of pregnancy begin.
If no fertilization took place, the system is build to menstruate.
The female reproductive system also produces female sex hormones which maintain this reproductive cycle.
Menopause is the stage in which the reproductive systems slowly stop making these female sex hormones, therefore ending the reproductive cycle.

ANATOMY OF THE FEMALE REPRODUCTIVE SYSTEM

The female reproductive systems consists of parts inside as well as outside the body.
Functions of the outside structures are to allow sperm to enter the body and to protect genital organs from infectious organisms.

External Organs

Labia Majora
- also known as large lips
- enclose and protect other external organs
- contain sweat and oil-secreting glands
- covers with hair after puberty

Labia Minora
- also known as small lips
- located just inside the large lips
- surround the openings to the vagina and urethra

Bartholin's glands
- located beside the opening of the vagina
- glands produce mucus secretion

Clitoris
- the two small lips meet here
- covered by the prepuce (fold of skin)
- sensitive to stimulation and able to become erect

Internal Organs

Vagina
- also known as the birth canal
- canal that joins the cervix to the outside of body

Uterus
- hollow organ that carries the fetus
- divided into the cervix and the corpus
- corpus can expand being able to hold a baby
- sperm can enter and menstrual blood exit via a channel through the cervix

Ovaries
- small glad located on both sides of the uterus
- ovaries produce eggs and hormones

Fallopian Tubes
- narrow tubes attached to the uterus (upper part)
- tubes aid as tunnels for egg cells

THE MENSTRUAL CYCLE

Women in a reproductive age (before menopause) experience monthly cycles of hormonal activity.
With each cycle, the female body prepares for a possible pregnancy.
The word menstruation refers to a monthly excretion of uterine lining.
An average cycle takes about 28 days (some cycles are shorter or longer) and happens in different phases – follicular phase, ovulatory phase and the luteal phase.
The menstrual cycle includes four major hormones: estrogen, progesterone, follicle-stimulating hormone and luteinizing hormone.

Follicular Phase

- starts on the first day of the period
- the brain releases follicle-stimulating and luteinizing hormones that travel in the blood to the ovaries
- these hormones stimulate growth of up to 20 eggs within the ovaries, each in a follicle (shell)
- these hormones trigger an increased production of estrogen
- as estrogen levels increase, the production of follicle-stimulating hormone stop
- this function of balance allows for control of follicles that mature
- as the follicular phase continues, one follicle will become dominant and mature

Ovulatory Phase

- starts about 14 days after follicular phase and is the mid part of the menstrual cycle
- the estrogen increase from the maturing follicle triggers production of the luteinizing hormone
- this causes the release of the egg from the ovary
- the released egg is caught by projections on the end of the fallopian tubes
- cervix produces more and thicker mucus, which helps sperm moving towards egg for fertilization

Luteal Phase

- this phase begins after ovulation
- once the follicle releases the egg, the follicle will develop into the corpus luteum
- the corpus luteum secretes progesterone which prepares the uterus to implant the fertilized egg
- if sperm fertilizes the egg, this egg will move through the fallopian tube and implant in the uterus
- this stage is considered as being pregnant
- if the egg is not fertilized it will pass through the uterus as the uterus lining breaks and the period starts

PREGNANCY

- the average pregnancy lasts about 40 weeks and is divided into three trimesters
- symptoms of early pregnancy: breast changes, absence of periods, nausea and/ or mood swings
- symptoms of late pregnancy: heartburn, swelling of ankles and fingers and/ or sleep problems
- during prenatal care, doctors use pelvimeters to determine a females pelvis in relation to the birth of the baby
- at 37 weeks a baby is considered full term as his organs are able to function on their own
- near due date the baby might turn into a head-down position for the birth
- babies generally weight between 6 to 9 pounds and are usually 19 to 21 inches long
- after giving birth, women experience physical and emotional changes and therefore receive post-partum care

First Trimester

- first trimester refers to pregnancy weeks 1 to 12
- hormonal changes in the first trimester affect almost every organ
- even in the first trimester these changes can trigger symptoms
- such as: tiredness, swollen breasts, mood swings, cravings for food, throwing up (morning sickness), headaches, heartburn and/ or weight loss or gain

Second Trimester

- second trimester refers to pregnancy weeks 13 to 28
- this trimester is found to be easier than the first
- symptoms from the first trimester now usually begin to fade
- more noticeable changes to the body will occur
- symptoms may include growing belly, body aches, stretch marks, numb or tingling hands, darkening around the nipples and/ or swelling of fingers, ankles or even face

Third Trimester

- third trimester refers to pregnancy weeks 29 – 40
- symptoms can include difficulty breathing, more frequent urination, heartburn, tender breasts, trouble sleeping, further growing belly and/ or contractions may occur
- near the due date the cervix becomes softer and thinner which helps the vagina to open during birth

2. MALE REPRODUCTIVE SYSTEM

ANATOMY OF THE MALE REPRODUCTIVE SYSTEM

External Organs	Internal Organs
Penis - the organ which is used for intercourse - the penis consists of three parts: the root (attaches to the abdomen wall), the shaft, and the glans (penis head) covered with the foreskin - removal of foreskin is called circumcision - transport of seamen happens through the urethra (a tube at the tip of the penis) - penis body has three chambers (circular shape) that are made of sponge-like tissue - this tissue has spaces which fill with blood as a men become aroused, therefore erecting the penis - as the man reaches the orgasm (climax) semen, the reproductive cells, are expelled through the end of the penis *Scrotum* - pouch-like sac that hanging below the penis - contains testicles, nerves and blood vessels - in order for normal sperm to develop, testicles must have a temperature a little cooler than the body temperature - muscles in the scrotum wall allow for relaxing and contractions *Testes* - oval shaped organs located inside the scrotum - responsible for making the primary male sex hormone (testosterone) and generating sperm - seminiferous tubes, located within the testicles, are responsible for sperm cell production	*Epididymis* - mass of coiled tube located against the testicles - transports, stores and matures sperm - during arousal, contractions move sperm into the vas defenrens *Vas deferens* - know as the sperm duct - muscular tube that transports sperm to the urethra to prepare for ejaculation (semen release) *Seminal vesicles* - sac-like pouches that attach to the vas deferens - produce fructose to provide sperm with energy - this fluid makes up most of the ejaculatory fluid *Prostate Gland* - located below the urinary bladder before rectum - contributes additional fluid to the ejaculate - urethra runs through the prostate gland *Bulbourethral glands* - also known as Cowper's glands - located on the sides of the urethra below the prostate gland - produce a clear fluid that empties into the urethra - fluid serves to lubricate the urethra as well as to neutralize any acid in the urethra

3. SEXUALLY TRANSMITTED DISEASE

Bacterial Vaginosis (BV)

- condition where the normal balance of bacteria in the vagina is disrupted
- most common vaginal infection in women of childbearing age
- symptoms can include abnormal vaginal discharge
- can be diagnosed by examination of the vagina or laboratory tests
- treatment includes the use of antibiotics

Chlamydia

- condition caused by bacteria called chlamydia trachomatis, that can damage the reproductive organs of women
- most frequent reported bacterial STD
- transmitted during oral, vaginal or anal sex
- symptoms may include abnormal vaginal discharge in women and/ or burning sensations while urinating, abdominal pain, fever or nausea
- symptoms in men may include discharge from the penis and/ or a burning sensation while urinating
- laboratory tests may be done to diagnose chlamydia
- treatment includes the use of antibiotics

Gonorrhea

- caused by the bacteria neisseria gonorrhoeae
- very common infectious disease
- caused by contact with genitals (penis, vagina), the mouth and/ or anus
- symptoms in women may include painful urination, vaginal discharge and/ or bleeding between menstrual cycle
- symptoms in men may include burning sensation while urinating, colored discharge from the penis and/ or even swollen testicles
- laboratory tests can be performed to diagnose gonorrhea
- antibiotics are used to treat this disease

Hepatitis

- three types of hepatitis: A, B and C

Hepatitis A

- incubation period of about 28 days
- transmitted by the fecal-oral route
- symptoms include rash, diarrhea, vomiting and/ or pain
- diagnosis is reached by serologic testing
- treatment is done by medications

Hepatitis B
- incubation period between 6 weeks to 6 months
- transmitted through unprotected sex
- symptoms include fatigue, vomiting and/ or dark urine
- diagnosis can be reached with serologic testing
- usually resolves on its own
- no medications are available to prevent hepatitis B from becoming a chronic condition

Hepatitis C
- incubation period between 1 to 6 months
- transmitted by any source of blood or blood products
- symptoms include diarrhea, nausea, pain and/ or fatigue
- diagnosis can be reached by screenings or blood tests
- treatment involves the use of antiviral medications

<u>Herpes</u>
- incubation period between 6 to 8 days
- transmitted by direct skin or mucous membrane contact
- symptoms include burning sensation in the genital area, fever, pain in the genital area, pain while urinating and/ or genital discharge
- can be diagnosed by examination or testing samples from sores
- no cure, antiviral medications are used to treat this condition

<u>HIV</u>
- HIV is the virus that causes Aids
- incubation period varies depending on the individual
- most commonly transmitted through sexual contact, needle sharing by drug users and/ or from mother to child during labor
- symptoms include sore throat, fever and/ or swollen glands
- diagnosis can be reached through an antibody test called ELISA, if the antibody test is positive or reactive, a confirmatory blood test is done, called the Western Blot test
- there is no cure for HIV
- antiviral medications are used to treat this disease

<u>Human Papillomavirus</u>
- most common STI (sexually transmitted infection)
- transmitted usually direct skin and/ or direct genital contact
- symptoms may include genital warts and/ or even cancers
- diagnosis is usually made based on pap smear results (women), although there are no tests to detect HPV in men
- there is no cure for HPV and usually the body rids of the virus itself
- treatment can include treating symptoms such as warts

Pelvic Inflammatory Disease
- infection of the female reproductive organs
- complication of STDs such as gonorrhea and chlamydia
- causes are untreated sexually transmitted disease
- symptoms include fever, vaginal discharge, painful intercourse and/ or abdominal pain that can range from mild to severa
- diagnosis can be reached by physical examination and/ or testing for the presence of chlamydia or gonorrhea
- treatment can involve several types of antibiotics

Syphilis
- caused by the bacteria treponema pallidum
- commonly caused through sexual activity with infected person
- symptoms vary with each stage
    - Primary Stage: small sore appears where the bacteria entered body
    - Secondary Stage: rash develops (eventually covering entire body)
    - Latent Stage: the infection continues with no symptoms present
- to diagnose syphilis, either the sore can be examined or by blood tests
- an antibody test called Wassermann Test can also determine syphilis
- if treated in early stages, syphilis is easy to cure with antibiotics
- if left untreated syphilis can cause complications

Trichomoniasis
- symptoms usually affect women more commonly
- caused by trichomonas vaginalis
- in men, the urethra is the most common infection site
- in women, the vagina is the most common infection site
- transmitted through penis-to-vagina or vagina-to-vagina contact
- symptoms include vaginal odorous discharge, discomfort during sex or urination as well as itching of the genital area
- physical examination is performed to determine this condition
- usually treated with medications

4. COMMON MEDICAL CONDITIONS

Infertility

- biological inability to contribute to reproduction
- causes for both sexes can include genetic factors, environmental factors and/ or general factors
- cause for infertility in men is mostly a deficiency in semen and low semen quality
- causes for infertility in women range from age, tubal blockage, uterine problems and / or problems with ovulation
- infertility can have a high impact on the psychological state of the affected person
- the person affected by infertility may be anxious, fall into depression and/ or emotional stress
- in certain cultures, infertility can lead to rejection in closed social (cultural) groups
- treatment for infertility may include medical treatments as well as alternative treatments

Impotence

- sexual dysfunction that characterizes itself in the inability to maintain erection of the penis
- causes can vary from psychological disorders, age, surgery, drugs to a persons lifestyle
- the main symptom is the inability to maintain an erection of the penis
- tests can be performed to see whether it is psychological or physiological impotence
- such tests are: duplex ultrasound, penile biothesiometry, nocturnal penile tumescence, dynamic infusion cavernosometry, corpus cavernosometry and/ or magnetic resonance angiography
- treatment of impotence depends much on the cause
- treatment may be as simple as exercise or may even include medications

CHAPTER IX

DIGESTIVE SYSTEM

Contents

1. ORGANS OF THE DIGESTIVE SYSTEM

ABDOMEN
- body part which contains digestive organs
- located between diaphragm and pelvis

ALIMENTARY CANAL
- passage through which food travels
- includes the mouth, esophagus, stomach, intestines and the anus

ANUS
- opening at the end of the digestive system
- excretes waste (feces) from the body

APPENDIX
- small sac which is located on the cecum

ASCENDING COLON
- part of the large intestine (upwards running)
- located after the cecum

BILE
- digestive chemical
- produced in the liver, stored in the gall bladder, secreted into the small intestines

CECUM
- first part of the large intestine
- connected to the appendix

CHYME
- partially digested food in the stomach mixed with stomach acids
- for further digestion chyme moves on to the small intestine

DESCENDING COLON
- part of the large intestine (downwards running)

DUODENUM
- first part of the small intestine
- runs from the stomach to the jejunum

EPIGLOTTIS
- flap at the back of the tongue
- keeps swallowed food from going down to the lungs through the windpipe
- as a person swallows, the epiglottis closes – as a person breathes in, the epiglottis opens

ESOPHAGUS
- long tube between mouth and stomach
- rhythmic muscle movements are used to force food from throat to stomach

GALL BLADDER
- small sac-like organ that stores and releases bile
- located by the duodenum

GASTROINTESTINAL TRACT
- commonly known as the GI tract
- systems that processes food and excretes waste (feces)

ILEUM
- last part of the small intestine before large intestine begins

INTESTINES
- part of the alimentary canal
- located between stomach and anus

JEJUNUM
- long and coiled middle part of the small intestine
- located between duodenum and ileum

LIVER
- filters toxins from the blood and produces bile
- located above and in front of the stomach

MOUTH
- first part of the digestive system in which food enters the body
- salivary enzymes begin the process of digestion

PANCREAS
- enzyme producing gland
- enzymes help in digestion of fats, proteins and carbohydrates
- located below the stomach and above the intestines

PERISTALIS
- rhythmic muscle movements which force food in the esophagus
- involuntary as it cannot be controlled

RECTUM
- lower part of the large intestine
- feces are stored here before being excreted

SALIVARY GLANDS
- glands that are producing saliva, which breaks down carbohydrates
- located in the mouth

SIGMOID COLON
- part of the large intestine
- located between descending colon and rectum

STOMACH
- sac-like muscular organ which is attached to the esophagus
- chemical and mechanical digestion take place in the stomach

TRANSVERSE COLON
- part of the large intestine
- runs across the abdomen

2. DIGESTIVE PROCESS

MOUTH

The mouth is the first part of the digestive system. Digestion actually starts before the first bite, as the smell of food triggers the salivary glands to produce saliva, therefore causing the mouth to water. Once the process of chewing and breaking down food has started, other mechanisms begin to work. Saliva production is increased, helping to break down food into a more absorbable form.

PHARNYX AND ESOPHAGUS

This part of the digestive tract is what receives the food from the mouth.
The esophagus branches off of the pharnyx. The esophagus carries the food to the stomach.
Swallowing takes place in the pharnyx (throat), part as reflex, and part as voluntary controlled.
The esophagus is a muscular tube which is extending from the throat. Food is forced through the tube and into the stomach.

STOMACH AND INTESTINES

The stomach is a sac-like organ that has strong muscular walls. The stomach holds food, mixes and grinds food.
It also secretes acids and enzymes that continue the process of breaking down food and changing it into a form that is more absorbable for the body.
Food travels from the stomach to the small instestine, which is made up of three parts – duodenum, jejunum and ileum.
The small intestine breaks down food as well by using enzymes that are released by the pancreas and bile from the liver.
Nutrients are absorbed through the walls into the bloodstream while food is in the small intestine – the waste will move into the large intestine.

COLON, RECTUM AND ANUS

The large intestine (colon) is a long muscular tube which connects to the small intestine and to the rectum. It consists of the ascending (right), descending (left), transverse (across) and the sigmoid colon. Attached to the ascending colon is the appendix.
The waste (feces) passes through the colon in a liquid shape first, and then transforming into solid form.
In general, it takes about 36 hours for stool (food debris and bacteria) to get through the colon.
As the descending colon fills with stool it empties the contents into the rectum. The rectum receives the stool from the colon, signals that there is stool to be excreted and holds the stool until excretion.

3. VITAMINS AND MINERALS

Vitamins and minerals are an essential part for the maintenance of proper health.

Vitamins are put into two groups: water-soluble which are vitamins B and C and fat-soluble which are vitamins A, D, E and K.

VITAMINS

Vitamin A - strong antioxidant
- essential for growth, healthy skin and healthy hair
- found in: cheese, butter, eggs, milk, chicken, kidney, liver, fish oils, trout and herring

Vitamin B - B6 and B12 help in the use of folic acid
- important nutrient in the process for cell repair, digestion, energy and the immune system
- found in: animal products (meat), asparagus, broccoli, potatoes, milk, eggs, cheese, and nuts

Vitamin C - very strong antioxidant
- important for healthy body tissue, growth, cell repair and immune system efficiency
- found in: strawberries, oranges, mango fruit, kiwi fruit, peas, and broccoli

Vitamin D - important for healthy teeth and bones
- found in: fish, liver, milk, eggs, butter, cheese

Vitamin E - important vitamin for cell maintenance, heart health, blood and circulation
- found in: salmon, tomatoes, avocados, nuts, whole grain, and sunflower oil

Vitamin K - important for blood clotting process and maintenance of strong bones
- found in: green vegetables (spinach, cabbage, and broccoli), avocado, grapes, and kiwi

Folic Acid - works with vitamin B12
- important for healthy blood cell production
- found in: liver, dried beans, tomatoes, whole grain, green vegetables

MINERALS

Minerals are divided into groups: major minerals (more than 100 mg/ day needed) and minor minerals, also known as trace elements (less than 100 mg/ day needed).

Major Minerals: - calcium, magnesium, phosphorus, potassium, sodium and chloride

Minor Minerals: - chromium, copper, iodine, iron, fluoride, manganese, selenium and zinc

Calcium - important for strong bones
- found in: nuts, broccoli, sesame seeds, salmon, and sardines

Magnesium - important for regulation of potassium and sodium levels in the body
- found in: apricots, bananas, brown rice, nuts, raisins, peas, sweet corn

Iron - important for healthy muscles and blood
- found in: prunes, eggs, beans, peas, tuna, nuts, liquorice

Selenium - important for a healthy liver
- found in: cashews, cheese, milk, eggs, onion, garlic, sunflower seeds, salmon

Potassium - works with sodium
- important as it regulates the water level of the body
- found in: almonds, barley, bananas, potatoes, corn, ginger, apricots

Zinc - antioxidant that is important in the maintenance of a healthy immune system
- found in: brown rice, crab, lobster, sardines, cheese, oysters, lean red meat

4. COMMON MEDICAL CONDITIONS

COLON CANCER

- condition in which cancer is affecting the large intestine
- symptons of colon cancer may include rectal bleeding or blood in stool, change in bowel habits, unexplained weight loss and abdominal pain and discomfort
- diagnosis can be done through blood tests, examination of the colon, CT scans and/ or X-rays
- treatments include radiation therapy, chemotherapy, medication and / or surgery

CONSTIPATION

- condition where a person experiences infrequent and/ or uncomfortable bowel movements
- causes may include personal lifestyle habits, as well as the intestine removing too much water
- symptons of constipation include painful bowel movements and feeling bloated
- in order to diagnose constipation a physical examination needs to be done
- tests for diagnosis of constipation can be Colonoscopy, Sigmoidoscopy and Anorectal funtion test
- treatment can include diet changes, laxatives and/ or enemas (to clear the bowel)

CROHN'S DISEASE

- inflammation of parts of the digestive tract
- symptoms can be abdominal pain, weight loss, diarrhea and poor appetite
- according to science, Crohn's disease may be caused by the immune system mistaking bacteria and food as “invaders” to the digestive system
- in many cases Crohn's disease run's in the family (more than 1 family member has it)
- tests and physical examination are needed to diagnose Crohn's disease
- treatment can include vitamin supplements, medication and/ or surgery

DYSPEPSIA

- condition in which indigestion (disturbance of diagestion) occurs
- symptoms may include fullness and tenderness upon touching, abdominal pain and bloating
- to diagnose dyspepsia, doctors can order blood tests, X-ray or even endoscopy
- treatment may include lifestyle and diet changes as well as medication

GALLSTONES

- small substances developed in the gallbladder
- form as stored liquid in the gallbladder hardens into small pebble-like pieces
- symptoms may include abdominal pain, vomiting and nausea, grey colored stools or fever
- CT scans and blood tests can be performed to diagnose this condition
- treatment may include grapefruit juice (gallbladder flushing), medication and/ or surgery

GASTRITIS

- inflammation of the stomach lining
- causes may include smoking, spicy foods, infection and/ or surgery
- symptoms include stomach pain, abdominal bleeding, vomiting and/ or blood in stool
- gastritis can be diagnosed by blood tests, testing of stool and even gastroscopy
- treatment depends on factors such as persons age, severity of condition and medication tolerance

LACTOSE INTOLERANCE

- condition caused by the lack of the enzyme lactase, therefore the body is unable to digest lactose
- most common symptons include cramps, bloating, nausea, gas and/ or diarrhea
- condition can be diagnosed through lactose tolerance tests or hydrogen breath tests
- treatment depends on the patients overall health, the severity of the condition and other factors

CHAPTER X

URINARY SYSTEM

Contents

1. ORGANS OF THE URINARY SYSTEM

The urinary system is defined as the group of organs that are responsible for filtering out excess fluid and substances from the bloodstream. These excess fluids as well as other substances are filtered out in the form of urine.
Urine is a liquid that is produced by the kidneys, collected in the bladder and then discharged through the urethra (tube that connects urinary bladder to the genitals to removal excess fluids).

Urine is also used to withdraw excess vitamins, minerals and/ or blood cells from the body.

Organs of the urinary systems are the kidneys (main organs of the urinary system), the bladder, ureters and the urethra, although the urinary systems work with other body systems to maintain internal stability.

KIDNEYS

The body consists of two kidneys that are located on each side of the spine, high in the abdominal cavity, and somewhat protected by the lower ribs.
The kidneys long axes are even with the body, but the kidneys upper end is slightly tilted toward the backbone.
The hilus, located in the midsection of the medial concave border, is the entry and exit point of the renal veins and arteries, nerves, lumphatic vessels and the upper end of the ureters.

Kidneys are reddish brown in color, resemble the shape of a bean and have a size of about 4 – 5 inches.

Kidneys consists of three main areas – the renal cortex, the renal medulla and the renal pelvis.

Renal cortex:	Outer portion of the kidneys between the renal capsule (fibrous layer surrounding the kidney) and the renal medulla (innermost part of the kidneys or center).
Renal medulla:	The center of the kidneys where blood enters through the renal artery. The renal medulla holds the structures of nephrons, which are maintaining the water-salt balance of blood.
Renal pelvis:	The upper end of the ureter, a tube through which urine flow from the kidneys to the urinary bladder takes place.
Renal artery:	These arteries arise from the abdominal aorta, giving off small branches to the adrenal gland and ureter, then branches into anterior and posterior divisions.

URETERS

The ureters are two narrow tubes that channel urine from the kidneys to the bladder.
These tubes (ureters) emerge from the kidneys (one ureter from each kidney), move down behind the abdominal cavity and open the bladder.
The strong walls of the ureters move the urine into the bladder. Once urine enters the bladder, small folds within the bladder mucosa prevent the backflow of urine.
At times the ureters can become infected, cause urinary tract infections.

URINARY BLADDER

The urinary bladder is the organ that temporarily stores urine from the kidneys. It is a muscular, hollow and extensible organ that is located in the pelvis.
It is connected to the kidneys through the ureters (tube like structures) and can hold about 15 ounces of urine.
Once filled with urine, so called stretch receptors send impulses to the spinal cord which sends back a reflex nerve impulse to the sphincter, a muscular valve at the bladder neck.
As urination starts, the sphincter muscles relax, therefore allowing urine to flow into the urethra and out of the body.

URETHRA

This is the last part of the urinary system, as it is the part that removes urine from the body.
In men and women, the urethra is different in length. In women, it is about 1.5 inches long, but in men it measures between 6 – 8 inches in length.
This difference in length is considered to be a reason why women are more susceptible to bladder infections than men, as bacteria travels a much shorter distance.
In women, the urethra opens in the vulva, between the clitoris and the vaginal opening.
In men, the urethra opens at the end of the penis head.

URETHRA SPHINCTER

The sphincters are muscles that are used to control urine flow from the bladder.
Sphincter muscles surround the urethra. As these muscles contract the urethra is closed.

It is divided into to areas of muscle:

- internal sphincter (located at the neck of the bladder)
- external sphincter

Men have much stronger sphincter muscles which allows for more urine to be stored.

NEPHRONS

Nephrons are structural and functional components of the kindneys. A nephron is actually the structure responsible for the production of urine in the process of waste removal and excess substances from blood. Nephrons remove waste from the body, manage blood pressure and volume, control levels of electrolytes and metabolits, and manage the blood pH.
The functions of nephrons are essential to life and are regulated by the endocrine system by hormones (as aldosterone, antidiuretic hormone and parathyroid hormone).
Each nephron has its own blood supply from two capillary regions from the renal artery and is made of an initial filtering part (renal corpuscle) and a tubule (renal tubule), specialized for reabsorption and secretion.
The renal corpuscle filters out large solutes (the substance dissolved in solvent to form a solution) from the blood, and then transferring small solutes and water to the renal tubule for adjustment.

GLOMERULUS

A capillaries tuft, located within a Bowman's capsule (cup-shaped structure, located around the glomerulus of nephrons) at the end of the renal tubule. It filters waste out the blood and initiates the formation of urine.
The excess blood that is not filtered into the glomerulus passes into the efferent arteriole, and then moves into the vasa recta (collecting capillaries connected with convoluted tubules), where the reabsorbed substances enter as well.
Connecting with efferent venules from other nephrons into the renal vein, it rejoins into the main bloodstream.

AFFERENT / EFFERENT ARTERIOLES

The afferent arteriole is a branch of an interlobular artery going to the renal glomerulus, to supply nephrons. Later the afferent arterioles will branch off to the capillaries of the glomerulus.
Afferent arterioles are an important part in regulating blood pressure.

The efferent arteriole is a branch of an interlobular artery that is arising from the renal glomerulus and breaking up into capillaries to supply renal tubules.
Efferent arterioles are an important part in maintaining the glomerular filtration rate in blood pressure.

BOWMAN'S CAPSULE (glomerular capsule)

This capsule (cup-like sac) that surrounds the glomerulus, is made of visceral (simple inner squamous cells) and parietal (simple outer squamous cells) layers.
The outside of the capsule consists of two “poles”: the vascular pole (side with the afferent and efferent arteriole), and the urinary pole (side with the proximal convoluted tubule).

Inside the capsule (outside to inside), the layers are: the parietal layer (single layer of simple squamous epithelium) that does not function in regards of filtration, the Bowman's space (between visceral and parietal layer, where filtrate enters), the visceral layer (located above the glomerular basement membrane), the filtration barrier (made of the fenestrated endothelium of the glomerular capillaries, fused basal lamina and the endothelial cells and podocytes) that allows the passage of ions, water and small molecules from the bloodstream to enter the Bowman's space.

PROXIMAL CONVOLUTED TUBULE (PCT)

This tube is the part of the duct system of nephrons that lead from the Bowman's capsule to the loop of Henle.
A very distinctive characteristic of this tube is the brush border (microvilli-covered surface).
The PCT can be separated into two parts – the pars convoluta and the pars recta.

- Pars convoluta: Defined as the initial convoluted portion, and confined to the renal cortex.
- Pars recta: Defined as the following straight portion, descending into the outer medulla.

The PCT is responsible for regulating the pH of filtrate through the exchange of hydrogen ions in the interstitium for bicarbonate ions in the filtrate. It is also responsible for the secretion of organic acids (like creatinine or other bases) into the filtrate.

DISTAL CONVOLUTED TUBULE (DCT)

This tube is part of the nephrons, located between the loop of Henle and the collecting duct system and is similar in structure and function to the PCT.
The cells that are lining the DCT have many mitochondria which enable active transport by the energy supplied, with the main ion transport being regulated by the endocrine system.
If the parathyroid hormone is present, the DCT will reabsorb more water and excrete more phosphate.
If aldosterone is present, the DCT will reabsorb more sodium and excrete more potassium.
Causing the excretion of more sodium is the atrial natriuretic peptide.
In order to regulate pH, the DCT also secretes hydrogen and ammonium.

2. FUNCTIONS OF THE URINARY SYSTEM

A major function of the urinary system is the process of eliminating waste products of the metabolism and other materials, also called excretion.
By regulating the amount of water that is excreted in the urine, the urinary system can maintain an appropriate amount of fluid (fluid volume).
The urinary system also regulates the concentration of certain electrolytes that are in body fluids and the maintenance of a normal pH of blood.

There are several organs that carry out excretion, with the kidneys being the most important one of the excretory organs.
The kidneys primary function is the maintenance of homeostatis (stable internal environment), in order to ensure optimal cell and tissue metabolism. Kidneys do this by separating mineral salts, toxins, urea and other waste products from the blood.
Kidneys also conserve water, salts and electrolytes.
In order to mainain life, at least one kidney has to function properly.

There are six important roles of the kidneys. These six roles are:

- *Regulation of plasma ionic composition*
  (ions like potassium, magnesium, sodium, chloride, calcium, bicarbonate and phosphates)
  - these compositions are regulated by the amount excreted by the kidneys

- *Regulation of plasma osmolarity*
  - osmolarity is regulated by the kidneys as they have direct control on how many ions and how much water is excreted

- *Removal of metabolic waste and other substances from the plasma*
  - while the liver breaks down amino acids, it releases ammonia, with the liver then combining that ammonia with carbon dioxide and creating urea (primary nitrogenous end product of metabolism), which is less toxic
  - ammonia, uric acid (from the break down of nucleotides) and creatinine (from the metabolic break down of creatine phosphate, a high energy phosphate in muscles) can also be excreted, although in small amounts
  - too much uric acid in the blood can build up and form crystals that can accumulate in the joints and cause gout

- *Secretion of hormones*
  - kidneys are assisting the endocrine system when releasing hormones
  - kidneys release renin, and renin leads to the secretion of aldosterone, which is then released from the adrenal cortex
  - aldosterone helps the kidneys to reabsorb sodium ions
  - if the blood doesn't have the capacity to carry oxygen the kidneys also secrete erythropoietin, which stimulates the production of red blood cells

3. FORMATION OF URINE

The formation of urine happens in three steps: filtration, reabsorption and secretion.

FILTRATION

Filtration, the first step in the urine formation, is the process that occurs continually in the renal corpuscles.
As the blood passes through the glomerulus, much of the fluid in the blood, which contains useful chemicals as well as dissolved waste materials, washes out the blood. It is then filtered as it moves into the Bowman's capsule – this is called the glomerular filtration.

The waste products, salt, water, glucose as well as other chemicals that were filtered out the blood are known as glomerular filtrate, which consists mainly of excess salt, water, glucose and waste products of the body known as urea.

Urea is produced by the body to remove ammonia, which is formed in the liver from amino acids.
Urea is the most abundant of waste products that have to be excreted by the kidneys.

REABSORPTION

Reabsorption is defined as the movement of molecules and ions from the renal tubules back into the blood capillaries.
The substances that are reabsorbed are glucose, water, salt, other nutrients and other ions.
The process of reabsorption begins in the PCT (proximal convoluted tubules), continues in the loop of Henle, the DCT and collecting tubules.

There are three main substances that are reabsorbed into the bloodstream.

- *WATER:* Large amounts of water are reabsorbed back into the bloodstream from the PCT.
  This happens because the physical forces acting on water in these tubules push most of the water back into blood capillaries.
  The process of water leaving the blood by glomerular filtration and returning to the bloodstream from the PCT is called passive reabsorption.

- *GLUCOSE:* Glucose (blood sugar) is all reabsorbed back in the bloodstream from the PCT. The blood sugar is moved out of the tubules and into the peritubular capillary blood – with none of it being wasted or lost through excretion of urine.
  But even with the kidneys working efficiently, the nephrons can reabsorb only so much sugar and water, and these limits are shown in cases of diabetes mellitus.
  Diabetes mellitus is a disease which causes the blood sugar to rise above normal blood sugar levels.

- *SODIUM IONS:* Sodium ions as well as other ions are partially reabsorbed back into the blood from the renal tubules.
  The amount of sodium ions that are reabsorbed can vary from time to time, and mainly depends on how much salt is taken in through the diet.
  As a person takes in more sodium through the diet, the kidneys will decrease the sodium amount that is being reabsorbed back into the blood.

SECRETION

The third step in the formation of urine is secretion. It is the process in which substances move from the blood in the capillaries into the distal and collecting tubules around these.

It is basically the reverse process of reabsorption – reabsorption moves substances out the tubules into the blood, and secretion moves substances out the blood into the tubules where they mix with water as well as other wastes and then converted into urine.

These substances can either be secreted through an active transport mechanism or as a result of diffusion across the membrane.
The substances that are secreted are: potassium ions, hydrogen ions, ammonia and certain drugs.

Urine is basically the collection of substances that have not been reabsorbed during glomerular filtration or tubular reabsorption.

4. WATER-SALT BALANCE

Kidneys are responsible for maintaining the water-salt balance of the blood. Also, they maintain blood pressure and blood volume.
This balance can simply be changed by factors such as dehydration, ingesting water, blood loss and salt ingestion.

REABSORPTION OF WATER

The anti-diuretic hormone (ADH) is responsible for the direct control of water excretion in the kidneys. ADH is released by the posterior lobe of the pituitary gland and causes insertion of water channels into the membranes of the cells that are lining the collecting ducts, therefore allowing water reabsorption to take place.
If ADH was not present, little water would be reabsorbed into the collecting ducts and thinner urine would be excreted as a result.
Several factors can cause changes to the secretion of ADH. For example, if blood plasma gets too concentrated, special receptors in the hypothalamus release ADH. When blood pressure falls, stretch receptors in the aorta and carotid arteries will stimulate ADH secretion in order to increase blood volume.

REABSORPTION OF SALT

Kidneys also regulate the salt balance in blood by controlling excretion and reabsorption of certain ions. ADH is an important part in the increase of water reabsorption, and therefore helps to weaken bodily fluids.
Kidneys have a regulated mechanism for reabsorbing sodium in the distal nephron, controlled by aldosterone, which promotes the excretion of potassium ions and reabsorption of sodium ions.
The release of aldosterone is started by the kidneys.
Following the reabsorption of sodium ions is the reabsorption of water, which causes an increase in blood pressure and blood volume.

ATRIAL NATRIURETIC HORMONE (ANH)

ANH is released by the atria of the heart when cardiac cells are stretched due to higher blood volume and prevents the secretion of renin by the juxtaglomerular apparaturs as well as the aldosterone by the adrenal cortex. This then promotes excretion of sodium – if sodium is excreted, so is water, which then causes blood volume and blood pressure to decrease.

HYPERNATREMIA

Hypernatremia is the increase in plasma sodium levels above normal.

Sodium levels play a major part in osmolarity regulation. The electrochemical gradient for sodium across the plasma membrane for excitable cells is critical for life.
Increased blood pressure and water retention are generally signs of hypernatremia.

If the plasma sodium levels are below the normal levels it is called hyponatremia. Signs for hyponatremia are hypotension and low plasma volume.

DIURETICS

Diuretics (also called water pills) are a medication used to elevate the rate of bodily urine excretion. Diuretics also decrease the volume of ECF (extracellular fluid) and are mainly used to produce a negative balance of ECF.

Diuretics are used to treat a variety of conditions including heart failure, hypertension, liver cirrhosis and certain kidney diseases as diuretics relieve the symptoms of these conditions by causing sodium and water loss through urine.

There are also diuretics (such as acetazolamide) which help in making urine more alkaline and are therefore helpful in the increased excretion of substances in case of overdose or poisoning.

Diuretics can either provoke or prevent certain hormones in the body to regulate urine production.

5. COMMON MEDICAL CONDITIONS

KIDNEY INFECTION

- medical term *pyelonephritis*
- type of urinary tract infection
- can occur in one or both kidneys
- usually caused by bacteria entering the urethra and traveling to the bladder and kidneys
- can cause infection to any part of the urinary tract
- if not treated properly, it can cause permanent damage to the kidneys and may lead to chronic kidney disease
- in rare cases, the bacteria causing the infection, can spread into the bloodstream, which can lead to sepsis (life-threatening condition)
- causes for kidney infection include surgery on urinary tract, bladder infections, long term use of catheters, enlarged prostate and kidney stones
- symptoms can include pain during urination, frequent urination, groin pain, fever or chills, foul-smelling urine, pus or blood in urine and/ or inability to urinate
- kidney infections are usually treated with antibiotics or antibacterial drugs
- the treatment medication should depend on the health of a person and the bacteria causing the infection, which can be identified through urine tests.

KIDNEY DISEASE

- kidney disease is the result from damage to the nephrons
- usually the damage occurs in both kidneys and happens gradually over years
- in the early stages there are no obvious symptoms
- the progress of the disease shows in the accumulation of fluid and wastes in the body
- once the kidneys fail or can't work efficiently to maintain life, a kidney transplant or undergoing dialysis is needed
- symptoms include loss of appetite, tissue swelling, itching, tiredness, nausea and vomiting, high blood pressure, drowsiness, difficulty urinating, and/ or darkening of the skin
- a person might be at risk for kidney disease if conditions like high blood pressure, diabetes, heart disease or kidney disease in family history are prominent
- diabetes and high blood pressure are the leading cause of kidney disease
- other causes may be glomerular disease and inherited and congenital kidney disease
- tests for the diagnosis of kidney disease include renal imaging and renal biopsy (biopsy is a medical test that involves the removal of cells and/ or tissues for examination)
- treatment of kidney disease is generally focused on the underlying cause and can include blood pressure management, monitoring blood sugar (diabetes) and/ or dietary and lifestyle changes

GLOMERULAR DISEASE

- condition that damages the glomerulus (plural form is glomeruli), a small structure within the kidney, that helps to clean blood of wastes by acting as filtration
- as the glomerulus or glomeruli become damaged, red blood cells and proteins can enter the urine
- proteins like albumin are important in taking out extra fluid from the body by acting as a sponge which draws the extra fluid into the bloodstream, until the kidneys remove this extra fluid
- if proteins like albumin enter the urine, blood is unable to absorb the excess fluid from the body, which results in the accumulation of fluid in face, feet, hands and/ or ankles leading to swelling
- glomerular diseases may also interfere with the secretion of waste products which can result in waste buildup in the blood
- symptoms may include swelling in hands, face, feet or ankles, foamy urine, blood in urine, reduced glomerular filtration rate and/ or low concentration of proteins in the blood
- causes can include infections, autoimmune diseases (when the body's immune system attacks the body itself) or sclerotic diseases (like diabetic nephropathy, glomerulosclerosis and focal segmental glomerulosclerosis)
- testing for glomerular disease can include testing samples of urine or blood, renal imaging or kidney biopsy
- treatment depends on the cause of glomerular disease
- when kidneys fail or can't work efficiently, dialysis or kidney transplant is needed

KIDNEY STONES

- one of the most common diseases of the urinary tract
- kidney stones are small hard substances developed from mineral salts and other waste products in urine
- usually these substances that make up kidney stones are dissolved in the urine
- once urine is too concentrated with salts and other substances, crystals are formed, these crystals stick together to form kidney stones
- as these stones pass through the narrow passages of the urinary tract they cause severe pain
- causes for kidney stones include urinary tract infections, hyperparathyroidism, renal tubular acidosis, cystinuria, cystic kidney disease or hyperoxaluria
- there are different types of kidney stones, calcium stones, uric acid stones, struvite stones and cystine stones
- certain factors may increase the risk for kidney stones such as not enough fluid intake, family history of kidney stones, diet, limited physical activity, gender, age and/ or medications
- most common symptom is sudden pain, but other symptoms can include painful urinating, blood in urine, fever and chills and/ or nausea and vomiting
- to diagnose kidney stones, blood and urine test can be done as well as x-rays and ultrasound
- treatment depends on the cause of kidney stones and can include extracorporeal shock wave lithotripsy, percutaneous nephrolithotomy or uteroscopic stone removal

URINARY RETENTION

- condition where a person is unable to empty the bladder properly
- can be acute or chronic
- acute means the person is unable to urinate at all even if the bladder is full
- acute urinary retention needs immediate medical treatment
- chronic urinary retention may urinate more often and/ or feel the urge to urinate
- chronic urinary retention may lead to future complications
- condition is caused by any health problem that causes an obstruction in the urinary tract and infection of the urinary tract which can cause swelling of the tract
- other causes can include bladder stone, surgery, medications, multiple sclerosis and diabetes
- symptoms depend much on the type of urinary retention
- in acute urinary retention, symptoms include abdominal pain or discomfort, inability to urinate or bloating in the lower belly
- in chronic urinary retention, symptoms include mild abdominal pain, difficulty starting to urinate, weak flow of urine and/ or the urge to urinate again after doing so
- treatment depends on the type and the cause of urinary retention
- acute urinary retention might require catheterization
- chronic urinary retention may also require the insertion of a catheter
- when using catheters it is important to sterilize thsese (sterilization is the process of complete destruction of all living micro-organisms, autoclaves are sometimes used to sterilize medical equipment and supplies) in order to prevent infections (such as urinary tract infections)

URINARY INCONTINENCE

- urinary incontinence is the accidental leakage of urine, caused by problems with muscles and nerves that help hold or release urine
- urinary incontinence can happen to anyone, although it is more common in older people
- women are more likely to have problems with incontinence than men
- this condition can often be cured or managed
- there are different types of incontinence: stress incontinence, urge incontinence, overactive bladder, functional incontinence and overflow incontinence
- causes for urinary incontinence include overactive or weak bladder muscles, diseases (like arthritis), damage in nerves that control the bladder and/or the blockage from an enlarged prostate in men
- simple urine and blood tests can be taken to diagnose urinary incontinence
- ultrasound and cystoscopy can also be taken to diagnose urinary incontinence
- treatment depends on the cause and severity of incontinence as well as a person's lifestyle
- treatments include certain drugs, special devices to help control incontinence, surgery or bladder control training

CYSTITIS

- cystitis is the medical term for bladder infection, a type of urinary tract infection
- commonly caused by bacteria
- often the bacteria travels from the urethra very fast and causes inflammation of the urethra, called urethritis
- sometimes the bacteria is not flushed out and travels up to the bladder and causes infection
- symptoms of cystitis include frequent urges to urinate, burning sensation when urinating, pain in the lower abdomen, dark or bloody and foul-smelling urin and/ or fever or chills
- treatment is done by antiobiotic therapy, but the antibiotics depend on the type of bacteria that caused the bladder infection

FALLEN BLADDER

- the medical term for fallen bladder is cystocele
- it occurs when the wall between a woman's bladder and vagina weakens, therefore allowing the bladder to bend into the vagina
- this condition can be caused by a lot of straining (as in childbirth)
- it can also occur as women go through menopause
- cystocele is split into 3 levels – mild, severe or advanced
- mild cystocele (grade 1) is where the bladder only bends a short way into the vagina
- severe cystocele (grade 2) is where the bladder bends far enough to reach the vagina opening
- advanced cystocele (grade 3) is where the bladder bulges out of the vagina opening
- mild cystocele may not cause any symptoms
- severe and advanced cystocele can cause symptoms as urine leakage while sneezing, coughing or laughing, feeling of not emptying the bladder and/ or a bulge that may be seen at the vagina opening
- diagnosis can be done through either describing symptoms, physical examination or imaging test such as cystourethrogram
- treatment is usually not needed for mild cystocele
- in more severe cases of cystocele, a pessary (device placed into the vagina to hold bladder in place) or surgery might be recommended

CHAPTER XI

MEDICAL FIELDS

Contents

MEDICAL FIELDS

ALLERGOLOGY

Allergology is the study of hypersensitivity and allergies (abnormal reactions to substances).

ANDROLOGY

Andrology is the medical specialty that deals with male health, especially pertaining to the male reproductive system and urological problems.

ANESTHESIOLOGY

Anesthesiology is the medical field relating to the condition of pharmacologically induced and reversible state of amnesia, loss of responsiveness, loss of skeletal muscle reflexes, analgesia or decreased stress response.

ANGIOLOGY

Angiology is the medical field that studies the vases of the circulatory system and the lymphatic systems such as veins and arteries and their diseases.

AVIATION MEDICINE

Also knows as aerospace medicine. This field focuses on the physiologic, pathologic and psychologic problems with people in space.

CARDIOLOGY

Cardiology is the medical field focusing on disorders of the heart, such as diagnosis and treatment of heart defects or heart failure.

DENTISTRY

Dentistry focuses on the study, diagnosis and treatment of disease regarding the oral (mouth) area and their impact on the human body.

DERMATOLOGY

Dermatology is a branch of medicine focusing on the skin and its diseases.

ENDOCRINOLOGY

This is the branch of medicine which focuses on the diagnosis and treatment of the endocrine organs, or dysregulation of hormone homeostasis.

GASTROENTEROLOGY

This is the field of medicine that focuses on treatment and diagnoses of diseases of the gastrointestinal tract (digestive tract such as stomach and small intestines).

GERIATRICS

This is a medical field that deals with the health care of older adults, helping to promote health as well as to prevent diseases or disabilities.

GYNAECOLOGY

Gynaecology specializes in the treatment and diagnosis of conditions and diseases related to the females and their reproductive system, such as uterus, vagina and ovaries.

HEMATOLOGY

A branch of internal medicine, pathology, clinical laboratory work, physiology and pediatrics. This medical field focuses on the study of blood, blood forming organs and blood diseases.

HEPATOLOGY

This is the medical field that deals with the study of liver, gallbladder and pancreas and the management of their disorders.

IMMUNOLOGY

Immunology is the medical field relating to the study of the immune system and its reaction to pathogens as well as malfunctions of it.

INTERNAL MEDICINE

The medical field that specializes in the prevention, diagnosis and treatment of diseases and conditions in adults.

MICROSCOPY

Medical microscopy is the field that specializes in viewing objects and samples that would be unable to be seen just by eye (such as examination of bacteria for size and shape, or identification of specimen)

NEUROLOGY

This is the medical branch that focuses on diseases of the nervous system.

ONCOLOGY

This field of medicine focuses on the diagnosis and treatment of cancer.

OPHTHALMOLOGY

Ophthalmology focuses on the physiology, anatomy and diseases of the eye.

OTOLARYNGOLOGY

Also known as ENT - this is the medical field specializing in diagnosis and treatment of disorders regarding the ear, nose and throat, head and neck

PATHOLOGY

Pathology is the medical field which focuses on the study and diagnosis of disease.

PEDIATRICS

This field specializes on the medical care of children, infants and adolescents.

PODIATRY

Podiatry is the medical field focusing on the study and treatment of disorders regarding the feet and ankles.

PSYCHOLOGY

This is the medical field which studies psychology in order to understand, prevent and relieve psychological based stress or even dysfunction.

PULMONOLOGY

The medical field dealing with diseases of the respiratory system.

RADIOLOGY

This medical field specializes in imaging technology such as X-rays. Therapeutic Radiology is often used to treat tumors and cancers.

RHEUMATOLOGY

A medical field that mainly focuses on the treatment of arthritis and vasculitis syndromes.

SEROLOGY

Serology is a medical field which is the scientific study of blood serum and other body fluids.

TOXICOLOGY

A branch of medicine that deals with the study of chemicals on living organisms such as the human.

UROLOGY

Urology is a medical field focusing on diseases of the urinary tract as well as the male reproductive system.