Ontario College of Reflexology

# N101 - Foot Reflexology Course

Ver. 3.3

# Chapter Summary

### History of Reflexology

- Oldest documentation of reflexology was found in Egypt in approximately 2,500 BC in an ancient papyrus scene depicting reflexology.
- Zone Therapy was developed in Europe in the late 14th century and used throughout Europe.
- Dr. William Fitzgerald, "*father of modern reflexology*", discovered zone therapy used by several North American Indians and introduced reflexology in the United States.
- Dr. Fitzgerald developed **Zone Therapy** which was also used by Dr. Riley.
- Early authors of reflexology books include Eunice Ingham and Mildred Carter.

### What Is Reflexology?

Reflexology is a focussed pressure technique, usually directed at the feet or hands. It is based on the premise that there are zones and reflexes on different parts of the body which correspond to and are relative to all parts, glands and organs of the entire body.

### How Does It Work?

When the reflexes are stimulated, the body's natural electrical energy works along the **nervous system** to clear any blockages in the corresponding zones. A reflexology session seems to break up deposits (felt as a sandy or gritty area beneath the skin) which may interfere with the body's electrical energy in the nervous system.

Manipulating specific reflexes removes stress, activating a parasympathetic response in the body to enable the blockages to be released by a physiological change in the body. With stress removed and circulation enhanced, the body is allowed to return to a state of homeostasis.

Homeostasis is the "*automatic*" process that the body incorporates to bring it back to the "*normal*" state. For example, if the blood pressure is abnormal, the kidneys will secrete the enzyme *renin* which is involved with blood pressure, and the hormone *erythropoietin* that increase the rate of red blood cell production.

### Four (4) Benefits of Reflexology:

1. Relaxation with the removal of stress.
2. Enhanced circulation.
3. Assists the body to normalize the metabolisms naturally.
4. Complements all other healing modalities.

### Reflexologists Do Not:

1. Diagnose medical conditions unless qualified to do so.
2. Prescribe medications unless qualified to do so.
3. Treat for specific conditions except in emergencies.
4. Work in opposition to the medical or other fields.
5. Encourage the client to cease taking their prescribed medication.

**Reflexologists do not diagnose medical conditions unless qualified to do so**. The only diagnosis made is a **"tender reflex**." A reflexologist will refer to other qualified health care practitioners when services required are outside the reflexologist's scope of practice.

Similarly, **reflexologists do not prescribe medications unless qualified to do so**. The therapeutic intervention is limited to "*working the reflexes*."

### Indications and Reasons for Referral:

- Types of people seeking reflexology sessions are of all ages but approx. 70% are female.
- Referrals are made in conjunction with other existing forms of therapy to supplement ongoing medical treatments.
- Reflexology has been known to help clients deal with physiological symptoms such as cancer chemotherapy.
- Reflexology can be performed on everyone.

Continued next page...

## Practical Applications:

### Frequency of Visits:

- The benefits of a session usually will go on working for 5 or more days.
- The client decides on the frequency of visits based on the client's requirements and expectations.

### Length of Session:

- A complete session on both feet is always performed which will last between 45 to 60 minutes.

### Pressure:

- Work within the client's pain tolerance with exerted pressure which ranges from 0 to 10 or 20 pounds.
- When tender reflexes are located, they should be worked with a degree of pressure to effect the desired result.
- The client should tell the reflexologist their threshold level of tender reflexes.
- Reflexes are worked according to the body's requirements.

### Tenderness:

- Stress
- Surgery
- Injury and illness
- Drugs
- Foot conditions
- Piriformis Muscle Syndrome

### Therapy Setting:

- Optimum location is a quiet, relaxing environment.
- A recliner chair is most suitable for eye-to-eye contact.
- Reflexology can be administered anywhere and anytime.

### Client's Responsibility:

1. Client practises cleanliness.
2. Client sits comfortably in a reclining chair for eye-to-eye contact with the reflexologist.
3. Client gives the reflexologist a **completed and signed Reflexology Health Record** (with consent given) and **accepts responsibility for the session**.
4. Client tells the reflexologist the pain tolerance threshold.
5. Client may enjoy the session and perhaps fall asleep.
6. Client is encouraged to rest upon returning home while the body is in the *parasympathetic response*.
7. It is suggested that the client drink a glass of water to help cleanse toxins released from a session.

### Reflexologist's Responsibility:

1. Practises hand cleanliness.
2. Keeps finger nails trimmed.
3. Keep long hair under control and is aware of any jewellery that may retard the session.
4. Provides a professional and comfortable environment.
5. Provides warmth, tissues and wet-cloths for the client's requirements if necessary.
6. Relaxing music may be played.
7. A **Reflexology Health Record** is taken and the client **signs a consent on the form accepting responsibility for the session.**
8. All client records and sessions are kept **confidential**. Records are to be dated and recorded in ink only.
9. The client's socks are removed **only**.
10. The client's bare feet are worked on (hands where necessary) or over socks in emergencies.
11. A thorough foot examination is done by the reflexologist.
12. Conversation is encouraged and the reflexologist is a good listener. (*Reflexologists are not psychologists*).
13. Works within a time frame by which the client does not feel rushed and has time for questions.
14. **Optional** - Olive oil may be used at the **end** of the session by the reflexologist. **Do not use** any creams or oils (other than olive oil) . They may contain perfumes that may cause an allergic reaction.
15. The results of the reflexology session are documented.

### Occupational Hazards:

1. The finger nails of a reflexologist's hands usually grow faster than normal due to the stimulation of the fingers during a session.
2. Contagious disease can be collected beneath the reflexologist's finger nails if not washed properly after each session.
3. Long finger nails can inflict scratches or cuts on the client's feet.

4. Cuts or open sores on the reflexologist's hands could expose the reflexologist to any pathological conditions that may be present on the client's feet.
5. **Carpal Tunnel Syndrome** can result if the reflexologist strains the hands, fingers and wrists. Take frequent breaks and exercise as often as necessary.
6. Improper posture will result in discomfort or pain in the shoulders, neck and arms.
7. Lack of back support can result in low back and/or hip pains.
8. Cleanliness of the work environment and supplies are very important to prevent contamination of both reflexologist and client.

# Foot Notes

# Chapter Summary

### Conventional Zone Theory - Figures 2-1 to 2-3

- Conventional Zone Theory is the foundation of Reflexology.
- Zones are a system for organizing relationships between various parts, glands and organs of the body and of the reflexes.
- There are 10 equal longitudinal or vertical zones running the length of the body.
- 5 zones on the right side and 5 on the left.
- Numbering 1 to 5 from the medial side to the lateral side.
- Each finger and toe falls into one zone; the left thumb and the left toe being Zone 1.
- 5 zones travel up each leg, through the body's trunk and also up each arm.
- Note how the zones intersect with each other in the shoulder, collar bone (clavicle),and neck.
- 10 longitudinal zones of the body correspond to the 10 longitudinal zones of the feet.
- Zone 1 represents and starts with the big toe and runs the vertical length of the medial side of the foot.
- Zones 2, 3, 4, and 5 start with the smaller toes, also running the vertical length of the foot.
- Zones of the right side of the body are represented and stimulated by the reflexes in the corresponding zones in the right foot. The zones on the left side of the body are also represented and stimulated by the reflexes in the corresponding zones in the left foot.
- The big toe represents one specific zone, Zone 1.
- The big toe **also** has 5 zones representing the zones of the head.
- Each big toe (Zone 1) corresponds to **half** of the head and its zones.

### 3-D Aspect of Reflexes:

- Every part, gland or organ of the body represented in a zone can be stimulated by working any reflex in that same zone.
- Pressure applied to any part of a zone will affect the entire zone.
- Reflexes are considered to pass through the body (3-D aspect.)
- **Note: Reflexology Zones** are not to be confused with *acupuncture and acupressure meridians*.

### Transverse Reflex Areas - Figure 2-4

Transverse Zones can be used to group major areas. The five commonly used transverse zone areas used, alone or in conjunction with the transverse zone lines, are as follows:

- *pelvic area* (below transverse pelvic line.)
- *lower abdominal area* (between transverse pelvic and waist lines)
- *upper abdominal area* (between transverse waist and diaphragm lines)
- *thoracic area* (between transverse diaphragm and neck lines)
- *head area* (above transverse neck line.)

### Internal Organs and the 3-D Aspect of the Body

- Internal organs lay on top, over, behind, between and against each other.
- Reflexes of the internal organs overlap as well.
- The 3-D aspects of the body makes understanding the foot chart easier.

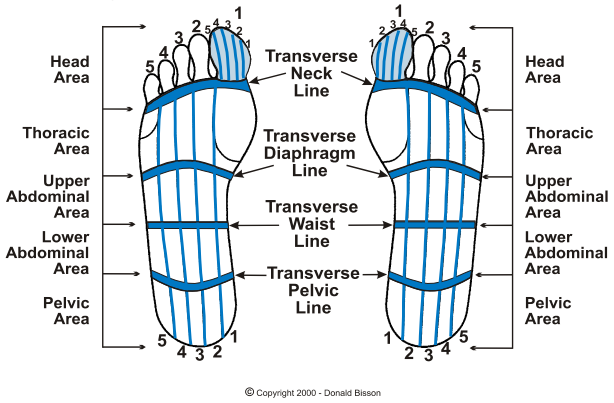
### Exception To The Zone Theory

- In the central nervous system, the right half of the brain controls the left side of the body and vice versa. In any disorders or problems that affect the brain or the CNS, emphasize the reflexes or area of disorder on the opposite foot.

### Referral Areas - Figure 2-5

- There are reflexes throughout the 10 zones of the body.
- Working a reflex in one zone can affect other reflexes in the same zone.
- **Avoid working on areas of the foot that are injured**. Use referral area reflexes instead.
- Problems in the legs can be helped by working the same general areas on the arms.
- Some *Referral Area* examples are: arm to leg; hand to foot; wrist to ankle; elbow to knee; and shoulder to hip.
- Referral areas can give insights into problem areas by showing the relationships to the areas in the same zone(s). For example, a shoulder problem may be due to a hip problem in the same zone.

Figure 2-4 Transverse Zones of the Feet




**Note:** In *Zonal Theory*, the thumbs are positioned towards the body, unlike that of medical anatomical charts. See *Appendix C for Anatomical Terms - Positions and Directions*.

Figure 2-2 Longitudinal Zones of the Feet

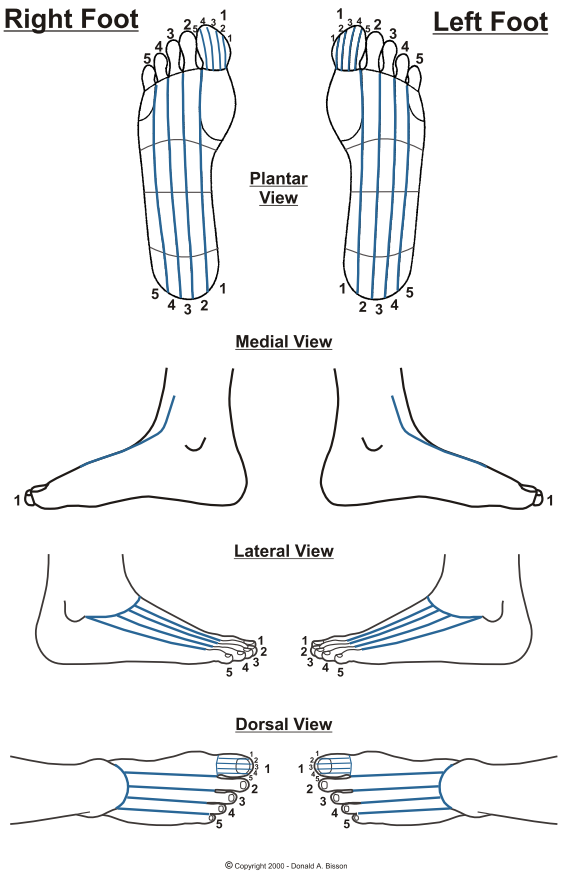



Figure 2-1 Longitudinal Zones of the Body

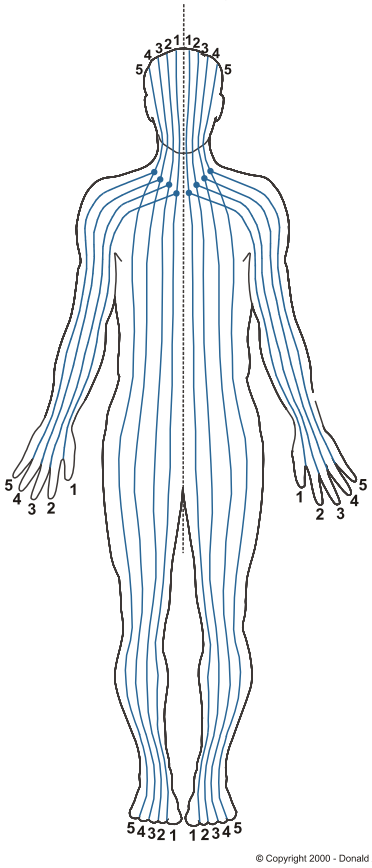
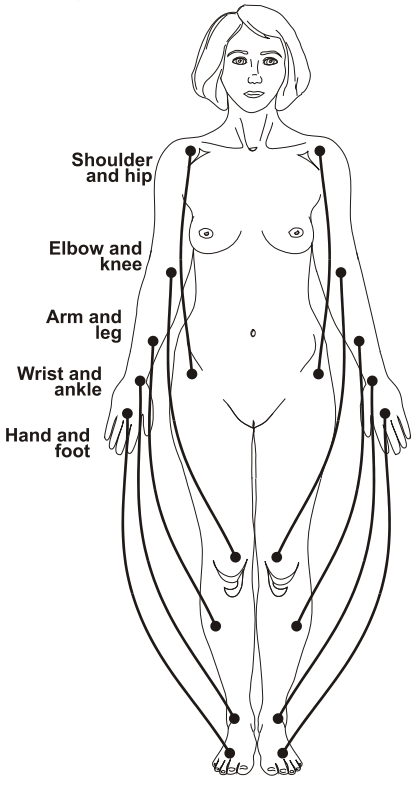



Figure 2-5 Zone Related Areas



# Chapter Summary

**Reflexologists do not diagnose foot conditions. If in doubt about any foot conditions, refer the volunteer client to a medical doctor.**

### Athlete's Foot
- contagious fungus infection that usually appears between toes.

### Bunion
- painful bulging of the joint at the base of the big toe.

### Callous
- hardened skin due to friction or pressure.

### Club Foot
- foot is turned inwards and the heel drawn up.
- surgery and/or splints are usually used to correct this condition.

### Cold Feet
- numerous possible causes, usually circulatory in nature.

### Corn
- a cone-shaped callus that causes pain when pressed on the nerve ending.
- hard corns are usually formed over outer parts of little or big toe due to pressure.
- soft corns occur between toes and not as result from pressure.
- usually caused by ill-fitting shoes.
- corn removal should be done by a professional.

### Cramps
- cramps are usually caused by lactic acid buildup (usually in the calf) from over exertion or exercise.
- calcium-magnesium imbalance.
- *Piriformis Muscle Syndrome* (short leg).
- plaque build-up in the arteries, known as *intermittent claudication*.

### Diabetes
- diabetics are prone to infections and loss of sensitivity in the feet.
- foot conditions caused by diabetes are *neuropathic* (affecting the nerves) and *circulatory*.

### Deformed Nails
- many variations of deformed nails.
- common deformity of the nail is the *ram's horn*, nail spirals to one side.

### Edema
- some symptoms of edema are swollen ankles.
- usually caused by excessive fluid retention and poor lymph drainage.

### Flat Foot
- is a biomechanical condition.
- arch of instep is lower than normal, so sole of foot lies flat to the ground.
- has limited shock absorption.
- "fallen arches" is an incorrect term - arches do not fall.

### Frostbite
- blood, nerve & soft tissue cells are frozen/frost bitten.
- bluish-white skin appears accompanied by burning pain.
- may develop into gangrene. Amputation may be necessary.
- **Do not work on this condition**.

### Fungal Toenails
- fungus of the toe nail known as *mycotic* nails.
- common on people over the age of 50 years old.

### Gangrene
- is dead flesh.
- many causes such as frostbite, arteriosclerosis, diabetes, infections, crushing injury, embolism and *Raynaud's Disease*.
- amputation is sometimes necessary.
- **Do not work on this condition**.

### Gout
- built up of uric acid - urate deposits form in the joints, especially big toe.
- known as *podagra* when the foot and more noticeably the big toe joint is affected.

### Hallux Valgus
- outward displacement of the big toe; in some cases forcing the toe to lie above or below the other toes.
- often associated with a bunion and may develop from pressure applied in this area.

### Hammer Toe
- toe is permanently bent in the middle joint causing a claw-like appearance.
- may be present in more than one toe but is most common in the second toe.
- usually caused by improper or ill-fitting shoes.

### Immersion Foot
- also known as *trench foot*.
- blackening of the toes and the skin of the foot due to death of superficial tissues.
- caused by prolonged immersion in cold water or exposure to damp and cold.

### Ingrown Toenails
- usually caused by nails that are cut too short and it grows back into the skin.

### Osteoarthritis
- the cartilage in and around the joint is worn down, causing pain due to friction in the joint.

### Phlebitis
- inflammation of the wall of the vein in the leg, usually near the knee.
- **Do not work on this condition** because it is associated with thrombosis, the formation of a blood clot *(thrombus*) in the blood vessels.

### Plantar Warts
- known as verrucae.
- due to virus infection.
- grows inward on the plantar side of the foot.

### Psoriasis
- chronic skin disease that can affect either skin or nails or both.
- characterized by itchy, scaly, red patches.
- often found on bony protuberances.

### Raynaud's Syndrome
- also known as *Raynaud's Phenomenon*.
- painful spasms of blood vessels in the fingers and toes due to lack of blood.
- colour of fingers or toes change very quickly from healthy skin tone to pale or blue.
- serious underlying causes are known as Raynaud's Disease.

### Rheumatoid Arthritis
- synovial membranes (lubricating fluid) in joints are mistakenly attacked by the immune system as foreign matter.

### Shin Splints
- painful over-contraction and/or tearing of leg muscles.

### Spurs (Heel)
- pointed growth on a bone, most commonly in the heel.
- may be caused by calcium deposits.
- may be caused by *Piriformis Muscle Syndrome* and weight carriage imbalance

### Tendinitis
- painful inflammation with or without swelling of the tendon from unusual and excessive use.
- the Achilles tendon at the back of the heel is prone to injury due to lack of protection.

### Ulceration
- disintegration of a skin area causing a lesion.
- often originates from diabetes.

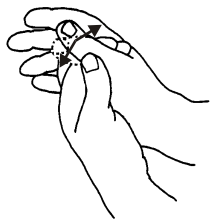
### Varicose Veins
- enlarged veins that are swollen or distorted.
- usually caused by blood backup weakening vein wall.
- may contain a thrombus (blood clot).
- **Do not work on this condition**.

### Warts
- caused by a virus carried in the blood.
- it is a small benign skin tumour.

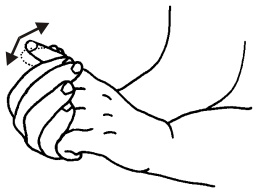
# Chapter Summary

## Basic Techniques

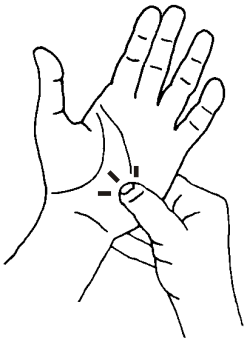
**Thumb Walking** - flex the first joint up and down while applying pressure over a reflex area.



**Finger Walking** - flex the first joint up and down while applying pressure over a reflex area.

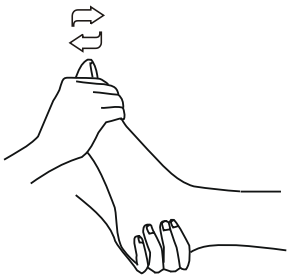


**Reflex Hooking** - push inward on the reflex and pull back or draw sideways while the thumb is still depressed.

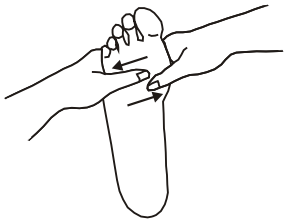


## Relaxation Techniques

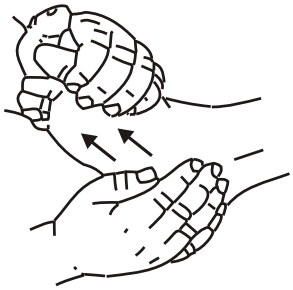
**Ankle Rotation** - rotate the foot gently in a circle at the ankle in both directions three (3) times.



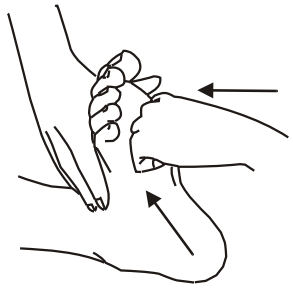
**Chest Stretch** - stretch and draw your thumbs in opposite directions horizontally to open the dorsal and plantar thoracic area reflexes.



**Clean-Out** - stroke the reflex area from the bottom upward to release tension with the palm of the hand, index finger or thumb.

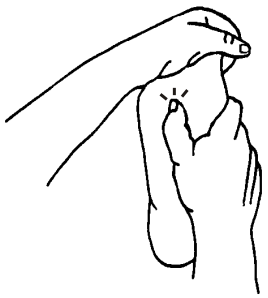


**Knuckle Draw / Roll** - press in and draw the fist or roll the knuckles upward from the heel to the toes.

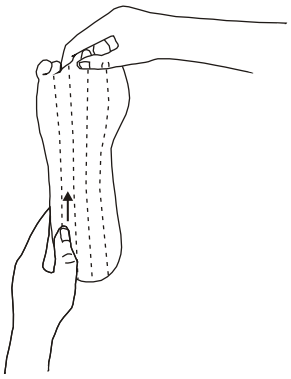


**Palm Rub** - use both palms of the hands in a back and forth rolling motion, rubbing each side of the foot.

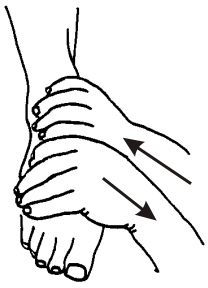
**Solar Plexus Push** - push inward on this reflex in Zone 3 with the thumb and lift up three (3) times while holding the toes without bending.



**Longitudinal Zoning Technique** - thumb-walk from the heel upward to and including the toes in all 5 zones of the foot. Also, thumb-walk the big toe from the base of the toe upward in all 5 zones of the big toe.



**Spine Reflex Twist** - twist both hands in opposite directions up and down along the spine reflex.



**Toe Rotation** - **gently** rotate the toe slowly and evenly with a slight upward pull three (3) times in a circle in both directions.

**Feather Touch** - **stroke very lightly** with the fingertips and the palms of the hands.

## Foot Notes

# Sample Reflexology Health Record

**Note:** This form to be completed on the **first visit only.**

Name: Doe, John A. Today's Date: Sept. 1/2000 (Month/Day/Year)

Address: 33 Town St. - Apt.6 Tel. Res: ( 905 ) 444-4444

Town: Sugarville Tel. Bus: ( 905 ) 334-3333

Prov./State: Ontario PC/Zip: V6V 2D2 Birth Date: 06/11/1957 (Month/Day/Year)

Last Medical Visit: Spring 2000 Findings (Medical): High blood pressure

| | | | | |
|---|---|---|---|---|
| Have you had any accidents? | No ☐ | Yes ☑ | What/When? | Car - 1988 |
| Do you have any serious illness? | No ☑ | Yes ☐ | What/When? | N/A |
| Have you been hospitalized recently? | No ☑ | Yes ☐ | Why/When? | N/A |
| Have you had any broken bones? | No ☐ | Yes ☑ | What/When? | Left arm - 1962 |
| Have you had any surgery? | No ☑ | Yes ☐ | What/When? | N/A |
| Are you on medication? | No ☐ | Yes ☑ | What/Why? | Tylenol |
| Do you have any heart problems? | No ☑ | Yes ☐ | What/When? | N/A |
| Do you have a pacemaker? | No ☑ | Yes ☐ | Where/When? | N/A |
| How is your blood pressure? | Normal ☐ | Not Normal ☑ | Why? | Stress, long work hours |
| Do you have any circulatory problems? | No ☑ | Yes ☐ | What? | N/A |
| Are you pregnant? (female only) | No ☑ | Yes ☐ | Trimester? | N/A |
| Any history of cancer? | No ☑ | Yes ☐ | What/When? | N/A |
| Do you have diabetes? | No ☑ | Yes ☐ | What/When? | N/A |
| Do you have epilepsy? | No ☑ | Yes ☐ | What/When? | N/A |
| Do you wear any prostheses? (artificial limbs, hearing aids, etc) | No ☑ | Yes ☐ | What/Where? | N/A |
| Do you smoke / have allergies? | No ☐ | Yes ☑ | What/When? | Smoke 20 years |
| Are you taking other therapies? | No ☐ | Yes ☑ | What? | Chiro., herbs, vitamins |
| Have you had Reflexology before? | No ☐ | Yes ☑ | Who/When? | 1996 - Jane Doe |

Who referred you to us? Website referral What is your occupation? Baker

Who is your doctor? Dr. White Doctor Tel. #: (416) 555-1212

Present Problems: Lower back problems, high blood pressure, indigestion. Pain in neck will not go away.

**Consent for Reflexology Session:**

I understand and accept that the sessions received are of therapeutic value only and fully accept responsibility for the same.

Signature: (parent/guardian) Mr. John Doe Date: Sept. 1/2000

**Volunteer Client:** Doe, John A.

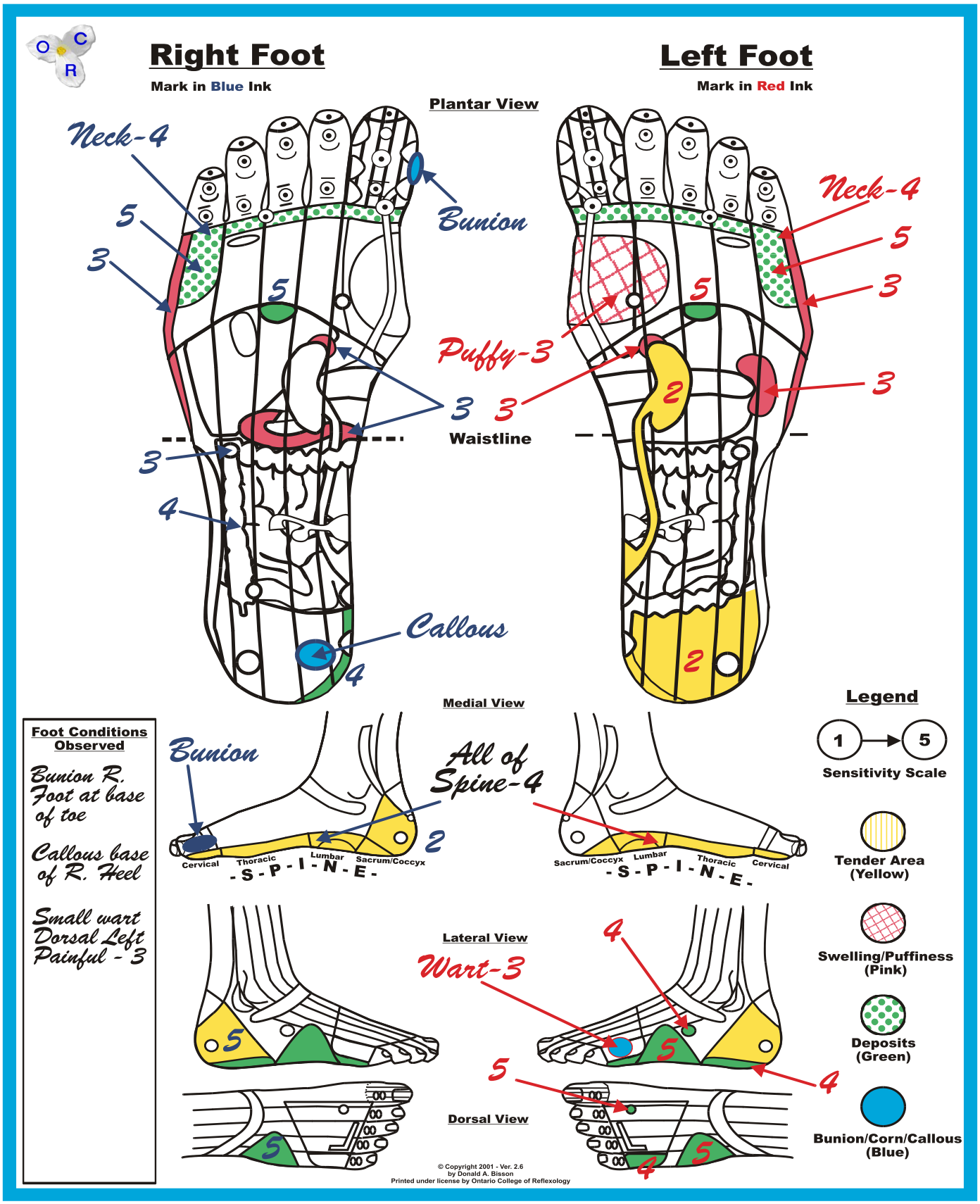
| **Date:** (mm/dd/yy) | **Observations:** |
|---|---|
| 09/01/2000 | Very relaxed and enjoyed the session. Spine Reflex very painful. Suggested that he see his chiropractor as Hip/Shoulder and Neck were all very sensitive. |
| 11/01/2000 | With Thanksgiving rush over, the bakery is not so hectic. Stress is reduced considerably. Chiro. session went well and is reflected in the neck & shoulders (less sensitive). Spine reflex is still tender. Extremely pleased with the sessions and will become a regular. Wishes to become active with his kids more often after this session. |

# Sample Reflexology Session Record

**Note:** This form is to be completed by the Reflexologist for each session

**Date of Session:** 09/01/2000 (mm/dd/yy)

**Session Number:** 01 **Volunteer Client:** Doe, John A.



# Chapter Summary

## Overview

- The primary organs of the skeletal system are the **bones** along with **joints**. The bones provide a rigid framework and support structure for the body.
- Bones are *living organs* that can change and help the body to respond to a changing environment.
- Movement is possible by the way bones are joined by joints and attached muscles.

## Bone Formation and Growth

- In an infant, the skeleton consists of cartilage and fibrous structures shaped like bones and are gradually replaced with a calcified bone matrix.
- The calcification process involves bone-forming cells called **osteoblasts** and bone-resorbing cells called **osteoclasts**. This process makes bones hard that respond to stress, injury by changing size, shape or density.

## Bone and Cartilage

- The skeletal system consists of 2 major types of connective tissue: **bone** and **cartilage**. The bone outer layer is called **dense** or **compact bone**. The porous bone in the end of a long bone is called **spongy bone** which may be filled with marrow.
- **Cartilage** resembles and differs from bone that it is gel-like and has the flexibility of a firm plastic rather than the rigidity of bone.
- Most bones are formed from a process called **endochrondral ossification** that means "*formed in cartilage*".

## Types of Bone

There are 4 types of bones:

- **Long** (e.g., humerus)
- **Short** (e.g., carpals)
- **Flat** (e.g., frontal skull bone)
- **Irregular** (e.g., vertebrae)

## Functions of Bone

- *Supports* and gives shape to the body.
- *Protects* internal organs - hard, bony 'boxes' protect delicate structures enclosed within them, for example, the skull protects the brain.
- Helps make *movements possible* - muscles are anchored firmly to bones. As muscles contract and shorten, they pull on bones and move them.
- *Stores calcium* - bones maintain homeostasis of blood calcium for normal nerve and muscle functions. Also serve as a storage medium for calcium. When calcium increases above normal, calcium moves out of blood and into bones for storage. When calcium decreases below normal, it moves out of storage in bones and enters blood.
- *Hemopoiesis* - means blood cell formation in the red bone marrow that is in the spongy type of bone in the ends of some long bones. As a person ages, much of the red marrow is transformed into *yellow bone marrow*, an inactive fatty tissue.

## Divisions of Skeleton - Table 6-1

**Note:** There are a total of 200 bones in the body. Teeth (Digestive System) and auditory bones (Nervous System - Special Senses) are **not** included. Source: Gray's Anatomy.

The skeleton consists of **200 bones** (not including teeth and auditory bones) and is composed of the following divisions and their subdivisions:

### A. Axial Skeleton - 74 bones

**1. Skull** - 22 bones
- **Cranium** - 8 bones
- **Face** - 14 bones

**2. Spine** - 26 bones - the *vertebral column* consists of 26 vertebrae connected so that they form a flexible curved rod. Between the vertebrae are pads of elastic cartilage (intervertebral discs) which absorb shocks and permits flexibility of movement. Figure 6-5 & Table 6-2.

- **Cervical** - 7 bones
- **Thoracic** - 12 bones
- **Lumbar** - 5 bones
- **Sacrum** - 1 bone (5 in child)
- **Coccyx** - 1 bone (3 to 5 in child)

**3. Thorax** - 12 ribs, sternum (breastbone) and the thoracic vertebrae form the bony cage known as the thorax, chest or thoracic cage. The thoracic cage protects the organs of the thorax and the upper abdomen. Each of the 12 pairs of ribs is attached posteriorly to a vertebra. All ribs except the lower 2 pairs are attached to the sternum and have anterior and posterior anchors. Figure 6-6 & Table 6-3.

- **Ribs** 12 pairs
- **Sternum** (breastbone)
- **Thoracic vertebrae**

**4. Hyoid bone** - used to anchor the tongue.

**B. Appendicular Skeleton** - 126 bones

**1. Upper Extremities** - 64 bones - Figure 6-8 & Table 6-4.

- **Shoulder girdle** - consist of the scapula or shoulder blade and the clavicle or collar bone which connects the upper extremity to the axial skeleton.
  - **scapula** (shoulder blade)
  - **clavicle** (collar bone)
- **Humerus** - long bone of the arm and the second longest bone in the body. It is attached to the scapula and articulates (joins) with the 2 bones of the forearm at the elbow joint. The bones of the forearm are the **radius** and the **ulna**.
- **Radius**
- **Ulna**
- **Hand bones** - consist of 27 bones. The wrist and hand have more bones for their size than any other part of the body.
  - 8 **carpal bones** (wrist)
  - 5 **metacarpal bones** - provides support structure for the palm of the hand.
  - 14 **phalanges** (finger)

**2. Lower Extremities - 62 bones** - Figures 6-9 to 6-12 & Table 6-5.

- **Pelvic girdle** (hip) - the hip connects the legs to the trunk. The hip girdle consists of 2 coxal or pelvic bones which provide a strong base of support for the torso and connect the lower extremities to the axial skeleton. In an infant, each coxal bone consists of 3 separate bones which grow together in an adult. Figure 6-9.
  - **pelvic girdle**( ilium, ischium & pubis)
- **Femur** (thigh bone) - the femur is the only bone in the thigh and is the longest bone in the body. It articulates toward the hip with the coxal bone and joins with the patella and the tibia. A slender non-weight bearing bone, the fibula, lies along the outer border of the lower leg.
- **Patella** (kneecap)
- **Tibia**
- **Fibula**
- **Foot bones** - 26 bones. Figures 6-11 and 6-12.
  - **7 tarsal bones** (ankle)
    - **talus bone** supports the leg bones
    - **calcaneus** forms the heel
    - **navicular bone** on *medial side*
    - **cuboid bone** on *lateral side*
    - **3 cuneiform tarsal bones**
  - **5 metatarsal bones**
  - **14 phalanges** (toes)
  - great toe (big toe) has only 2 phalanx bones
  - remaining toes have 3 phalanges each.

**Joints (Articulations)** Table 6-6

- Every bone in the body except the hyoid bone forms a joint with another bone.

### Kinds of Joints

There are 3 types of joints:

- **Synarthroses** (no movement)
- **Amphiarthroses** (slight movement)
- **Diarthroses** (free movement).

**Synarthroses** - a joint in which fibrous connective tissue grows between the articulating bones. An example is the joint between the cranial bones called *sutures*.

**Amphiarthroses** - a joint which cartilage connects the articulating bones such as symphysis pubis, the joint between the two pubic bones. Joints between vertebrae are also amphiarthroses and diarthroses.

**Diarthroses** - most joints are diarthroses which allow considerable movement and have a *joint capsule*, a *joint cavity* and a *layer of cartilage* over the ends to 2 joining bones. The joint capsule is a fibrous connective tissue that fits over the ends of the 2 bones.

- **Ligaments** are strong fibrous connective tissue that joins 2 bones together firmly.
- The layer of **articular cartilage** over the joint ends of bones absorbs jolts. The **synovial membrane** secretes a lubricating fluid (*synovial fluid*) that allows easier movement with less friction.

For reflexes to work on the above pathological conditions, refer to the **Pathological Conditions** section on page 11.

## Pathological Conditions:

**Fractures** - fractures are bones that have broken or cracked. There are many types of fractures due to many causes. Common fractures are: *simple fracture* (clean break, no tissue injury), *compound fracture* (bone and tissue has damage and risk infection), *spontaneous fracture* (occurs with without cause in fragile bones, especially in the elderly).

**Low Back Pain** - can be caused by a variety of mechanisms. Main causes are acute injury or degeneration of the joints, ligaments, muscles, or intervertebral discs. Referral pain can be felt in the back because of nerve root irritation. Muscles that are in a spasm because of attempts to protect some local injury can also cause secondary pain.

**Osteomyelitis** - an infection of the bone marrow within the bone. Usually a hazard following compound fractures or bone surgery. A common childhood disease but can occur in adults.

**Osteoporosis** - a common bone disease that is characterized by excessive loss of calcified bone tissue from the bone that result in bones that are brittle, liable to fracture, causes disc bone degeneration, and curvatures to the spine. Generally common among the elderly and menopausal women.

**Scoliosis** - curvature of the spine. The vertebrae are displaced to form a curved line along the spinal column. Some causes are congenital or from improper muscle action and nerves.

**Shoulder Pain** - shoulder pain can be caused by many conditions not originating in the joint itself. Pain may be referred from the pleura, diaphragm, or the pericardium. Shingles, disturbances of the spinal cord in the neck region, and muscular dystrophies can also produce shoulder pain.

**Whiplash** - usually sustained in an automobile accident that causes the head to be thrown forward suddenly and jerked backward, or vice versa, like '*cracking a whip*'. Injury is usually at the level of the fifth cervical vertebra where muscles and ligaments can be torn and strained. Occasionally there may be associated bone or nerve damage but is not common.

# Chapter Summary

### Overview

- There are 3 types of muscles; **skeletal**, **smooth**, and **cardiac**.
- Muscles produce movement, maintain body posture and generate heat.
- A muscle is stimulated by a nervous impulse that shortens or contracts the muscle tissue.
- Muscles contribute 40% to 50% of the body weight.
- All muscle cells shorten or contract by converting chemical energy obtained from food into mechanical energy that is translated into movement.
- Muscular tissue works by alternate contraction and relaxation.
- Activated by electrical stimulation of nerves.

### **Muscle Tissue**: (Table 7-1)

1. *Skeletal muscle* - also called striated or voluntary muscle. (Figure 7-3)
   - 3 names for skeletal muscle tissues: **skeletal muscles** - attaches to bone; **striated muscle** - cross stripes or striations; and **voluntary muscle** -contractions can be controlled voluntarily.
   - Muscles take energy from glucose furnished by food. It produces the waste, *carbon dioxide* and *lactic-acid* if fatigued.

2. *Smooth muscle* or involuntary muscle - also called nonstriated muscle.
   - lack striations.
   - found in walls of hollow internal organs such as stomach, intestines, bladder, uterus and blood vessels.
   - creates movement such as *peristalsis*, blood pressure and childbirth.

3. *Cardiac muscle* - composes the bulk of the heart.
   - found only in the heart.
   - are striated or cross striped.
   - fibres are branched and interconnected in complex networks.
   - each cell has a single nucleus.
   - enables the heart to contract and relax in heartbeats by involuntary control.

**Pathological Conditions:**

**Arthritis** - inflammation of one or more joints.

**Bursitis** - inflammation of the bursa.

**Carpal Tunnel Syndrome** - pain and numbness in fingers due to compression of nerves in the wrist and arm.

**Cerebral Palsy** - neurological disorder resulting in stiffness or paralysis.

**Gout** - uric acid excess in the blood and joints.

**Muscular Dystrophy** - degeneration of muscle fibres into fatty tissue due to impaired nourishment to the affected area.

**Osteoarthritis** - degenerative disease of the joint cartilage.

**Parkinson's Disease** - also known as *parkinsonism* and *palsy*. A degenerative disease affecting the nervous system that result in tremors and spontaneous movements in elderly or middle-aged people.

**Piriformis Muscle Syndrome** - sciatic nerve pressed into the piriformis muscle causing referral pains.

**Temporomandibular Joint Syndrome (TMJ)** - painful joints of the temporomandibular joints.

For reflexes to work on for the above pathological conditions, refer to the **Pathological Conditions** section on page 4.

# Chapter Summary

## Overview: Figure 8-1

- The endocrine system is composed of specialized glands that secrete chemicals known as **hormones** directly into the blood.
- Sometimes called *ductless glands*, the organs of the endocrine system perform the same general functions as the nervous system.
- The nervous system provides *rapid control* by nerve impulses and the endocrine system provides *slower* but *longer-lasting control* by hormone secretion.
- Besides controlling growth, hormones are the main regulators of metabolism, reproduction and other body activities. They play important roles in maintaining *homeostasis* - fluid and electrolyte balance, acid-base balance, and energy metabolisms.
- All organs of the endocrine system are glands, but not all glands are organs of the endocrine system.
- Of the 2 types of glands in the body - **exocrine glands** and **endocrine glands**, only endocrine glands belong to this system.
- *Exocrine glands* secrete their products *into ducts*.
- *Endocrine glands* are *ductless glands*. They secrete hormones *directly into the bloodstream*.
- The endocrine glands are widely distributed throughout the body. The **pituitary gland**, **pineal gland**, and **hypothalamus** are located in the skull. The **thyroid** and **parathyroid glands** are in the neck, and the **thymus gland** is in the thoracic cavity. The **adrenal glands** and **pancreas** are found in the abdominal cavity. The **ovaries** in the pelvic cavity of the female and the **testes**, externally located in the male also function as endocrine glands.

## Pituitary Gland Figure 8-2

- The pituitary gland, also known as the **hypophysis**, is the size of a pea - about 1 cm (½") in diameter and is located at the base of the brain or cranial cavity.
- The pituitary gland consists of two (2) parts or lobes:
  - The **anterior pituitary gland** or **adenohypophysis** (anterior lobe)which has the structure of an *endocrine gland* and is part of the endocrine system
  - The **posterior pituitary gland** or **neurohypophysis** (posterior lobe)which has the structure of a *nervous tissue* and is part of the nervous system.
- The anterior pituitary gland secretes a number of major hormones that stimulate other endocrine glands to grow and secrete their hormones.
- It is sometimes referred to as a **master gland** because the anterior pituitary gland exerts *control* over the structure and function of the *thyroid gland*, *adrenal cortex*, *ovarian follicles* and *corpus luteum*.
- The **posterior pituitary gland** does not manufacture any hormones but it does *receive*, *store*, and *release* hormones made by the hypothalamus, *vasopressin* (antidiuretic effect) and *oxytocin* (induces uterine contractions).
- The pituitary gland is attached to the **hypothalamus** by the *pituitary stalk*.

## Hypothalamus

- The hypothalamus is located at the base of the brain, below the thalamus and above the pituitary gland.
- The hypothalamus is part of *both* the **Nervous** and **Endocrine systems**.
- The hormones released from the posterior lobe of the pituitary gland are produced in the hypothalamus which is an *endocrine tissue*.
- The hypothalamus also produces *releasing* and *inhibiting* hormones that travel to the anterior pituitary gland where it causes the *release* of the anterior pituitary hormones or *inhibit* their production and their release into the circulation.
- The combined nervous and endocrine functions of the hypothalamus allow it to play a *dominant role in homeostasis*.
- The hypothalamus contains several important centres controlling body temperature, thirst, hunger, eating, water balance, and sexual function.
- It is also closely connected with emotional activity and sleep and it functions as a centre for the integration of hormonal and *autonomic nervous activity* through pituitary secretions.

## Thyroid Gland Figures 8-3 and 8-4

- The **thyroid gland** is a butterfly-shaped organ at the base of the neck, below the larynx.
- It consists of **2 lobes**, one on either side of the trachea, that are joined by an **isthmus** (sometimes a third lobe extends upward from the isthmus).
- The thyroid gland produces a number of hormones, including *thyroxin* and *triiodothyronine* (iodine) that help regulates cellular metabolisms.
- The thyroid plays an important part in the regulation of *calcium* in the blood and tissue for the skeletal system.
- The thyroid also controls *iodine metabolisms* and regulates the manner and speed of the food transformation into energy and usage of energy.
- An overactive thyroid (*hyperthyroid*) produces rapid heart rate, underweight, protruding eyes, and nervous or emotional disorders.
- An underactive thyroid (*hypothyroid*) produces general lack of energy, overweight, thinning hair, dry skin, mental or emotional disorders, and physical sluggishness.

## Parathyroid Glands Figures 8-3, 8-4 and 8-5

- There are **4 parathyroid glands** on the back of the thyroid gland.
- The parathyroid glands secrete a hormone that is responsible for the maintenance of balance in calcium and phosphorous metabolisms.

## Adrenal Glands Figures 8-6 and 8-7

- The adrenal glands are known as the **suprarenal glands** and they sit on top of each kidney and are embedded in a mass of fat that encloses each kidney.
- The adrenal gland has **2** separate endocrine glands: the **adrenal cortex** and the **adrenal medulla**.
- The *adrenal cortex* secretes a number of corticoid hormones that regulate potassium and glucose in the blood.
- The *adrenal cortex* is under the control of the *pituitary hormone* (adrenocorticotrophin - ACTH) and it also secretes the hormone, *hydrocortisone* which has *anti-inflammatory* and *antiallergy* properties.
- As a result of the emotional stimulation on the nervous system, the *adrenal medulla* is stimulated by the sympathetic nervous system to produce *epinephrine* and *norepinephrine* into the bloodstream. Epinephrine (adrenalin) prepares the body for the "*fight or flight*" response. Norepinephrine (noradrenaline) is closely related to epinephrine with similar actions. It is also released as a neurotransmitter by the sympathetic nervous system. These two hormones prepare the body to act as an accelerator for the *Sympathetic Nervous System* of the *Autonomic Nervous System - the "fight or flight"* response. They increase muscular power, postpone fatigue, halt digestion and route blood to the extremities for action. See Table 8-2.

## Pancreas Gland Figure 8-8

- The pancreas gland is an elongated gland on the back wall of the upper abdomen with its rounded head encircled by the curve of the duodenum and its body and tail extend to the left, crossing the left kidney and reaching the spleen. The pancreas has *both digestive and endocrine functions*.
- The pancreas consists of 2 distinct types of tissue. The main secretory cells produce digestive enzymes which pass by ducts to the pancreatic duct and into the duodenum.
- Embedded in the tissue is another type of cell, known as the **pancreatic islets** or **islets of Langerhans** that produce the hormone, **insulin** for metabolism of carbohydrates. The insulin is absorbed directly into the blood stream.
- **Diabetes mellitus** is a term used when the pancreatic islets secrete too little insulin resulting in a high blood sugar.
- **Hypoglycemia** is a condition of too much insulin resulting in a low blood sugar.

## Ovary Glands Figure 8-9

- The **2 ovaries** of a female reproductive system produce the hormone **estrogen** by the ovarian follicles and the hormone **progesterone** by the corpus luteum (glandular tissue of ovary) which regulate the female menstrual cycle.
- See the Reproductive chapter for more details.

## Testes Figure 8-10

- The cells in the **testes** of a male reproductive system produce sperm cells and secrete the hormone **testosterone** directly into the blood.
- See the Reproductive chapter for more details.

## Thymus Gland

- The **thymus gland** is a lymphoid organ in the mediastinum behind the sternum and between the lungs. It is large in children but diminishes in size with age.
- It secretes a hormone called **thymosin** that affects the production of white blood cells.
- The thymus gland regulates growth and controls the lymphatic system.
- It also controls the production of infection fighting white blood cells, thus strengthening the immune system.
- During the first few weeks of life in an infant, the thymus produces basal cells that are distributed throughout the body to other lymphatic organs, the lymph nodes and the spleen, in which they begin to mass-produce lymphocytes and carry on the production of antibodies.

## Pineal Gland

- Also known as the **epithalamus**, the **pineal gland** is a small, pine cone-shaped gland near the roof of the third ventricle of the brain.
- The pineal gland produces a number of hormones in small quantities, with **melatonin** being significant. Melatonin inhibits the tropic hormones that affect the ovaries and is thought to be involved in regulating the onset of puberty and the menstrual cycle in women.
- Because the pineal gland receives and responds to sensory information from the optic nerves, it is sometimes called the "**third eye**", similar to that found in reptiles and amphibians. It uses information regarding changing light levels to adjust the output of melatonin; melatonin levels increase during the night and decrease during the day.
- The cyclic variation is thought to be an important timekeeping mechanism for the body's internal clock.

## Other Endocrine Structures

- **Heart** - the heart secretes the hormone, *atrial natriuretic hormone* (ANH) that is an important regulator of fluid and electrolyte homeostasis.
- **Kidney** - the kidneys secrete the enzyme *renin* that is involved with blood pressure and the hormone *erythropoietin* which stimulate red blood corpuscle cell development.
- **G.I. Tract** - the G.I. tract produces a number of hormones that regulate gastrointestinal motility and enzyme secretion.
- **Placenta** - the placenta produces hormones to support embryonic growth, temporarily functioning as an endocrine gland. Also *estrogen*, *progesterone* and a *lactogenic hormone* to stimulate the lactation glands of the breasts.

## Pathological Conditions:

**Addison's Disease** - a chronic deficiency of the hormone corticosteroid from the adrenal cortex that causes weakness, loss of energy, low blood pressure and dark colouration of the skin.

**Cushing's Disease** - an excessive production of the hormone of the adrenal cortex that causes reddening of the face and neck, weight gain, body and facial hair growth, high blood pressure, and high glucose levels.

**Diabetes Insipidus** - a rare metabolic condition of inadequate release of the antidiuretic hormone, vasopressin by the posterior pituitary gland which is made by the hypothalamus. It results in excessive thirst and large excretions of urine.

**Diabetes Mellitus** - a condition of *an insufficient amount of insulin* produced by the pancreas islets of Langerhans that causes high blood glucose levels which are excreted into the urine.

**Goiter** - the enlargement of the thyroid gland and neck area and is usually caused by a deficiency of iodine in water.

**Hyperparathyroidism** - a condition of **overproduction** of the parathyroid hormone resulting in an increased amount of calcium in the blood stream and excretion of a large amount of calcium in the urine which produces the loss of bone minerals which weaken or cause fractured skeletal bones and kidney stones..

**Hyperthyroidism** - **over secretion** of the thyroid hormones that dramatically increase the metabolic rate. Food is burned at an excessive rate, and an individual loses weight, has increased appetite, bulging eyes and nervous irritability. It can cause goiter and severe cases are known as *Grave's disease* or *thyrotoxicosis*.

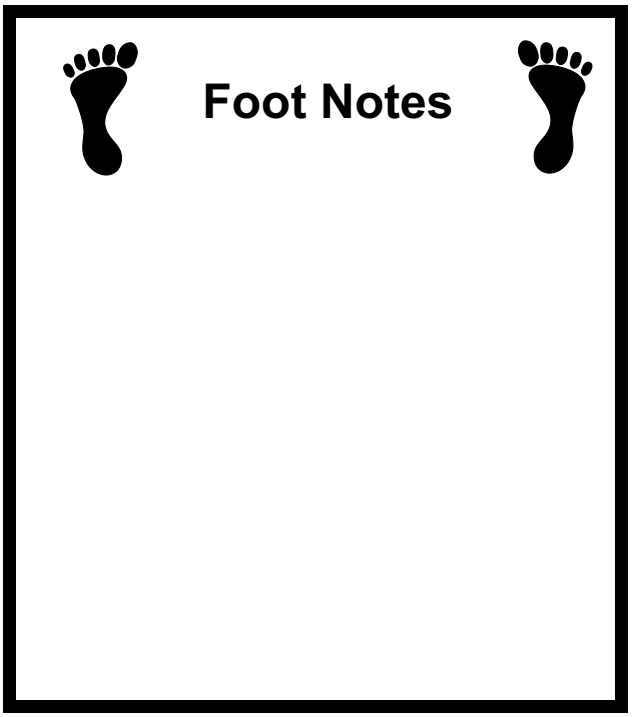
**Hypogonadism** - a condition of below normal production of the reproductive hormone (testes in males and ovaries in females) causing or impairing the secondary sexual characteristics. Symptoms include undersized prostate gland, reduced semen volume, diminished growth of facial and body hair in males and underdeveloped breasts for females.

**Hypoparathyroidism** - **underactivity** of the parathyroid glands. Symptoms include sudden spasms and cramps in muscles and tetany (involuntary contractions of the muscles) or convulsions.

**Menopause** - a condition of reduced ovarian function and menstruation ceases. Symptoms include hot flashes, vaginal dryness, and emotional and sleep disturbances.

**Thyroiditis** - inflammatory reaction within the thyroid gland caused by bacteria, viruses or autoimmune mechanisms.

For reflexes to work on for the above pathological conditions, refer to the **Pathological Conditions** section on page 8.



# Chapter Summary

### Overview:

- Urinary system includes the **kidneys**, **ureters**, **urinary bladder** and **urethra**.
- The kidneys clear or clean the blood of waste products produced in the cells.
- The kidneys also play an important role in maintaining the electrolyte, water, and acid-base balances.
- Waste product produced by the kidneys is called **urine**.
- Urine flows from the kidneys through the ureters and is stored in the urinary bladder. Urine is expelled from the bladder via the urethra.
- Male urethra passes through the *penis* which has dual functions: urinary and reproductive. The female urinary passage is separate.
- The kidneys secrete the hormone *erythropoietin* to help control the rate of red blood cell formation.
- Helps regulate blood pressure by the enzyme *renin* secreted by the kidneys.
- Regulates absorption of calcium by activating Vitamin D.
- Regulates the pH balance of body fluids.

### Kidneys

- Two kidneys; one on each side of the spinal column at the back just above the waist.
- Outer part is called the *cortex* and the inner part is called the *medulla*.
- They cleanse the blood of poisons and impurities, regulate blood volume and recycle water, minerals and nutrients.
- The kidneys adjust the chemical composition of the blood.
- They receive approx. one quart of blood per minute from the aorta.
- The *nephron unit's* function is to filter the blood, reabsorb water and nutrients and produce urine to carry off waste.

### Functions:

a. Excretes the waste removed from the blood to the outside
b. Produces urine.
c. Maintains the acid-alkaline balance (pH).
d. Eliminates water (balances body water).
e. Reabsorbs vital nutrients.

### Ureters

- Ureters are the tubes that lead from each kidney to the urinary bladder
- The ureters' smooth muscular wall helps to move urine.

### Urinary Bladder

- A hollow smooth muscle organ.
- Located within the pelvic cavity behind the symphysis pubis.
- It is expandable for holding urine produced by the kidneys until expelled from the body.

### Urethra

- A smooth muscular tube that conveys urine from the urinary bladder to the outside of the body.

### Pathological Conditions:

**Cystitis** - an inflammation of the urinary bladder.Inflammation of the kidneys and ureters may frequently accompany cystitis, which is known as *Urinary Tract Infection*. These are commonly caused by bacteria.

**Cystocele** - tissues that hold the urinary bladder may become weak and allow the bladder to prolapse or bulge downward into the vagina.

**Diabetes Mellitus** - blood glucose concentration becomes too high. The excess glucose is excreted in the urine instead of being reabsorbed by the kidneys and back into the blood.

**Edema** - excessive accumulation of fluid in the body tissues.

**Kidney Stones** - usually caused by a metabolic abnormality that increases the concentration of crystalloids (mostly calcium) in the urine.

**Proteinuria** - presence of abnormal amounts of plasma proteins in the urine. Intense exercise may cause temporary proteinuria.

For reflexes to work on for the above pathological conditions, refer to the **Pathological Conditions** section on page 4.

# Chapter Summary

**Overview:**

- Reproductive system ensures survival of species.
- Production of hormones that allows sexual characteristics.

### Male:

- **Gonads** are testes which produce **sperm**.
- Genital ducts called the **vas** or **ductus deferens**.
- **Prostate gland**.
- **External genitalia** include the **penis** and **scrotum**.
- The **urethra**, which is part of the urinary system, serves as a genital duct that carries sperm to the exterior.
- **Sperm** produced by the testes travel through a number of ducts with the prostate and other glands adding fluid and nutrients to it on its way to the exterior into the female reproductive tract.

### Female:

- **Gonads** are **ovaries** which produce ova (egg cells).
- Organs include the **uterus**, **uterine** or **fallopian tubes**, and **vagina**.
- The **vulva** is the external genitalia.
- **Breast** or **mammary glands** are classified as external accessory sex organs.
- Female reproductive system produces ova, receives male sperm, permits fertilization (occurring in the fallopian tubes), transfers the fertilized egg to the uterus where it implants, nourishes and develops until birth.

## Male Reproductive System

- Male reproductive system includes the **testes**, **vas** or **ductus deferens** and the **prostate gland**.
- The **external genitals** consist of the **penis** and **scrotum**.
- Male genital system is designed to produce **sperm** and deposit them in the female.

### Testes

- Testes lie within the scrotum and produce sperm.
- Also produce male sex hormone testosterone.

### Sperm

- Sperm is a male reproductive cell whose purpose is to achieve fertilization with the female cell (ovum).
- Sperm requires a temperature of $1^0$ C ($3^0$ F) lower than body temperature.
- Sperm have tails to propel them. They carry ½ the complement of genes (sperm = 23 chromosomes, ovum = 23 chromosomes, both equals a full complement of 46 genes).

### Prostate Gland

- Walnut shaped, located at the base of the bladder surrounding the urethra.
- Produces 30% of the fluid that mixes with semen to make up part of the seminal fluid.

### Seminal Vesicles

- Attached to the vas (Ductus) Deferens situated by the prostate gland.
- Contribute about 60% of seminal fluid.

### Vas or Ductus Deferens

- Paired ducts (2) that transport semen up from the testes.
- Extends around and down to join with the seminal vesicles to form the ejaculatory duct.
- The ejaculatory duct permits sperm and the prostate secretions to empty into the urethra.

## Female Reproductive System

- Female reproductive system consists of **ovaries**, **uterus**, **fallopian tubes** and **vagina**.
- Receives sperm, produces ova (eggs) for fertilization and nurtures a fertilized egg (ovum) to develop a fetus (baby).
- External genital is the **vulva** (clitoris, labia majora and labia minora).

### Vagina

- A channel that opens to the exterior.
- Leads from the vulva to the uterus.
- Allows sperm to enter.
- Allows offspring to emerge.
- An expandable birth canal.

### Uterus

- Also known as womb, it is a hollow pear-shaped organ in the lower central portion of the pelvic cavity.
- The neck of the uterus (cervix) connects to the vagina.
- Endometrium develops each month to provide nutrition for a fertilized egg.
- If egg is not fertilized, the endometrium lining is shed every 28 days during menstruation.
- Hypothalamus controls cycle.

### Ovaries

- Stores and release egg cells (ova) during monthly menstrual cycles.
- Also acts as endocrine glands to produce estrogen and progesterone.
- Monthly cycles are regulated by hormones secreted by the ovaries, pituitary gland and hypothalamus gland.

### Fallopian Tubes

- When the ovary releases a mature egg, it is wafted by the feathery ends of the fallopian tubes into the tube openings, guiding the egg to the uterus.
- Fertilization occurs in the distal third of the tubes.

### Breasts

- Are external accessory organs.
- Lactation is controlled by hormones from the pituitary gland.
- Lactation organs produce colostrum and milk. Both secretions are released by the sucking action of the infant.

## Pathological Conditions:

**Cystocele** - Prolapse of the urinary bladder into the vagina.

**Endometriosis** - Womb lining or endometrium grows outside the uterus and surrounding organs.

**Fibroid Tumour** - Growths in the walls of the womb or uterus.

**Hydrocele** - Collection of clear fluid within a testicle sac.

**Menstrual Disorders** - All types of menstrual disorders including painful, absence of, excessive, PMS and mood swings.

**Prostatic Hypertrophy** - Enlargement of the prostate gland that squeezes the urethra making urination difficult.

**Prostatitis** - Inflammation of the prostate gland caused by a bacterial infection.

**Rectocele** - Bulging of rectum into the vagina.

For reflexes to work on for the above pathological conditions, refer to the **Pathological Conditions** section on page 5.

**Foot Notes**

# Chapter Summary

**Overview**:

- The organs of the digestive system are separated into two groups: **primary organs** and **secondary** or **accessory organs**.
- *Primary organs* include:
  - mouth
  - pharynx
  - esophagus
  - stomach
  - small intestine
  - large intestine
  - rectum
  - anal canal
- *Accessory organs* include:
  - teeth
  - salivary glands
  - tongue
  - liver
  - gallbladder
  - pancreas
  - appendix
- The primary organs form a tube, open at both ends called the **gastrointestinal** or **GI tract** (also called the **alimentary canal**) which is 9 metres or 29 feet long in adults.
- Food enters the tract and is *digested*, its nutrients are *absorbed* and undigested residues are *eliminated* from the body as **feces**.
- Accessory organs help in the mechanical or chemical breakdown of food.
- The breakdown of food is both *mechanical* and *chemical* in nature.
- *Teeth* are used to break down food and the **stomach** churns the food to continue the mechanical breakdown process.
- Chemical breakdown results from the digestive enzymes and other chemicals acting on food as it passes through the GI tract.
- In chemical digestion, large food molecules are reduced to smaller molecules that can be absorbed through the intestinal wall lining and distributed to the body cells.
- The process of altering the chemical and physical composition of food is called *digestion*.
- The digestive system also functions as an *organ of elimination*, eliminating waste or *feces*.
- Foods undergo three (3) kinds of processes: **digestion**, **absorption**, and **metabolism**.
- The *appendix* is physically attached to the digestive tube and classified as an accessory organ. It is not functionally important in the digestive process.
- Table 11-1, page 2 - Organs of the Digestive System.

**Oral Cavity** - Figure 11-2

- *Oral cavity* or *mouth* is a hollow chamber where food and air enter.
- The tongue is made of skeletal muscle and is anchored to bones in the skull and the hyoid bone in the neck. It aids in mechanical manipulation of food into the *pharynx* during swallowing.
- The tongue has sensory taste buds called *papillae*.

**Teeth** - Figure 11-3

- Teeth provide for *mastication* of food.
- Chewing stimulates the salivary glands.
- An adult has 32 permanent teeth.

**Salivary Glands** - Figure 11-4

- Contains enzymes which break down starches into simple sugars.
- Moistens food to pass through the esophagus.

**Pharynx**

- The pharynx is part of the *respiratory* and *digestive systems*.
- It allows food to move into the stomach by passing through the esophagus.
- A safety valve called the **epiglottis** prevents food from entering the trachea. This is where air would pass through into the lungs.

**Esophagus**

- It is a mucus lined muscular tube that connects the pharynx with the stomach.
- It is approx. 25 cm (10 inches) long.
- Peristalsis assists the passage of food.

**Stomach** - Figure 11-5

- It is a pouch-shaped organ about 25 - 30 cm (10-12 inches) long.
- It hangs under the diaphragm and has the capacity of 1 litre or more with thick folds that disappear when distended.
- Stomach receives food from the esophagus. The food mixes with gastric juices that contain **hydrochloric acid** and **enzymes** by contractions called *peristalsis*.

**Small Intestine**

- Function is to absorb food and water.
- Consists of three (3) portions:
- *duodenum*
- *jejunum*
- *ileum*
- It connects the stomach from the pyloric sphincter to the small intestine.

- Fills most of the abdominal cavity and the tube has circular muscles that move partially digested food called **chyme** through the intestine by a wavelike movement called *peristalsis*.
- It is approx. 7 metres or 20 feet long.
- The mucous lining contains thousands of microscopic glands that secrete intestinal digestive juice and also contains thousands of "*fingers*" called **villi** that absorbs nutrients and water that are transferred to the capillaries.
- The duodenum is approx. 25 cm (10 inches) long and most of the chemical digestion occurs here.
- The middle third of the duodenum has duct openings that empty *pancreatic digestive juice* from the pancreas and *bile* from the liver.
- Small intestines' walls secrete the hormone *cholecystokinin* to stimulate the contraction of the *gallbladder* to empty **bile** into the duodenum and to stimulate the pancreas for pancreatic digestive enzymes (juice).

**Liver** - Figure 11-6
- Largest gland **in** the body.
- An *exocrine gland* that secretes bile into ducts.
- Store and release proteins, minerals, vitamins and glycogen (sugar).
- Manufactures **bile** to aid digestion.
- Blood is *detoxified* from harmful ingested substances by filtration and fat is broken down.
- Processes and distributes nutrients to the cells via the circulatory hepatic portal system.
- Plays a key role in carbohydrate metabolisms by maintaining the normal concentration of blood glucose.

**Gallbladder** - Figure 11-7
- Function is to concentrate and store bile produced by the liver.
- A pear-shaped sac on the undersurface of the liver with a capacity of 30 to 50 ml. (1-2 oz.) to store bile between meals.
- **Bile** is concentrated by reabsorbing water and is released into the *duodenum* when stimulated by the hormone *cholecystokinin* from the small intestine via the *common bile duct*.
- The function of bile is to emulsify fats into smaller particles for easier digestion of the food particles.
- *Jaundice* is a condition caused by excessive bile absorbed into the blood due to a blockage such as gallstones which produces a yellowish skin discolouration.

**Pancreas** - Figure 11-8
- Lies behind the stomach in the concavity of the 'C' -shape of the duodenum.
- It is an *exocrine gland* that secretes pancreatic juice into ducts and an *endocrine gland* that secretes hormones into the blood.
- Pancreatic juice contains enzymes that digest food and also contains sodium bicarbonate to neutralize hydrochloric acid in the gastric juice.
- Pancreatic juice empties into the duodenum of the small intestine.
- The pancreas also contains cells that have no contact with ducts, called **islets (of Langerhans**) which secretes the hormone **insulin** (to regulate blood sugar) which is an endocrine function (see Endocrine System.)
- The pancreas provides **both** digestive and endocrine functions.

**Large Intestines** - Figure 11-9
- It is about 1.5 metres (5 feet) in length and consists of:
  - cecum
  - ascending colon
  - transverse colon
  - descending colon
  - sigmoid colon
  - rectum
  - anal canal
- Partially digested and unabsorbed food material is called *chyme* and it enters the large intestine from the small intestine after passing through a sphincter called the **ileocecal valve**.
- Chyme becomes *feces* as water and salts are reabsorbed due to bacterial action.
- The ileocecal valve prevents the contents of the cecum of the large intestine from backing up into the ileum of the small intestine.
- After a meal, *peristalsis* in the ileum is increased and forces some content of the small intestine into the cecum.
- The **appendix** or **vermiform appendix** is directly attached to the cecum but does not serve an important digestive function.
- The appendix contains *lymphatic tissue* and is part of the *immune system*.

## Pathological Conditions:

**Constipation** - Difficulty in having a bowel movement. *Functional constipation* is caused by poor bowel or eating habits, irritable colon, spastic colitis or emotional disturbances. *Organic constipation* is caused by paralytic or mechanical obstruction to stool by adhesions, tumours of the bowel, a stricture of the anus or rectum and inflammatory conditions.

**Diarrhea** - Passage of frequent, loose, unformed stools.

**Diverticulosis** - Pouches of mucous membrane that poke through the muscle wall of the large bowel. *Diverticulitis* is an inflamed pouch.

**Duodenitis** - Inflammation and irritation of the duodenum.

**Dyspepsia** - Indigestion which involves sense of fullness, heartburn, acid regurgitation of food, nausea and vomiting.

**Gastritis** - Inflammation of the stomach lining caused by bacteria, viruses, chemical irritants or spoiled foods.

**Gastroenteritis** - Acute inflammation of the small intestine and stomach.

**Hemorrhoids** - Also known as "*piles*" which are dilations of the veins in the rectum and anus.

**Meckel's Diverticulum** - A sac or pouch-like projections at weak points of small intestinal wall.

**Mumps** - Infectious viral disease of the salivary glands.

**Peptic Ulcer** - Ulcers of the stomach, duodenum or esophagus.

**For reflexes to work on for the above pathological conditions, refer to the Pathological Conditions section on page 7.**

## Foot Notes

# Chapter Summary

**Overview:** Figures 12-1 and 12-2

- The **circulatory system** consists of the **heart** (muscular pumping device) and a system of vessels made up of **arteries**, **veins**, **capillaries**, and **blood**.
- The terms *circulatory system* and *cardiovascular system* are sometimes used interchangeably. The *cardiovascular* system is associated to the heart and its blood vessels in the thoracic cavity.
- The primary function of the circulatory system is transportation.
- The heart functions as a muscular pump that forces blood through blood vessels.
- The *blood pressure* (high, low, or normal) depends on a number of factors; output from the heart, resistance to blood flow of the blood vessels, volume of blood and the distribution to various organs. All of these factors in turn can be affected by the activities of the nervous system and certain hormones.
- The **blood** serves as a fluid for transporting oxygen, nutrients, hormones and waste. It carries oxygen from the lungs and nutrients from the digestive system to all body cells. It also transports hormones from endocrine glands to destinations and waste from the body cells to the excretory organs.
- The circulatory system helps regulate body temperature.
- Certain cells can become involved in the immunity process.

**Pulmonary Circulation** Figure 12-3

- **Pulmonary circulation** refers to *blood flow through the lungs* beginning from the right atrium to the right ventricle, to the pulmonary artery to both lungs. Oxygenated blood returns via the pulmonary vein to the left atrium, entering the left ventricle to be pumped out through to the body.

**Systemic Circulation** Figure 12-3

- Systemic circulation refers to movement of blood from the left ventricle of the heart and throughout the body as a whole.

**Hepatic Portal Circulation** Figure 12-4

- **Hepatic portal circulation** refers to the route of *blood flow through the liver* from the abdominal area. Veins from the *spleen*, *stomach*, *pancreas*, *gallbladder*, and *intestines* do not move the blood directly into the inferior vena cava as do the veins from other abdominal organs. Instead, the blood is sent to the liver by means of the **hepatic portal vein**. The blood then leaves the liver through the hepatic veins, empyting into the inferior vena cava.

**Heart** Figures 12-5 and 12-6

- The heart is a conical and hollow *muscular pump* that is located centrally in the thorax cavity, between the sternum in the front and the thoracic vertebrae behind.
- The heart is close to the lungs, with ⅓ of its bulk to the right, and ⅔ to the left.
- In the average adult, it is 14 cm (5½") long and 9 cm (3½") wide and 480 to 560 grams (17-20 oz.)
- It is divided internally into **4 chambers** of which it acts as *2 separate pumps*.
- Ventricle pumping of *venous or deoxygenated blood* from the capillaries via the inferior and superior vena cavae, enter the right atrium, the right ventricle and through to the pulmonary artery **into** the lungs. *Arterial or oxygenated blood* **from** the lungs returns to the left atrium through the pulmonary vein and pumped from the left ventricle to the capillaries via the aorta.

**Blood Vessels** Figure 12-7

- Arterial (oxygenated) blood is pumped from the heart through **arteries**.
- The largest artery in the body is the **aorta**.
- Arteries subdivide into vessels that become smaller and become **arterioles** that *control the flow* into exchange vessels called **capillaries**.
- In the **capillary beds**, exchange of nutrients and respiratory gases occur between blood and tissue fluid around cells.
- Deoxygenated blood is then drained from the capillary beds and enters small **venules**, which join with other **venules** and increases in size, becoming **veins**.
- The largest veins are the **superior vena cava** and the **inferior vena cava**.
- **Arteries** and **arterioles** distribute oxygenated blood from the heart to capillaries. They also help *maintain arterial blood pressure* by constriction or dilation.

- **Venules** and **veins** collect impure blood from capillaries and return to the heart. They serve as *blood reservoirs* by expansion or constriction.
- **Capillaries** function as *exchange vessels*. Glucose and oxygen move out of blood in capillaries into interstitial fluid and on into cells. Carbon dioxide and other substances move into the capillary blood from the cells.
- The **aorta** carries oxygenated blood *out* of the left ventricle of the heart. The superior vena cava and the inferior vena cava *return* deoxygenated blood to the right atrium *after* the blood has circulated through the body.

## Pathological Conditions:

**Aneurysm** - A weakness in the artery wall may distend or a sac or pouch may protrude from the wall of the artery.

**Arteriosclerosis** - An excessive amount of mineral and fatty material built-up that it becomes calcified and hardens the arteries.

**Atherosclerosis** - The excessive amount of a mineral and fatty material build-up in the blood vessel walls that narrows the passageway. This decreases blood flow and pressure, leading to the blockage of coronary arteries and a "*heart attack*".

**Embolism** - A small portion of material that clogs a blood vessel, breaks loose and flows in a blood stream until lodged in a smaller vessel, cutting off blood supply to the body part.

**Hypertension** - High blood pressure.

**Hypotension** - Low blood pressure.

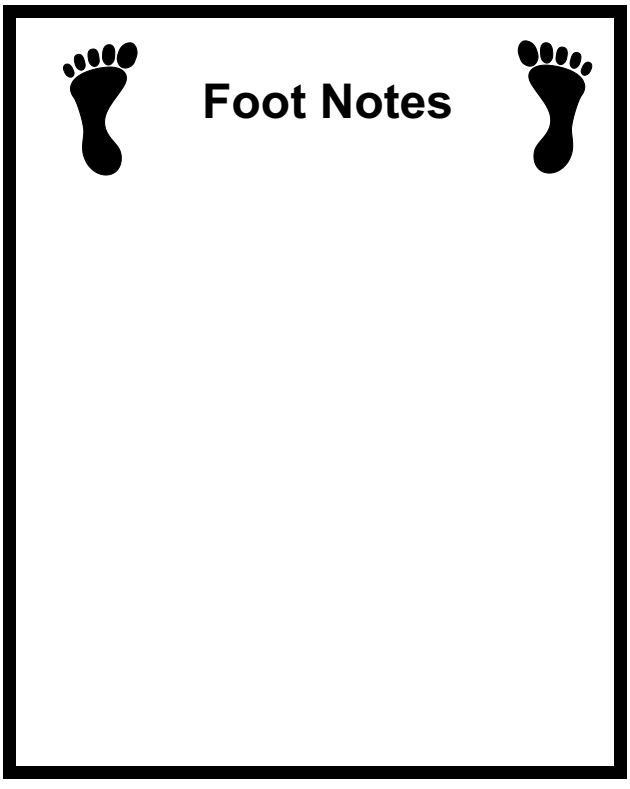
**Raynaud's Phenomenon** - Painful spasm of the blood vessels in the fingers and toes due to lack of blood flow. The colour of the fingers or toes can change very quickly to pale or blue (acrocyanosis).

**Thrombosis** - Thrombosis is a condition in which the blood changes from a liquid to a solid state forming a clot or thrombus within a blood vessel. A thrombus may become detached from its site of formation only to lodge somewhere else (*embolism*). Coronary *Thrombosis or Coronary Occlusion* (occlusion is the closing or obstruction of a hollow organ) is the clotting of blood in the blood vessels which supply the heart. This results in a myocardial infarction of the heart (heart muscle damage) resulting in a "heart attack": sudden or severe chest pains which may spread to the arms and throat. **Gently work on all reflexes to prevent dislodging a thrombus or clot.**

**Varicose Veins** - Varicose veins are veins that have valve problems and are very common in legs. Circulation is impaired and blood accumulates in the veins, stretching them. The veins enlarge, bulge, are often bluish in colour and lumpy-looking. The legs may be sore, swollen and feels heavy.

Most cases are manageable, however complications may cause deep vein blood clots known as phlebothrombosis. **Do not work on this condition for risk of dislodging a clot or thrombus. Do not work directly on varicose veins.**

For reflexes to work on for the above pathological conditions, refer to the **Pathological Conditions** section on page 7.



# Chapter Summary

**Overview** Figures 13-1 and 13-2

- The lymphatic system is composed of **lymph nodes**, **lymphatic vessels** and specialized organs such as **tonsils**, **thymus**, **spleen**, and **appendix**.
- The thymus has dual functions: lymphatic and endocrine.
- Lymph is a whitish, watery fluid that contains **lymphocytes** (type of white blood cell for immunity), proteins and fatty molecules and does not contain red blood cells.
- Lymph is formed from fluid around body cells and diffuses into lymph vessels.
- Lymph does not circulate repeatedly through a closed circuit but eventually enters the circulatory system by passing through large ducts, which connect with veins in the upper thoracic cavity.
- Lymphatic system provides a type of continuous cleansing that operates at a cellular level.
- Functions of lymphatic system include movement of fluids and certain large molecules, waste products, toxins, and other debris from tissue spaces around cells and movement of fat-related nutrients from the digestive tract back to the venous or deoxygenated blood.
- The lymphatic system is also involved with the immune system playing a critical role in defence.
- The immune system identifies materials that are foreign or harmful and destroy them.
- Lymphatic system is similar to circulatory system but does not have a muscular pump. Lymph is moved through vessels against gravity by muscular contractions of the body.

**Lymph and Lymph Vessels**

- Circulatory system provides nutrients to cells and removes waste products. Additional wastes not removed by the circulatory system are returned to blood as **lymph**.
- Lymph is a whitish, watery fluid transported through the **lymphatic vessels**.
- Lymph is collected from **capillary beds** and into **lymphatic capillaries**.
- Lymph flows from lymphatic capillaries to larger vessels called **lymphatic venules** and **veins**.
- Lymphatic system empties into two terminal vessels called **right lymphatic duct** and **thoracic duct** which empty lymph into the blood in veins in the neck area.
- Lymph from ¾ of the body drains into thoracic duct (largest lymphatic vessel in body) and lymph from right upper extremity, right side of head, neck and upper torso drains into the right lymphatic duct. Figure 13-3.

**Lymph Nodes** Figure 13-2

- Lymph nodes perform two functions: defence or immune by filtration and white blood cell formation.
- Lymph nodes act as filters. They remove bacteria, abnormal cells, ect., from the lymph as it pass through the nodes.
- Lymph nodes also produce white blood cells and antibodies to help the body defend against infection.
- Lymph is filtered by moving through **lymph nodes** that are located in clusters.
- Major locations of lymph nodes are: groin, behind knees, armpits, elbows and below jaw line.

**Thymus**

- The thymus is a small lymphoid tissue organ in the **mediastinum**. The mediastinum is the space in the chest cavity between the two lungs, the sternum and the vertebral column.
- Plays a central role in immunity. At approx. 35g., the thymus is largest at puberty.
- A source of lymphocytes (type of white blood cells for immunity) before birth and is important in development of lymphocytes that leave the thymus and circulate to spleen, tonsils, lymph nodes and other lymphatic tissues.
- **T-lymphocytes** or T-cells develops under influence of the thymus hormone, **thymosin**.
- The thymus completes its work early in childhood and is replaced by fat and connective tissue, a process called *involution*.

**Tonsils** Figures 13-4 and 13-5

- **Tonsils** are masses of lymphoid tissue located in a ring under the mucous membranes in the mouth and back of the throat that help protects against bacteria around openings between nasal and oral cavities.
- **Palatine tonsils** are located on each side of the throat.
- **Pharyngeal tonsils**, also known as **adenoids**, are near the posterior opening of the nasal cavity.

- **Lingual tonsils** are near the base of the tongue.

**Spleen** Figure 13-6

- Spleen is the *largest lymphoid organ* in body and is located high in upper left quadrant of the abdomen, lateral to stomach.
- Blood flows through pulp-like accumulations of lymphocytes (type of white blood cell for immunity) and phagocytes (types of white blood cells which engulf and digest microorganisms).
- The spleen removes bacteria and other foreign substance by filtration and phagocytosis (engulfment, ingestion, and digestion of enemy particles by a cell, phagocyte).
- Destroys red blood cells and salvages iron in hemoglobin for future use.
- Serves as reservoir for blood.
- Spleen has a very rich supply of blood and may contain over 1 pint.
- If damaged, spleen is removed by *Splenectomy* (surgical removal) to stop loss of blood.

**Appendix** Figure 13-7

- The appendix is also known as **vermiform appendix**.
- It is a wormlike structure that is directly attached to the cecum and is composed of lymphatic tissue.
- The appendix may play a minor role in immune system.

## Pathological Conditions:

**AIDS** - **Acquired Immunodeficiency Syndrome** is caused by *Human Immunodeficiency Virus* or *HIV* that impairs or destroy T-cells.

**Appendicitis** - inflammation or abscess of the appendix usually due to infections. Surgical removal is called **appendectomy**.

**Cancer** - Cancer - any malignant (poisonous) tumour (growth). The cells are abnormal and have uncontrolled divisions of cells, invade and destroy the surrounding tissues. Most types of cancers fall under:

1. Carcinomas (skin, mucous membrane, glands, organs)
2. Leukemias (blood forming tissues)
3. Sarcomas (muscle, connective tissue, bones)
4. Lymphomas (Lymphatic system).

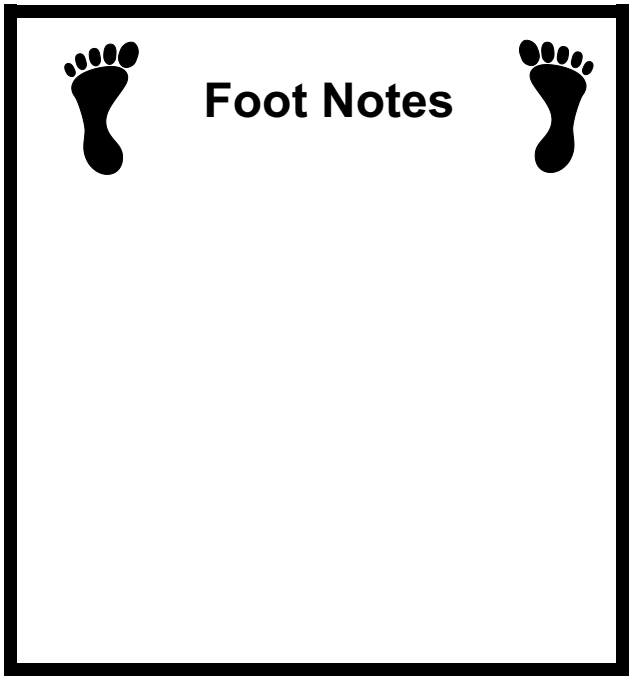
**Hodgkin's Disease** - also known as **lymphoma**, it is the painless progressive enlargement of malignant lymph glands and lymphoid tissue.

**Leukemia** - characterized by excessive activity of either bone marrow or spleen and lymph glands resulting in an increase in number of lymphocytes. Types of leukemia include *lymphocytic leukemia* (white blood cells known as lymphocytes are involved), *granulocytic leukemia* (granulocytes originating in the bone marrow), *monocytic leukemia* (monocytes of connective tissue origin) and *subleukemic leukemia* (lower than normal white blood cell count).

**Lymphadenitis** - inflammation of lymph nodes.

**Tonsillitis** - inflammation of tonsils and adenoids due to bacterial infection.

**For reflexes to work on for the above pathological conditions, refer to the Pathological Conditions section on page 6.**



# Chapter Summary

### Overview

- Organs of the **respiratory system** include the **nose**, **pharynx**, **larynx**, **trachea**, **bronchi**, and **lungs**.
- Respiratory organs permit movement of air into lung sacs called **alveoli**. In the alveoli, **oxygen** is *exchanged* for **carbon dioxide** which is carried to the lungs by the blood for elimination.
- The respiratory system is designed to perform 2 functions:
  - **air distributor**
  - **gas exchanger**
- The respiratory system ensures that **oxygen** is *supplied* to and **carbon dioxide** is *removed* from the body's cells.
- The respiration process is an important **homoeostatic mechanism** which maintains a constant environment for body cells to function effectively.
- The respiratory system also **filters**, **warms**, and **humidifies** air as it is breathed into the body.
- Some parts of the respiratory organs, such as the **sinuses**, also influence speech or sound production and make possible the sense of **smell** or **olfaction**.

### Nose Figure 14-3

- Air enters the *respiratory tract* through the **external nares** or **nostrils** which then flows into the right and left **nasal cavities** that are lined by *respiratory mucosa*.
- The surface of the nasal cavities is moist from mucus and warm from blood flowing under them.
- Nerves endings for the sense of smell, olfactory receptors, are located in the nasal mucosa.
- Four **paranasal sinuses** drain into the nasal cavities.
- Within the nasal cavities are 3 **conchae** that protrude into the nasal cavity on each side and they assist in *warming* and *humidifying* the air.

### Pharynx

- Also known as the **throat**, the **pharynx** is part of the *respiratory* and *digestive* systems.
- About 12.5 cm (5") long, it allows air to pass through to the lungs and food into the stomach.
- Air enters the pharynx from 2 nasal cavities and leaves it by way of the larynx and food enters it from the mouth and leaves it by way of the esophagus.
- The right and left **auditory** or **eustachian tubes** open into the nasopharynx which connects the middle ears that permit equalization of air pressure between the middle and the exterior ear.
- There are 3 types of lymphatic tissue called **tonsils** and are embedded in the mucous membrane of the pharynx.
  - **Pharyngeal tonsils** or **adenoids** are in the nasopharynx.
  - **Palatine tonsils** are located in the oropharynx.
  - **Lingual tonsils** are located near the base of the tongue.

### Larynx

- Also known as the **voice box**, the **larynx** is located just below the pharynx.
- It is composed of several pieces of cartilage in which the largest is the **thyroid cartilage**, also known as the "*Adam's Apple*."
- Two short fibrous bands or **vocal cords**, stretch across the interior of the larynx. Muscles that attach to the larynx cartilages can pull any cord tense or relaxed. When tense, the voice is high pitched and when relaxed, the voice is low pitched.
- The space between the vocal cords is called the **glottis**.
- The **epiglottis** partially covers the opening of the larynx and acts like a *trapdoor*, closing off the larynx during swallowing and preventing food from entering the trachea.

### Trachea Figure 14-4 and 14-5

- Also known as the **windpipe**, the **trachea** is a tube (11 cm or 4 ½") that extends from the larynx in the neck to the bronchi in the chest cavity where it extends downward in front of the esophagus and into the thoracic cavity where it splits into the right and left bronchi.
- The trachea is made of an almost noncollapsible material of 15 to 20 C-shaped rings of cartilage placed one above the other.

### Bronchi, Bronchioles and Alveoli

- The **primary bronchi** consist of the right bronchus (tube leading into right lung) and the left bronchus (tube leading into left lung), branches from the trachea and into smaller or **secondary bronchi**.
- The secondary bronchi further branch into **bronchioles** which subdivide into **alveolar ducts** that contain **alveolar sacs** which are lined with **alveoli** where gas exchange takes place close to the blood capillaries.

### Lungs Figure 14-6

- **Lungs** are a pair of soft, spongy, and elastic cone-shaped organs in the thoracic cavity that *expand* and *compresses* by movements from the diaphragm and the ribs while *breathing*.
- The right and left lungs are situated on either side of the heart in the **mediastinum**. The mediastinum is between the sternum in front and the vertebral column behind, and from the base of the neck to the diaphragm. It is a collection of tissues and organs containing the heart and great blood vessels, the trachea, esophagus, thymus gland, and lymph nodes.
- Each lung is enclosed with a covering called the **pleura** that consists of a double layer of serous membrane, a smooth and moist closed sac.
- The lungs house the bronchi, bronchioles and alveoli where the process of gas exchange takes place.
- Other functions of the lungs include: water evaporation for fluid balance and heat regulation of the body.

### Diaphragm

- The **diaphragm** is a thin dome-shaped muscle separating the thoracic cavity from the abdominal cavity. It arches upwards against the heart and lungs and over the stomach, spleen, and liver.
- The diaphragm plays an important role in *breathing*. As the muscle contracts downwards, it flattens with each **inspiration** (inhalation) to provide increasing volume for the thoracic cavity as it **draws** *air into the lungs*. The diaphragm then, with each **expiration** (exhalation) relaxes, returning to its dome-shape as it **forces** the *air out of the lungs*.

### Pathological Conditions:

**Asthma** - a condition of breathing difficulties caused by an obstruction to the air flow. It is not a disease itself but a symptom of one or more other conditions.

**Bronchitis** - an inflammation of the mucous membrane of the bronchi.

**Emphysema** - a progressive disease characterized by the over-distention of the lung with air that cannot be expelled.

**Laryngitis** - an inflammation of the mucous membrane of the voice box or larynx accompanied by hoarseness and sometimes a cough.

**Pleurisy** - a painful inflammation of the membrane that covers the lungs and the surfaces of the chest cavity (pleura) due to common causes such as pneumonia, tuberculosis and influenza.

**Pneumonia** - an inflammation involving either one or both lungs due to bacterial or viral infections or other causes such as chemical, trauma and postoperative.

**Sinusitis** - an inflammation of the mucous membrane lining the sinus cavity that may be either acute, prolonged, or persistent (chronic).

**Strep Throat** - also known as septic sore throat, it is a disease caused by a type of bacterium (streptococcus) which destroys red blood corpuscles.

For reflexes to work on for the above pathological conditions, refer to the **Pathological Conditions** section on page 6.

# Chapter Summary

### Overview

- The organs of the **nervous system** consist of the **brain**, **spinal cord**, **nerves** and **specialized sense organs** such as the *eyes* and *ear* (specialized), and microscopic general sense organs such as the *skin*.
- Control of the body's cells is accomplished by two communication systems:
  - **Nervous system** - transmit information *very rapidly* by nerve impulses from one body area to another.
  - **Endocrine system** - transmit information more slowly by hormones secreted by ductless glands into the bloodstream and circulate from the glands to other parts of the body.
- Nerves extend from the brain and the spinal cord to every area of the body which make it possible to perform its primary functions that include:
  - *Communication* between body functions
  - *Integration* of body functions
  - *Control* of body functions
  - *Recognition* of sensory stimuli.
- The above functions are accomplished by specialized signals called **nerve impulses** that results in rapid activity that usually last for a short duration of time. Some impulses permit the rapid and precise control of body functions. Other nerve impulses cause glands to secrete fluids.
- The nervous system can recognize certain **stimuli**, such as heat, light, pressure, or temperature, that affect the body and impulses are generated to convey this information to the brain, where it is analysed and appropriate action is initiated.

### Divisions of the Nervous System

- The nervous system consists of **two principal divisions** called the **Central Nervous system** (**CNS**) and the **Peripheral Nervous system** (**PNS**). A subdivision of the PNS, called the **Autonomic Nervous system** (**ANS**) consists of structures that regulate the body's automatic or involuntary functions. Figure 15-2.

### Central Nervous System - CNS

- Figure 15-3, Table 15-1

- The 2 major structures of the CNS, the **brain** and the **spinal cord** are found along the longitudinal plane of the body (Figure 15-1).
- The brain is protected in the cranial cavity of the skull, and the spinal cord is surrounded in the spinal cavity by the vertebral column.

### Division of the Brain

- The **brain**, one of the largest organs, consists of the following major divisions:
  1. **Brain stem**
     a. Medulla oblongata
     b. Pons
     c. Midbrain
  2. **Cerebellum**
  3. **Diencephalon**
     a. Hypothalamus
     b. Thalamus
  4. **Cerebrum**
     a. Cerebral cortex
     b. Corpus callosum

### Brain Stem

- The 3 parts of the **brain stem**, the *medulla oblongata*, *pons* and *midbrain*, function as 2-way conduction paths. *Sensory fibres* send impulses **up** from the spinal cord to the brain, and motor fibres send impulses **down** from the brain to the spinal cord.
- Many important physiological reflex centres lie in the brain stem - cardiac, respiratory, and vasomotor centres are located in the medulla where impulses from these centres control the heartbeat, respirations, and blood vessel diameter for blood pressure control.

### Cerebellum

- The **cerebellum** is the second largest part of the brain whose functions are to produce smooth coordinated movements, maintain equilibrium, and sustain normal postures.

### Diencephalon

- The **diencephalon** consists of 2 major structures:
  - **hypothalamus**
  - **thalamus**

#### Hypothalamus

- The **hypothalamus** is located below the thalamus, the extensions of the hypothalamus are the posterior pituitary gland's stalks.

- The hypothalamus exerts major control over all internal organs. The vital functions that it helps to control are the heart beat, constriction and dilation of blood vessels, and contractions of the stomach and intestines.
- The hypothalamus *influences* the hormones produced by other endocrine structures to regulate water balance, temperature, sleep cycles, appetite and emotions involved in pleasure, fear, anger, sexual arousal, and pain.
- The endocrine function of the hypothalamus is discussed in *Chapter 8, The Endocrine System*.

### Thalamus

- The **thalami** (2 thalamus organs) helps produce sensations by *relaying impulses* to the *cerebral cortex* from the *sense organs* and associates sensations with emotions. The thalamus also play a part in associating sensory impulses with pleasant and unpleasant feelings, in the arousal mechanisms of the body, and in the mechanisms that produce complex reflex movements.

### Cerebrum

- The **cerebrum** is the largest and uppermost part of the brain and consists of the *cerebral cortex* (divided into 2 longitudinal halves or hemispheres) and the *corpus callosum* that connects the cerebrum together.
- The cerebrum functions as a processing centre or "*computer*" where information from the body is processed and decisions made by sending appropriate impulses.
- Specific areas of the cerebrum are responsible for certain functions such as visual and auditory sensory perceptions.

### Spinal Cord

- The nerve tracts passing to and from the brain are contained in the **spinal cord** that is continuous along with the lower part of the brain (brain stem), down the spinal column to the lower lumbar region.
- The spinal cord is approximately 45 cm (18") long and is rounded in shape.
- The spinal cord acts as a "*telephone switchboard*" that *relay impulses received from the body to the brain* for processing and it also *relay impulses from the brain to the nerve cells* which control the various muscles.
- Nerve cells along the side of the spinal cord send out fibres that unite with others to form the *sympathetic chain* that is concerned with the action of *involuntary muscles* in the intestines, arteries, and other internal structures.
- Nerve cells on the back or posterior side of the spinal cord receive the *sensations* of touch, pain, vibration, temperature, pressure, and position which then transmit these sensations to other nerve cells in the brain.
- Impulses travel up and down the cord and as well as travelling only part way up and setting off the spinal physiological reflexes.

### Peripheral Nervous System

- The **Peripheral Nervous system** (**PNS**) consists of the **cranial** and **spinal nerves** that *connect* the *brain* and *spinal cord* to peripheral structures such as the skin surface and the skeletal muscles.
- In addition, the *Autonomic Nervous System* (ANS) is part of the PNS that connect the brain and spinal cord to various glands in the body and to the cardiac and smooth muscles in the thorax and abdomen.

### Cranial Nerves Figure 15-4

- 12 pairs of **cranial nerves** are attached to the undersurface of the brain, mostly from the brain stem.
- The fibres conduct impulses between the brain and structures in the head and neck and in the thoracic and abdominal cavities.

### Spinal Nerves

- 31 pairs of nerves are attached to the spinal cord.
- **Spinal nerves** conduct impulses between the *spinal cord* and *parts of the body not supplied by the cranial nerves* and contain sensory and motor fibres.

### Autonomic Nervous System Table 15-2

- The **Autonomic Nervous System** (**ANS**) consists of certain motor neurons that conduct impulses from the spinal cord or brain stem to the following tissue:
  - Cardiac muscle tissue
  - Smooth muscle tissue
  - Glandular epithelial tissue (tissue covering).

- The **ANS** consists of parts of the nervous system that regulate *involuntary functions* (for example, the heartbeat, contractions of the stomach and intestines, and secretions by glands). On the other hand, motor nerves that control the voluntary actions of skeletal muscles is sometimes called the somatic nervous system.
- The *somatic nervous* system consists of *motor nerves* that control the *voluntary actions* of the skeletal muscles.
- The ANS consists of 2 divisions:
  - **Sympathetic Nervous system**
  - **Parasympathetic Nervous system**

### Sympathetic Nervous System

- The **Sympathetic Nervous System** functions as an **emergency system** which take control of many internal organs during strenuous exercise and when strong emotions are present.
- **Under stress**, the sympathetic impulses **increase** to many visceral effectors (internal organs capable of responding to nerve impulses) to produce widespread changes within the body.
- The sympathetic responses allow a body to be ready for strenuous muscular work or for *fight or flight* which is known as the **fight-or-flight syndrome**.

### Parasympathetic Nervous System

- The **Parasympathetic Nervous System** dominates control of many visceral effectors under normal conditions.
- Parasympathetic impulses are sent to slow heartbeat, increase peristalsis, and increase secretion of digestive juices and insulin.
- This system works in **balance** with the *Sympathetic Nervous System*, the actions of which it frequently opposes. This is the *Parasympathetic* ***Response*** to balance.

### Autonomic Nervous System as a Whole

- The function of the ANS is to regulate the body's *automatic, involuntary functions* to maintain or quickly restore **homeostasis**.
- Many internal organs are doubly innervated by the ANS because they receive fibres from the *parasympathetic* and *sympathetic divisions*. Parasympathetic and sympathetic impulses are continually sent that influence their function in *opposite* or *antagonistic ways*. For example, the heart receives sympathetic impulses that make it beat faster and parasympathetic impulses to slow it down. The ratio between the *two antagonistic forces* determines the actual heart rate.

### Sense Organs

- Sense organs are often classified as:
  - **Special sense organs**, such as the *eyes*, are characterized by large and complex organs or by localized grouping of specialized receptors in areas such as the nasal mucosa or tongue.
  - **General sense organs** are microscopic receptors widely distributed throughout the body that detect stimuli such as pain and touch.

### Special Sense Organs Table 15-3

#### The Eye Figure 15-5

- The **eye** is one of the most important organs where a large portion of the body's information is acquired through vision. The remainder is provided by such senses as hearing, smelling, tasting, and touching.
- The eye contains a lens that focuses light on a light-sensitive area.
- The working parts of the eye are the **lens** that focuses the picture, the **retina** that receives it, and the **optic nerve** which transmit an impression to the brain.
- The *accessory parts* are the **lacrimal glands** that keep the eye moist.

#### The Ear Figure 15-6

- In addition to *hearing*, the **ear** functions as the sense organ of *equilibrium* and *balance*.
- The ear consists of *3 parts*:
  - the visible portion called the **external ear** (auricle)
  - the **middle ear** inside the head
  - the **internal or inner ear** that is formed partly of one of the bones of the skull (*temporal bone*).
- Both the middle ear and the internal ear are essential for *transmitting* to the hearing centre of the brain, the vibrations which comprise sound. These vibrations are transmitted to the middle ear through the *external auditory canal*.
- An accessory part is the *auditory tube* or *Eustachian Tube* that is a canal that connects the

back of the nose with the middle ear to equalize pressure.
- Another important function of the ear is the **semicircular canals** that are responsible for the sense of **balance** or **equilibrium**. The canals contain a fluid that remains at a certain level and when the body is off balance, the fluid is displaced over a series of sensory hairs that communicate with the brain.

**The Taste Receptors** Figure 15-7
- Chemical receptors that generate nervous impulses resulting in the sense of taste are called *taste buds* and they are found on the papillae of the tongue.
- 4 kinds of taste sensations are detected - sweet, sour, bitter, and salty.

**The Smell Receptors** Figure 15-8
- Chemical receptors of the sense of smell are located in the *epithelial tissue* in the upper part of the nasal cavity.
- Due to the hidden location of the **olfactory receptors**, a person is required to forcefully sniff air to smell delicate odours.
- Each olfactory cell has a number of specialized *cilia* that sense different chemicals that cause the cell to generate a nervous impulse.
- Chemicals must be dissolved in the watery mucus of the nasal cavity in order to be detected by the olfactory receptors.

**General Sense Organs** Figure 15-9 and Table 15-4
- General sense organs are found throughout the body and there are various types of sensors to detect pain, temperature, touch, vibration, and proprioception (sense of position).

## Pathological Conditions:

**Note**: The brain reflexes are to be worked on the **opposite foot** for any pathological conditions that occurs within the brain for the corresponding physiological symptoms including paralysis caused by a condition occurring within the brain. It is best to work on all the brain reflexes for any brain pathological conditions (big toe and all toes).

Some examples:
- Migraine headache on the right side of the head - work on the left brain reflex.
- Stroke - paralysis on the left side of the body - work the right brain reflexes.

**Cerebral Palsy** - a group of neurological disorders that affects children resulting from brain injury. Muscular condition is characterized by a stiffness or spasticity of the limbs, or some type of paralysis, resulting in an awkward or stiff-legged gait.

**Encephalitis** - an inflammatory process in the brain usually caused by a virus that is accompanied by hemorrhages of the brain and muscular rigidity. *Parkinsonism* is frequently the result of encephalitis.

**Epilepsy** - characterized by a sudden, brief disturbance in the brain function, causing a loss or change of consciousness and is sometimes accompanied by recurrent convulsive seizures.

**Glaucoma** - an increase of pressure within the eyeball caused by an inability to eliminate fluid produced by the ciliary body of the eye.

**Lockjaw (Tetanus)** - a disease of the nervous system caused by poisons from wounds infected with tetanus bacteria that are found in dust, rust, sewage, soil, and domesticated animals' feces.

**Meniere's Syndrome** - a condition of the inner ear accompanied by sudden, severe episodes of vertigo, tinnitus, and fluctuating hearing loss.

**Meningitis** - an inflammation of the brain's membrane covering that may be caused by a head injury or a viral infection. It causes headaches, fever, loss of appetite, and intolerance to light and sound.

**Multiple Sclerosis (MS)** - Multiple sclerosis is a chronic auto immune disease that destroys the myelin protective covering of the brain and spinal cord in patches, leaving multiple areas of scar tissue in the nerve pathways interfering with normal control and function of organ and body parts.

**Poliomyelitis** - also known as *polio* or *infantile paralysis*, it is an acute, infectious viral disease of the nervous system in which the inflammation attacks the anterior part of the spinal cord that may result in paralysis of any part of the body. For paralysis, work on the brain reflexes on the opposite foot.

For reflexes to work on for the above pathological conditions, refer to the **Pathological Conditions** section on page 10.