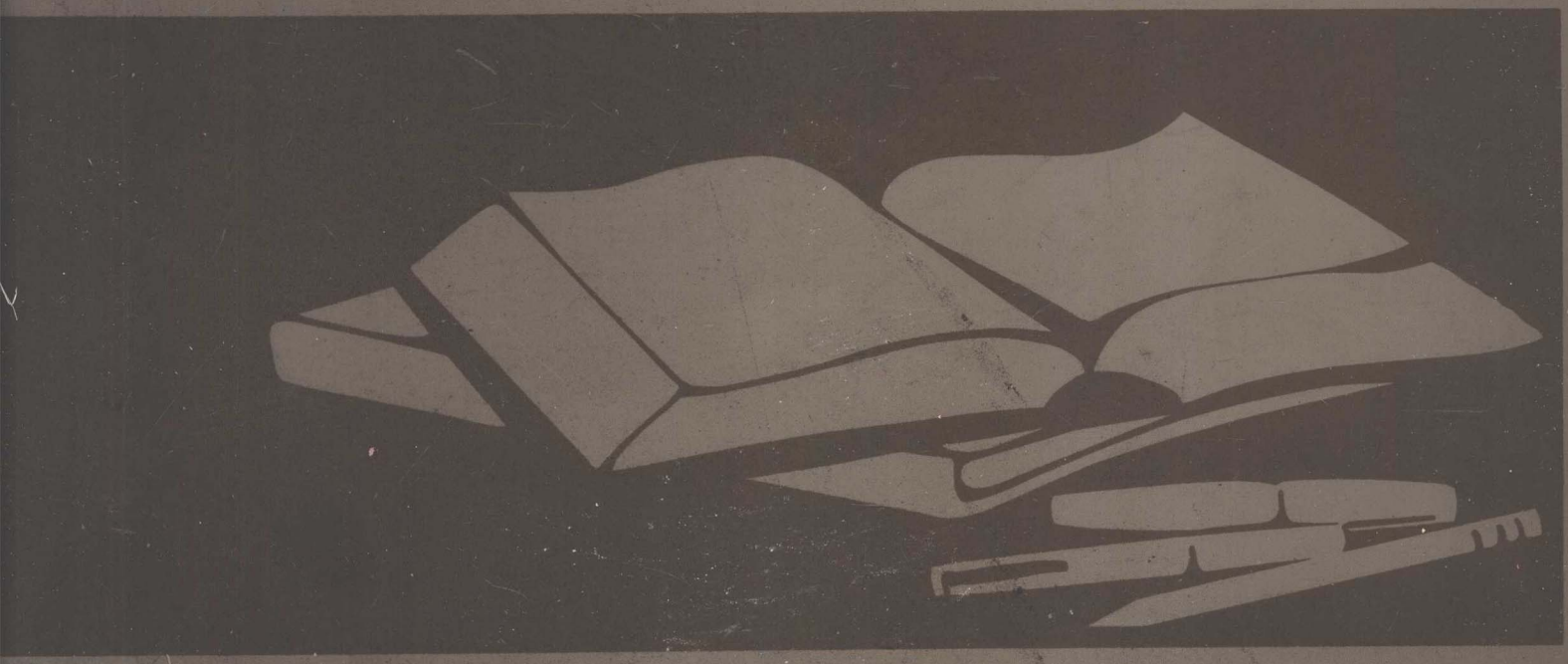

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"ANATOMY & BODY SYSTEMS"

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M E D I C I N E F O R L A W Y E R S

OVERVIEW OF ANATOMY AND BODY SYSTEMS

These materials were prepared by Dr. C.E. Slonecker of Vancouver, B.C., for Continuing Legal Education, December, 1982.

OVERVIEW OF ANATOMY AND BODY SYSTEMS

C O N T E N T S

OVERVIEW OF ANATOMY AND BODY SYSTEMS

I. INTRODUCTION

The body of man has resulted from the evolution of biological organisms over the last three and one-half billion years. One billion years ago, the first multicellular animals evolved. The development of specialized cell populations in these more complex forms gave rise to the different organ systems which served the organism as a whole. More resistant cells were evolved for body coverings, sensitive cells with increased properties of excitability became neural (nerve) components, contractile cells were evolved for movement of body parts, and absorptive and secretory cells evolved to modify the intake and output of the body systems.

The earlier forms of life produced a core of body structure that was designed to facilitate vegetative and reproductive function of the organism. Some 500 million years ago, the vertebrates (animals with back bones) evolved. This form of life was designed around an internal body skeleton centred around the vertebral column. The body core was more flexible and mobile due to the segmented nature of this internal skeleton and specialized contractile elements (muscles) to move it.

In higher invertebrate forms and lower vertebrate forms (fishes), the body core began to evolve appendages. These served two principal functions in evolution. The upper and lower extremities were for locomotion in fluids, in air, and on land. The head evolved as an appendage for locating food, mate, and enemy. The head contained an elaborate sensory mechanism for detecting features in the immediate environment of the organism. These were principally sensory mechanisms initially, and included olfactory (smell), vision, hearing, and proprioceptive (feeling) receptors. Some motor function in the developing head was organized around the oral cavity as a prehensile (grasping) organ, masticatory (chewing) and deglutatory (swallowing) mechanism. The oral mechanisms also evolved in some quadrapeds (four legged animals) as an efficient defence mechanism.

The evolution of man is characterized by the evolution of bipedalism (two-legged stance) and the rapid growth of the cerebral cortex (area of brain for higher sensory, motor, and behavioural control). The upper extremity is freed from the principal role of locomotion and becomes a prehensile and defensive organ in the arboreal (tree-dwelling) primate. The highly proprioceptive sensitivity (sense of touch) of the lips and tongue is matched by the proprioceptive sensitivity in the thumb, index, and middle fingers and these functions shift from the oral cavity to the dev- eloping hand in the growing human being. The snout and face region are altered due to the reduced requirement for these shifting functions and diminishing requirement for smell as a primary sens- ory mechanism for survival in the human species. The motor function of the head is then centred around the masticatory and swallowing functions of the mouth and pharynx (throat) and the newly-evolving laryngeal (voice box), pharyngeal, palatal, and labial (lip) function in language production. In addition, man has an extensive development in muscles of the face (plate 25) that serve to augment language through the nonverbal gestures produced by the muscles of facial expression under the influence of the emotional and voluntary centres of the forebrain.

II. VERTEBRAL SYSTEM (Plate 13)

This is the basis of the internal skelton of the human body. It is the major weight bearing

component of the body and all of the appendages are attached to it. It is a segmented series of of bones (vertebrae) that articulate with each other in a limited range of movement. This allows for stability and strength in the vertebral column, but great flexibility when one summates the small degree of movements between each individual vertebra. There are 33 bones in the developing vertebral column - 7 cervical (neck region), 12 thoracic (chest region), 5 lumbar (lower back region), 5 sacral (buttocks region which become fused into a single sacrum), and 4 coccygeal (tail bone which also fuses into a single coccyx) vertebrae. The non-fused components of the vertebral column are separated by 24 intervertebral discs. These are joints consisting of non-osseous (non-bony), ligamentous (tendonous), and elastic (compressible) tissues. They assist in providing flexibility to the column as well as absorptive cushion to the shock which is transmitted through the vertebral column in all our weight-bearing activities.

The intervertebral discs account for one fourth of the dimension of the spinal column. The changes in the amount of this soft tissue with increasing age is the basis for people losing height in the later years.

The vertebrae increase in size, particularly in the body component (plate 13) as one descends to the lower lumbar region. This is due to the increasing weight that needs to be supported as the arms and viscera (body organs) are added to the total body mass as we descend from the neck to the pelvis. The sacrum tapers back to a point inferiorly when the body weight is transferred to the iliac (hip) bones and femurs (thigh bones) through the hip joint. The femurs then articulate with the tibia and fibula (leg bones) through the knee and finally the foot through the ankle joint.

When viewed from the lateral (right or left side) aspect (plate 13), the vertebral column has a sigmoid (S shaped) configuration. In the developing embryo (first eight weeks of interuterine life) and the fetus (2 months - 9 months' stage of inter-uterine life) the entire vertebral column is concaved anteriorly (toward the ventral or frontal surface of the body). As a child begins to lift its head off its crib at 3-6 months of postnatal life, the curve in the cervical (neck) region reverses. Likewise, when the child begins to stand and walk on its lower extremities, the curvature on the lumbar (lower back) reverses. This allows for the development of a bipedal organism.

The two reverse curvatures in the cervical and lumbar regions are not as stable as those areas in the thoracic and sacral region that remain the same as in the developing human. To strengthen these reversed curvature areas, a large mass of muscles evolve in the back of the neck and small of the back region. Changes also occur in the intervertebral discs of these regions. These growth changes are factors which influence the stability of these areas. Most instability in the vertebral area can be related to these areas and may result from alteration in either muscles, bones, or intervertebral discs in these areas. Dr. Meeks or Dr. Grisdale will have more to say about these regions in the sessions to follow.

III. THE CRANIUM

The vertebral column contains the vertebral canal which surrounds and protects the spinal cord and the developing Central Nervous System (Plate 116, Spinal Cord and Brain). The spinal cord is continuous with the brain stem and cerebral cortex (brain) through the foramen magnum (Plate 12, the largest opening in the base of the skull). The brain is thus enclosed within the skull by a series of flat bones which make up the cranial (head) vault. These bones are non-moveable in adults and fused together in ossified joints called sutures. In the newborn and young child

(up to 6 years), these sutural joints are moveable and allow expansion of the cranial vault to accommodate the growing brain. The anterior fontanelle (soft spot) on a baby's head usually ossifies around 3 years and the brain attains its adult size in early childhood, 6-12 years of age. This mobility of the skull bones also allows some changes in head size at the time of birth and may allow the head to accommodate to a smaller diameter birth canal in the mother's pelvis.

The principal openings in the cranial vaults are for the passage of the cranial nerves (those directly off the forebrain and brain stem, Plates 116 & 133). The sensory receptors of the head are contained in (Plate 11) the orbits (vision), nasal cavity (olfaction), oral cavity (taste), and external auditory meatus (hearing). Motor function in the head and neck would be effected by some of the cranial nerves through the muscles of facial expression, muscles of mastication (Plate 25), muscles of the palate and pharynx (Plate 81), and the larynx (voicebox, Plate 73).

IV. THE EXTREMITIES (Plate 10)

A. UPPER EXTREMITY Plate 18.

It consists of the bones of the shoulder girdle (scapula and clavicle), arm (humerus), forearm (radius and ulna), and hand (carpal bones in wrist, metacarpal bones in the hand and the phalanges in the fingers). The upper extremity is also called the brachium. Mobility of the upper extremity is effected through a number of muscles and the respective joints which these muscles cross. The major muscles are shown in Plates 33, 34, 35, 36, 37. They may be named because of their shape or form (deltoid, 33; biceps, triceps, 34), their position (brachialis, 34) or their function (pronators, supinators, flexors, extensors, abductors, and adductors, 34, 35, 36).

These muscles are controlled by a plexus of nerves that arise in the cervical (neck) region (Plate 130). This is called the brachial plexus and can be injured in neck, shoulder, and arm injuries. The most devasting aspects of these injuries are the loss of function to the hand. These defects may be expressed as sensory and/or motor deficits.

B. LOWER EXTREMITY

The bones of the lower limb are the femur, tibia, fibula (Plate 20), tarsal (ankle), metatarsal, and phalanges (Plate 21). The movement of the lower extremity is effected through the joints by a number of muscles contained in functional groups. The adductors of the thigh (Plate 40) pull the legs together, the extensors of the knee (Plate 41) straighten the leg, the flexors of the knee (Plate 39), the hamstrings, bend the knee. The muscles on anterior (front) of the leg (shin) lift the toes away from the ground (dorsiflex the foot, Plate 42), and those on the calf (back of the leg) lift the heel off the ground (plantar flex the toes, Plate 43).

The control of these muscles is by two major nervous plexuses in the lower back (lumbar) region. The lumbar plexus (Plate 131) controls the adductors of the thigh and extensors of the knee. This is associated with the upper lumbar spinal nerves and can be tested by eliciting a knee jerk reflex by stretching the patellar (knee cap) tendon in front of the knee. The lumbo-sacral plexus is formed by the lower lumbar nerves and the upper sacral nerves (Plate 131). It enters the back of the leg as it exits from the pelvis as the sciatic nerve. It is tested readily by eliciting an ankle jerk reflex which occurs when the Achilles tendon is stretched above the heel

eliciting an ankle jerk reflex which occurs when the Achilles tendon is stretched above the heel bone (calcaneous). These two nerve plexuses are vulnerable to damage in injuries to the lower back, pelvis, buttock and leg regions.

V. THE BODY CORE

This area contains the viscera (organs) of the thoracic (chest), abdominal and pelvic cavities. These vital structures are protected by a musculo-skeletal body wall which is formed by the rib cage, the abdominal wall, and the pelvic bones (Plates 28, 29).

A. THORACIC CAVITY (Plate 49)

The principal function in this region is respiration and cardiovascular. The lungs are elastic organs which communicate with the nose and mouth through the larynx (voice box) in the neck and the trachea (windpipe) in the upper thorax. The trachea bifurcates behind the heart to enter each lung in a series of dividing tubes that make up the bronchial tree (Plates 74, 75). The terminal branches of this bronchial tree support the alveoli (air sacs) where oxygen and carbon dioxide are exchanged with the capillaries of the pulmonary (lung) vascular system.

Breathing is mainly regulated by the neural control to the diaphragm, a muscle separating the thoracic and abdominal cavity (Plate 49). The nerves which innervate this muscle are the phrenic nerves and they arise in the neck region just above the cervical nerves that go out into the arm as the brachial plexus (Plate 130). This allows the diaphragm to function in persons with spinal cord injuries that render an individual quadriplegic (4 limbs paralyzed) or paraplegic (lower limbs paralyzed).

The heart (Kardia in Greek) and its major blood vessels are also located in the thorax. Plate 50 shows how venous blood enters the right side of the heart through the superior and inferior vena cava. The atrium on the right side is the first chamber to receive the blood and then transmit it into the right ventricle. Blood from the right ventricle is pumped into the pulmonary system (pulmonary arteries) where the venous blood is dispelled of its carbon dioxide and reoxygenated. The arterial blood then returns it to the heart via the pulmonary veins into the left artrium. (Any vessel leaving the heart is an artery and any returning to it is a vein regardless of whether it is carrying oxygenated or deoxygenated blood). As the heart's pressure falls (diastole - "relaxing") the blood moves from the left atrium to the left ventricle. Contraction of the left ventricle drives the blood into the aorta and increases the pressure of the systemic system (systole - "contracting"). The oxygenated blood in the aorta then is distributed to the heart itself via the coronary arteries (Plate 52) and its major branches:

(Plate 53)	-	Brachiocephalic - to arm and head
		Carotids - head (from the Greek word Karotides, meaning to stupefy)
(Plate 54)	-	Cerebral - brain
(Plate 55)	-	Subclavian - below clavicles
		Brachial - arm
		Radial and ulnar - forearm
		Palmar & digital - hand

(Plate 57) - Arch of Aorta
Descending aorta
Abdominal aorta } body core
Iliac arteries

(Plate 56) - Lower extremity
Femoral - Femur (thigh)
Popliteal and genicular - knee
Tibial - leg
Dorsalis pedis } Foot
Plantar

B. ABDOMINAL CAVITY

Food from the mouth and pharynx (throat) reach the abdominal cavity via the esophagus (a muscular tube that traverses the thorax and penetrates the left side of the diaphragm). The esophagus empties into the stomach which is located on the left side of the abdomen behind the costal (rib cage) margin. (Much of the abdominal viscera is protected by the rib cage and lies up in the domes of the diaphragm). The stomach (Plate 83) is a muscular bag that holds food, mixes it with gastric (belly) juices of hydrochloric acid and enzymes, and then expels it into the small intestine. The small intestine continues the digestion process by receiving digestive gland juices from the liver and pancreas (Plate 87) as well as its own structure in its initial part, the duodenum. The jejunum and ilium absorb nutrients and move the intestinal contents into the large bowel (intestine) where water and some vitamins are absorbed before excretion.

Absorbed nutrients are taken into the blood stream of the intestines (mesenteric vessels). These drain via a special portal vein to the liver where the nutrients are modified by some 500 different biochemical procedures to produce the building blocks for many of the bodies functions. The liver is obviously an extremely vital organ and necessary for life. Blood from the liver enters the inferior vena cava and is then distributed via the heart to the systemic circulation.

Waste products of the blood are eliminated by the lungs or the kidneys. The kidneys are filters of the blood and located in the posterior (back) aspect of the abdominal cavity (Plate 88). They have developed in the pelvic region but "ascended" by differential growth to the level of the diaphragm and rib cage area. Sometimes they fail to "ascend" and may be found in the pelvic contents or lower abdominal area. The kidneys are connected to the bladder in the pelvis by the ureters. These are muscular tubes that propel urine, which is the filtrate of the blood in the kidney, to the bladder. The bladder is a reservoir which collects urine and expels it through the urethra in the external genitalia.

C. THE REPRODUCTIVE SYSTEM

This consists of a series of glands and muscular tubes that facilitate the production, transport, and interaction of the gametes (Plate 95, 96, 97, & 98). The gonad (testicles and ovaries) are glands which produce sperm and ova. The sperm is then transported from the scrotal area to the ejaculatory duct (behind the bladder) through the vas deferens (Plate 95). Sperm are ejaculated with a mixture of fluid (semen) from the ejaculatory duct and prostate gland. The semen enters the urethra and exits the body via. the penile uretha.

The ova is expelled from the ovary (ovulation) into the peritoneal (abdominal) cavity. The ova

is captured by the initial part of the oviduct (Fallopian or uterine tube, Plates 96, 97) and transported to the uterus over a 4-5 day period. Fertilization of the ovum by the sperm usually occurs in the oviduct. If the ovum is not "caught" by the oviduct and does become fertilized, an ectopic pregnancy can occur in the abdominal cavity. The fertilized egg in most cases is transported to the uterus where implantation and placentation takes place to establish the fetal-maternal interconnection (Plates 101, 102, 103).

This overview of Anatomy and the Body Systems was designed to introduce you to some basic terminology, the functional roles of some important anatomical components, and some clinical features that relate directly to anatomical development. The clinicians will be re-emphasizing many of these points and building on the clinical relevance of these structures in health and disease. I encourage you to go through your Anatomy Colouring Book. It is full of good information and terminology. I'm sure that your kids will enjoy the parts that you don't want to colour!

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"MEDICAL TERMINOLOGY & PRINCIPLES"

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