

# SUBJECT GNK 124 : Cell to Tissue

## UNITS 3 to 6 (Week 1 to 4)

### SPECIFIC OUTCOMES (for GNK 124 as a whole)

On successful completion of GNK 124, students will be able to demonstrate:

1. Insight and understanding of the different types of tissue and their structure in the body.
2. Knowledge of the pre-implantation period, formation of the trilaminar embryonic disc, placenta and foetal circulation.
3. Understanding of the different ways of determining DNA and multifactorial inheritance.
4. Knowledge of the history of immunology.

### EMBEDDED KNOWLEDGE

This subject contributes essential knowledge to reach the ultimate Specific Outcomes stated for the Medical Programme.

### METHODS OF STUDY AND STUDY MATERIAL

1. This subject is offered over a period of four weeks and is thus divided into four closely integrated units (3 to 6). In each of these units one or more **key case** studies are introduced to illustrate certain aspects of the study material and to emphasize the importance of a background of basic embedded knowledge for the assessment of clinical conditions.
2. Formal **lectures** are offered – see Sub-units and Reference List.
3. **Practicals and Demonstrations**  
 Histology practicals:
  - Histology practicals are presented in the Histology laboratory, room 6-30 BMW Building
  - The class is divided into four groups for the practicals. The list of names will be placed on the Anatomy notice board on the second level of the building, as well as on the notice board in the corridor at the Histology laboratory.
  - The timetable for the four groups - see **Timetable** in the Organisational component
  - Students need the Histology Practical Guide, Coetzee et al, as well as colour pencils.
  - Students must also prepare for the practical on: the microscope, lining and glandular epithelia, and general connective tissue.
  - Examples of the various types of epithelia and connective tissue which will be demonstrated during the practical.
  - It is expected that the student study each preparation under the light microscope after the demonstration. Each example of the epithelia and connective tissue must then be drawn in your Histology Practical Guide, and the questions answered.
  - A video spot test will be done by the students on the Wednesday and Thursday mornings during the practical.
4. **Other activities** during the four-week period:  
 Slides, video, and CBE programmes - See Organisational component
5. **Self assessment** – see possible Questions, Tasks and Self Tests.

# **SUBJECT GNK 124 : Cell to tissue**

## **UNIT 3 [week 1]**

Personal notes:

**UNIT 3 [week 1]****SPECIFIC OUTCOMES** for UNIT 3:

On successful completion of this unit, students will be able to demonstrate knowledge, insight and understanding of:

1. the developmental stages of the gametes leading to conception, and to the formation of the three germ discs from which the different tissues of the body develop.
2. the finer structure of the epithelia and some of the support tissues that both play an important role during the healing of wounds.
3. the gametes from both parents that provide the future genetic material of the zygote and the application of recombinant DNA technology in the identification and diagnosis of genetic diseases.

**Key case A: Infertility**

One year after an initial visit, a general practitioner refers a childless couple to the infertility clinic at the academic hospital. The husband is hesitant, because he is of the opinion that "all his functions are normal". He is eventually persuaded to go.

During the examination, the hormonal status, as well as the condition of the endometrium of the wife is examined. The husband is requested to deliver a sample of his semen at the laboratory. The results on the seminal fluid indicate a normal picture. The family history is checked regarding the possibility of genetic causes for the infertility. It appears that both the husband and wife have a history of cystic fibrosis.

Next, the wife has to report for hysterosalpingography and echography of the ovaries. The echography shows a ripe Graafian follicle. Contrast medium fills only the cavity of the uterus during the hysterosalpingography.

**Possible questions you should be able to answer at the end of the week's program:**

1. What are the ways in which cystic fibrosis can be inherited?
2. Will it be necessary to test both the husband and wife for carrier status?
3. Which technique/s can be applied to determine cystic fibrosis [CF] mutations?
4. Which CF mutation is the most common?
5. How are the developmental stages of the gametes and the early development of the zygote illustrated by means of the case study of the childless couple? Which aspects [emotions, development of the gametes, genetics, etc.] must be stressed?
6. Why did the GP only refer the couple to the infertility clinic after one year?
7. What does it mean: "the husband thinks his functions are normal"? How can he be wrong?
8. Which reasons might be the cause of the wife's inability to have children? Excluding possible causes due to the husband?
9. Regarding their inability to have children, what is the diagnosis?

**Key case B: Pap smear**

A 28-year-old woman visits her gynaecologist for a regular check up. After a physical examination of her abdomen, the doctor takes a pap smear and sends it away for analysis. The results indicate abnormal cells present and the gynaecologist suggests further tests.

**Possible questions regarding key study B you should be able to answer at the end of the week's program:**

1. What type of epithelial cells lines the cervix?
2. What is a Pap smear?
3. On a Pap smear, what are the differences between normal and abnormal cells?
4. What are the causes of abnormal cells?
5. What follow-up procedures are recommended if the pre-cancerous cells are present?
6. Classify the lining epithelia.
7. What is meant by "mitotic figures"?
8. Discuss normal mitosis.
9. What are the differences between mitosis and meiosis?
10. Name the characteristics of lining epithelium.
11. What are junctional complexes and why are they necessary?
12. How would the epithelial cells seen on a slide differ from those seen in a histological section?
13. What is a basement membrane?
14. Where would you expect to find stratified squamous epithelia? Why?
15. Where would you expect to find simple squamous epithelia? Why?

**SUB-UNITS**

- 3.1 Genetic diagnoses of DNA (Genetics)
- 3.2 Introductory embryology and terminology (Anatomy)
- 3.3 Histology of tissues (Histology)

**SUB-UNIT-THEMES**

- 3.1.1 Indirect DNA diagnosis
- 3.1.2 Direct DNA diagnosis
- 3.1.3 Discussion - DNA diagnosis
- 3.2.1 Introduction to embryology
- 3.2.2 Gametogenesis
- 3.2.3 Reproductive cycles
- 3.2.4 Weeks 1 and 2 after fertilization
- 3.2.5 Trilaminar germ disc [15-21 days]
- 3.3.1 Introduction to the study of tissues
- 3.3.2 Lining epithelia
- 3.3.3 Classification of connective tissue cells of loose connective tissue
- 3.3.4 Fibres and amorphous ground substance of loose connective tissue
- 3.3.5 Loose and dense connective tissues

## **SPECIFIC SUB-UNIT OUTCOMES**

The student should be able to demonstrate the knowledge as listed under each of the following sub-unit themes:

### **3.1.1 Indirect DNA diagnosis [Gene tracing]**

- Discuss the principles of genetic linkage and the application to mapping the genes responsible for disease.
- Discuss and apply the concept of restriction fragment length polymorphisms [RFLPs] as well as polymorphic tandem repeat sequences [VNTR], and the use in tracing a mutant gene in an indirect way.
- Explain the concepts: LOD-score, informativity of a polymorphic marker, genetic locus, allele, recombination, genotype, phenotype and linkage phase.
- Know that genetic linkage can only be carried out in families.
- Determine the linkage phase of individuals in the pedigree.

### **3.1.2 Direct DNA diagnosis [Direct determination of mutations]**

- Describe the nature of mutations [deletions, insertions and point mutations].
- Give definitions of the various types of point mutations, viz. frame shift, non-sense, missense, and samesense.
- Know of the methods of direct determination of mutations.
- Discuss the use of the Southern blot technique and DNA hybridization during direct determination, as well as the use of the polymerase chain reaction [PCR] to amplify a specific DNA sequence from genomic DNA.
- Describe with appropriate examples how a mutant gene could be determined by restriction mapping or by the use of PCR and allele-specific oligo-nucleotides [ASO].

### **3.1.3 Discussion - DNA diagnosis [Solution to examples of genetic problems]**

- Solve the problems, distributed to the students during the first lecture, during this discussion.

### **3.2.1 Introduction to embryology**

- Define the following terms: embryology, embryo, fetus, conceptus, teratology, rostral, cranial, caudal, ventral, dorsal.
- Explain how the subject is subdivided for descriptive purposes.
- Give a brief description of the male and female reproductive systems.
- Annotate sketches of both systems.
- Know and describe structures that produce secretions.

### **3.2.2 Gametogenesis**

- Describe the reasons for the changes in the primordial cells during maturation.
- Name the origin and migration of the primordial cells.
- Describe, or illustrate by means of a schematic representation, the changes in the primordial germ cells, under the following headings:
  - [i] chromosomal changes
  - [ii] morphological changes
- Describe oogenesis.
- Briefly describe spermatogenesis.
- Compare the sperm and ovum regarding size, chromosomal composition, developmental period, and survival.
- Briefly describe the structure of a sperm by means of a simple annotated drawing.

### 3.2.3 Reproductive cycles

- Explain the three aims of the ovarian cycle.
- Describe and/or make an annotated diagrammatic sketch of the mature Graafian follicle.
- Describe the mechanisms of ovulation, the movement of the ovum into the uterine tube, and transport in the tube.
- Explain the development, degeneration and purpose of the corpus luteum.
- Briefly describe the influence of hormones in the development of the Graafian follicle, ovulation and the maintenance of the corpus luteum.
- Name the phases of the uterine cycle.
- Briefly describe the occurrences during each of the phases.
- Briefly explain the aim of each phase of the cycle in your own words.
- Explain in writing the correlation between the ovarian and the uterine cycles.

### 3.2.4 Week 1 and 2 after fertilization

- Briefly describe what happens during fertilization:  
[refer in your answer to location, timing, capacitation, acrosome reaction, occurrences during penetration of the ovum, and the end result of fertilization].
- Name the occurrences in the ovaries and the endometrium which correlate with fertilization/non-fertilization.
- Describe the following stages during division of the zygote by means of annotated drawings: 2-cell phase, 4-cell phase, morula, blastocele and blastocyst.
- Correctly annotate sketches regarding the stages.
- Describe implantation correctly by means of simple drawings and indicate: when it happens. Describe the implanted blastocyst, and the uterus during implantation with reference to:
  - [i] division of the decidua
  - [ii] position of normal implantation
  - [iii] decidual reaction
  - [iv] sites of abnormal implantations
- Briefly describe the changed nutritional needs of the zygote and blastocele.
- Explain the development of the embryoblast.
- Explain the development of the trophoblast.
- Explain the development of the amnion cavity and the yolk sac.
- Explain the origin and development of the extra-embryonic mesoderm with special reference to the formation of the extra-embryonic coelom, splanchnic and somatic mesoderm, as well as the connecting stalk.
- Discuss the nutritional needs of the blastocyst.
- Describe the decidual reaction.
- Describe the development of the primitive utero-placental circulation.
- Briefly define applicable terms in your own words.

### 3.2.5 Trilaminar embryo disc [Gastrula]

- Describe the formation of the third germ layer, ie. mesoderm, with reference to: blastocyst, primitive streak, invagination of mesodermal cells, migration and distribution of mesodermal cells, as well as the areas they do not migrate to.
- The formation of the chorda dorsalis.
- Describe the general structure of the gastrula.
- Correctly annotate a drawing of the trilaminar germ disc.
- Write concise notes on the buccopharyngeal membrane, cloacal membrane, allantois, cardiogenic area, septum transversum, and the regression and disappearance of the primitive streak and node.

**3.3.1 Introduction to the study of tissues**

- Understand and explain the concept, "tissue".
- Name the four types of tissues, and give a brief description of the structure and function of each.

**3.3.2 Lining epithelia**

- Name the general properties of epithelia.
- Name the locations of the intercellular junctions in the various cell types, and describe their morphology and functions.
- Classify the lining epithelia and describe the principles on which this classification is based.
- Describe the location, structure and function of simple epithelium.
- Describe the location of pseudostratified epithelium.
- Explain the pseudostratified appearance of these epithelia.
- Describe the typical structure and function of this epithelium.
- Name the locations of the various types of stratified epithelia.
- Describe the structure and functions of these epithelia.
- Describe the locations, structure and functions of the stratified epithelia.

**3.3.3 Classification of connective tissue cells in loose connective tissue**

- Give a morphological classification of loose connective tissue.
- Name the locations of loose connective tissue in the body.
- Describe the general structure of loose connective tissue.
- Describe the structure and function of the various types of connective tissue cells.
- Name the relative quantity of the above-mentioned cells in relation to each other.
- Name the wandering [extrinsic] cells in connective tissue. Why do these cells move around?

**3.3.4 Fibres and amorphous ground substance in loose connective tissue**

- Describe the locations, arrangement, structure and function of collagen, elastic, and reticular fibres in loose connective tissue.
- Describe the properties, structure and functions of amorphous ground substance.
- Name the location and components of basal membranes.
- Describe the structure and functions of basal membranes.

**3.3.5 Loose and dense connective tissue**

- Describe and compare the development, locations, structure and functions of the various types of loose connective tissues.
- Describe the locations, morphology, and functions of the various types of dense connective tissue.
- Compare the structural properties of loose and dense connective tissue.

## NEW TERMINOLOGY

Allele, allele specific oligonucleotide, centiMorgan [cM], genetic marker, genetic linkage, LOD-counting, molecular hybridization, polymorphism, DNA marker, restriction fragment length polymorphism.

Sub-unit-themes 3.3.1 to 3.3.4 refer to textbook.

Menstruation, zygote, decidua, gastrula, differentiation, stomodeum, mesothelium, obliterate.

Zonula occludens, zonula adherens, desmosome of macula adherens, hemidesmosome.

Types of epithelium [see classification], basal cells, goblet cells, stratum basale, stratum spinosum, stratum planum, stratum granulosum, stratum lucidum, stratum corneum, keratohyalin, eleidin, soft keratin.

Types of connective tissue [see classification], fibroblasts, undifferentiated mesenchymal cells, macrophages or histiocytes, adipocytes, plasma cells, mast cells, melanocytes, amorphous ground substance.

Collagen fibres, elastic fibres, reticular fibres, tropocollagen, elastin, basal membrane, lamina rara, lamina densa, lamina reticularis.

Mesenchyme, gelatinous connective tissue, reticular connective tissue, system of macrophages [reticuloendothelial system], irregular and regular dense connective tissue.

## PREPARATIONS FOR FOLLOWING SESSIONS

1. Read through the references of each sub-unit theme before the next lecture.
2. Solve the problems distributed during the first **Genetics** lecture [Sub-unit theme 3.1.3] before the discussion group.

## REFERENCES

Turnpenny, Ellard:	23-27, 59-69, 69-71, 315-318
Mueller & Young:	21-24, 55-61, 64-69, 288-289
Coetzee et al:	1-6, 35-68
Wheater:	65-96
Ross:	18-162
Stevens:	26-27, 36-39, 42-51, 54-56, 75-77, 232
Langman:	3, 8, 18-29, 31-40, 42-48, 51-58, 61, 62, 65-72
Jacobs, Greyling & Meiring:	1-21
Grant's:	204, 214, 224, 225, 227, 244, 256
Netter:	348, 352, 356, 359, 365, 367, 371

## TASKS

1. Convert **each** of the study outcomes into a question and answer them.
2. Draw the intercellular junctions.
3. Draw the simple and pseudostratified lining epithelia.
4. Draw the stratified epithelia.
5. Draw line diagrams of each type of gland mentioned in the lecture unit themes.
6. Tabulate the differences and similarities of the loose connective tissue fibres.
7. Compare the loose and dense connective tissues in table form.
8. How is the structure of connective tissue adapted to its function?

**SELF TEST; [3]1**

1. Which laboratory method/methods are the most appropriate for the following diagnostic situations:
  - a] Prenatal diagnosis of a male foetus with a risk of Duchenne muscular dystrophy [DMD]. Previous investigations already indicated a complete gene deletion.
  - b] Prenatal diagnosis of a male foetus with a risk of DMD. Previous investigations indicated a specific nucleotide base change, as the cause of DMD in this family.
2. From which tissues can DNA readily be obtained for diagnostic purposes: tissue biopsy, lymphocytes, amnion or red blood cells?
3. Why is cloning of genes seen as a significant progress in human genetics? What are we now able to do that could not previously be done, due to the availability of cloned genes?
4. Decide which of the following statements are true or false. Give reasons for your answers:
  - a) Development of the Graafian follicle in the adult woman is characterised by growth, and completion of Meiosis 1 by the primary oocytes already present in the ovaries before birth.
  - b) Bleeding at, or near the 13th day of development may wrongly be interpreted as menstruation.
  - c) The proliferation phase of the uterus and increased production of progesterone, always happen at the same time during the monthly reproductive cycle in the woman.
  - d) The connecting stalk suspends the embryo in the amniotic cavity.
  - e) The inner cell mass of the blastocyst contains cells responsible for the formation of the ectoderm during the embryonic period.
5. Define the term, tissue.
6. Name the four types of tissue.
7. How are lining epithelia classified? Which epithelium does not fit in this classification?
8. Name the various intercellular junctions found in epithelia.
9. Decide which of the following are true or false. Give reasons for your choices:
  - a) A zonula occludens represents a complete fusion of the cell membranes between two adjacent cells.
  - b) At the zonula adherens, the intermediary filaments form loops against the cell membranes. Desmosomes form solid junctions between cells.
  - c) A desmosome can easily be recognised from its cell membrane plaques.
  - d) Do desmosomes bind cells solidly?
  - e) In nexuses, the gap between the two cells measures 20 nm.
  - f) Mesothelium has wavelike borders and large, light nuclei.
  - g) Endothelium is cubic cells and lines the renal tubuli.
  - h) Simple cuboidal epithelium only occurs in the ovaries.
  - i) Simple columnar epithelium frequently has microvilli and long, small nuclei situated at the basal part.
  - j) Only simple columnar epithelia have cilia.

- k) Pseudostratified epithelia are in reality, stratified.
- l) The epidermis is the only example of a stratified squamous epithelium.

10. What is the most outstanding characteristic of urinary epithelium?
11. Name the components of general connective tissue.
12. Name two outstanding characteristics of a fibroblast.
13. Which cytoplasmic organelle is conspicuous in a fibroblast?
14. Name three outstanding characteristics of a fat cell [adipocyte].
15. What is typical of the nucleus of a plasma cell and its cytoplasm?
16. What is the most outstanding characteristic of a mast cell?
17. How do the amorphous ground substance, collagen and elastic fibres influence the nature of connective tissue?
18. What are the characteristics of the three types of connective tissue fibres regarding thickness, fibrilles, and branching?
19. What is the main component of dense connective tissue, and how are these components arranged?

# **SUBJECT GNK 124 : Cell to Tissue**

## **UNIT 4 [week 2]**

Personal notes:

**UNIT 4 [week 2]:****SPECIFIC OUTCOMES** for UNIT 4:

On successful completion of this unit, students should be able to demonstrate knowledge, insight and understanding -

1. the interaction between the environment and polygenes, the role played in the phenotypic differences between individuals, as well as in congenital abnormalities and general diseases in adults.
2. of human embryology regarding further differentiation of germ discs, the structures that derive from them, and the influence on the general structure of the body;
3. of the normal development and normal structure of cartilage and bone;
4. of the various types of cells, their integrated cooperation, and their products, associated with protective immune reactions against intruding microbial pathogens.

**Key case A: Achondroplasia**

After a home birth, a mother took her 6-month-old boy to a paediatrician for a check up. The woman was concerned because her child's limbs were short in relation to his body and his head was abnormally big. After a physical examination the paediatrician diagnosed achondroplasia.

**Possible questions regarding case study A you should be able to answer at the end of the week's program:**

1. Achondroplasia is a disease of the epiphyseal plate, resulting in a decrease in proliferation of the growth plate. Make an annotated drawing of a long bone of a juvenile, indicating the diaphysis, metaphysis and epiphysis.
2. How does bone grow?
3. What is endochondral ossification? Describe the process in detail.
4. Discuss intramembranous ossification.
5. What is Haversian system? Describe the blood supply of normal bone, taking the histological structure of bone into account.
6. Name the 3 types of cartilage. Which type of cartilage would you expect to find in an epiphyseal plate?
7. Describe the normal histological structure of hyaline cartilage.
8. Achondroplasia is inherited in an autosomal dominant fashion. What does this mean? Draw a possible genealogical tree.
9. What are the long term prospects for patients with achondroplasia as far as their growth and longevity are concerned?
10. Although growth at the epiphyseal plate is impaired, appositional growth at the metaphysis continues. How will this influence the eventual shape of the bone?
11. Discuss the various cells found in bone.

**Key case B: Fracture of the ulna**

A 31-year old cyclist fell from his bicycle during practice and complained of a painful left elbow. Upon his arrival at the emergency unit, he was still complaining of severe pain and a fracture of the ulna was clinically diagnosed and confirmed by X-ray.

**Possible questions regarding case study B you should be able to answer at the end of the week's program:**

1. What happens when a bone is fractured?
2. What is the callus that develops during recovery of the bone?
3. Which cells are responsible for the initial recovery in bone?
4. What are the first visible signs of this recovery?
5. How are the external and internal calluses formed?
6. Why does cartilage develop in a callus?
7. How many layers are there in the external callus?
8. What is the further development of the bony collar of the external callus? How is union achieved between the two bony ends?
9. What happens to the cartilage in the callus?
10. What happens to the dead bone fragments of the fractured bone?
11. How does the cartilage in the callus eventually change into compact bone?

**SUB-UNITS:**

- 4.1 Aspects of inheritance (Genetics)
- 4.2 Introduction to embryology (Anatomy)
- 4.3 Histology of bone and cartilage (Histology)
- 4.4 Introduction to Immunology and host defence mechanisms (Immunology)

**SUB-UNIT THEMES:**

- 4.1.1 Multifactorial inheritance
- 4.2.1 Germ discs and the general body form
- 4.2.2 Derivatives of germ discs
- 4.3.1 Cartilage
- 4.3.2 Bone
- 4.4.1 A history of Immunology
- 4.4.2 Antigens and haptens
- 4.4.3 Intrinsic and acquired immunity
- 4.4.4 Cells of the immune system

**SPECIFIC SUB-UNIT OUTCOMES:**

After studying this study unit theme, the student should now be able to demonstrate the knowledge as listed under each of the following sub-unit themes:

**4.1.1 Multifactorial inheritance**

- Define the following concepts: polygenic, multifactorial, quantitative/qualitative properties, continue/discontinue variations.
- Know the factors that influence the repeat risk for multifactorial conditions.
- Be aware of normal variation between individuals.
- Discuss the clinical properties of multifactorial diseases in principle.

**4.2.1 Germ layers and general body form**

- Trace the development [differentiation] of the neural tube and explain by means of a written discussion and annotated diagrams.
- Indicate the division of the intraembryonic mesoderm, formation and division of the intra embryonic coelom by means of a description.
- Indicate the association between somites and acquisition of segmentation in the general body form and explain the implication thereof for the innervation of serous membranes and skin.

- Explain in writing the influence of folding on the formation and position of the following structures: septum transversum, position of the heart, yolk sac, vitelline duct, allantois, connecting stalk, amnion, and extra-embryonic coelom [chorion].
- Annotate diagrammatic drawings of transverse and longitudinal sections of a 4-8 week old embryo.
- Trace and describe the development of the primitive gut.
- Trace and describe the development of the primitive umbilicus with special reference to the contents of the ring at six weeks of embryological life.
- Describe the structure of the umbilical cord in detail, but its development briefly.
- Annotate a drawing of the external appearance of a 4-week-old embryo.
- Name and briefly explain the features present on the external surface of the embryo at four to eight weeks age.
- Define the applicable terms.

#### 4.2.2 Derivatives of the germ layers

- Name the three germ layers and explain how its derivatives are concerned with communication, movement and nutrition of the adult.
- Name the derivatives of the ectoderm germ layer.
- Name the derivatives of the paraxial, intermediary and lateral plate mesoderm.
- Give a schematic representation and a written explanation of the intra-embryonic coelom after folding, regarding: [i] formation; [ii] division, [iii] origin of the lining mesothelium and [iv] organ content.
- Know and describe derivatives of the parietal and visceral mesoderm germ layer.
- Name the derivatives of the endoderm germ layer.

#### 4.3.1 Cartilage

- Classify cartilage.
- Describe the embryological development, location, structure and functions of hyaline cartilage.
- Describe the development, location, structure, and functions of elastic cartilage.
- Describe the development, location, structure, and functions of fibrous cartilage.
- Explain the mechanisms of cartilage growth.

#### 4.3.2 The properties and components of bone

- Classify bone tissue.
- Describe the properties of bone tissue.
- Describe the development, location, structure, and functions of bone cells.
- Name the components of bone matrix, and describe the arrangement, structure and function thereof.

#### 4.3.3 Architecture of bone

- Describe the structure of compact bone.
- Explain the concept of bone lamellae.
- Briefly describe the structure of compact bone.
- Describe the position, layers, and structure of the periosteum.
- Describe the position, and structure of the endosteum.

#### 4.3.4 Intramembranous growth of bone

- Indicate where this type of bone growth occurs in the body.
- Describe this process of bone development.

**4.3.5 Endochondrial bone development**

- Describe the various stages of endochondrial bone development by means of line diagrams.

**4.3.6 Further growth of bone**

- Explain growth in bone after birth;
- Explain remodelling during the individual's life.

**4.4.1 A history of Immunology**

- Take note of highlights in the development of immunisation.
- Identify the current challenges in Immunology.

**4.4.2 Antigens and Haptens**

- Understand the difference between antigens and haptens.
- Know the different classes of antigens.

**4.4.3 Intrinsic and acquired immunity**

- Know and describe the differences between intrinsic and acquired immunity.

**4.4.4. Cells of the immune system**

- Know the different types of phagocytes, lymphocytes and antigen presenting cells and describe their functions.

**INSTRUCTIONS:**

1. Convert each outcome into a question and answer it.
2. Study the references and know the study unit as indicated in the outcomes.
3. Classify the cartilage.
4. Compare the various types of cartilage.
5. Make annotated drawings of hyaline cartilage and the perichondrium.
6. Make annotated drawings of elastic and fibrous cartilage.
7. Draw each of the bone cells referred to in the study unit.
8. Draw a three-dimensional line diagram of the architecture of compact bone.
9. Give a diagrammatic representation of intramembranous development of bone.
10. Give diagrammatic representations of the various stages of endochondrial development of bone. How is the structure of each of the connective tissues adapted to its function?
11. Compare the properties of bone to that of other connective tissue.
12. How are the collagen fibres arranged in the bone lamellae?
13. Name infective diseases against which vaccines were successfully developed during the "Golden Era" and Renaissance.
14. Identify important challenges in modern Immunology.

**SELF TEST: [4]2**

1. Indicate if the following statements are true or false, and explain each answer:
  - a] The cavities for the heart, lungs, and intestinal canal in the adult, develop in the intra-embryonic mesoderm of the embryo.
  - b] The somites play an important role in the fact that the vertebrae, ribs, and blood vessels in the trunk occur at even distances.
  - c] During folding, the endoderm and the cranial and caudal ends of the embryo are passively folded in to become the epithelium of the foregut, midgut and hindgut.

- d] It can be stated that the trilaminar embryo disc is transformed into a threefold cylindrical body, with three main functions: contact with the environment, movement, and nourishment.
  - e] The hindgut opens in the stomodeum.
  - f] After folding, the amnion attaches to the edge of the umbilicus.
2. Which growth patterns occur in cartilage and bone?
  3. How are the chondrocytes arranged in hyaline cartilage? What causes this arrangement?
  4. What are the most important differences between hyaline and elastic cartilage?
  5. In what way does fibrous cartilage differ from the other types of cartilage?
  6. Which components does the matrix in bone consist of, and where do bone matrix and bone cells occur in the bone lamellae?
  7. What are the most important properties of the various bone cells?
  8. Which structures eventually determine the morphology of the Haversian system? How are the lamellae arranged in this system?
  9. How do the general lamellae in bone develop, and what do they look like under the light microscope?
  10. Compare the structures of periosteum and endosteum.
  11. What are the differences between intramembranous and endochondral bone development?
  12. Name the various zones in a developing long bone. Briefly describe the developments in each zone.
  13. Define primary and secondary ossification centres.
  14. Name the researchers involved in the discovery of cow pox vaccination, attenuated vaccines, phagocytosis by leucocytes, diphtheria anti-toxin, and the tuberculosis bacillus.
  15.
    - a) Describe the difference between intrinsic and acquired immunity.
    - b) Describe the different types of cells of the immune system and their functions.
  16. Indicate which of the following statements are true or false:
    - a) Multifactorial inheritance is concerned in most cases of systemic hypertension.
    - b) A large number of congenital malformations indicate multifactorial inheritance patterns.
    - c) The height of a person is determined as a multifactorial property.

### **NEW TERMINOLOGY:**

Polygenic, continued/discontinued variation, quantitative/qualitative properties.

Differentiation, stomodeum, mesothelium, obliterate.

Chondrocytes, perichondrium, interstitial and appositional growth.

Compact and spongy bone, osteoblasts, osteocytes, osteoclasts, hydroxyapatite crystals, Haversian bone lamellae, general bone lamellae, interstitial bone lamellae, periosteum, endosteum, Sharpey's fibres, intramembranous development of bone.

Primary ossification centre, resting zone, zone of proliferation, zone of maturation, zone of calcification, osteogenic zone, zone of reabsorption, epiphyseal plate, secondary ossification centre.

Vaccination, toxoids, attenuated vaccines, active and passive immunisation, toxin, antitoxin, antibody, humoral immunity, leucocytes, cellular immunity, phagocytosis, and hypersensitivity.

[In the Glossary of most Immunology textbooks, including: Immunologie Handleiding]

### **PREPARATION TO BE DONE BEFORE THE NEXT MEETING:**

Read all the references of each unit theme before the next lecture.

### **REFERENCES:**

Turnpenny & Ellard:	137-146
Mueller & Young:	127-135
Langman:	87-105, 107 – 108, 112, 135-136, 171, 199-203, 211-220, 278-280, 318, 321, 433, 445-448, 479.
Jacobs, Greyling & Meiring:	21-29
Coetzee et al:	69-90
Wheater:	172-175,189
Ross:	164-213
Stevens:	52-53, 233-248
Anderson et al:	Notes: "Introduction to Immunology"

# **SUBJECT GNK 124 : Cell to Tissue**

## **UNIT 5 [week 3]**

Personal notes:

**UNIT 5 [week 3]:****SPECIFIC OUTCOMES** for UNIT 5:

On successful completion of this unit, students will be able to demonstrate knowledge, insight and understanding of:

1. Functioning of genes in populations.
2. The developmental stages and the functions of the placenta, as well as the fetal circulation.
3. The development and structure of the various blood cells and platelets in the circulation of an adult.
4. The basic concepts of the formation of antibodies against certain parts of the micro-organism, which protect against possible future infections by the same pathogen as well as the various types of vaccines and their shortcomings.

**Key case A: The tired, worn out man - a case of chronic myeloid leukaemia.**

A 40-year old man visited his GP and complained of tiredness and feeling run down. He said that had lost some weight and experienced abdominal discomfort. The doctor examined the patient and found his spleen enlarged. Blood was drawn and a full blood count done. An increased white cell and decreased platelet count was found. All of these symptoms indicated a diagnosis of chronic myeloid leukaemia [CML]. A bone marrow aspiration and cytogenetic investigation confirmed the diagnosis. The investigation showed the presence of the Philadelphia chromosome t[9;22], which confirms the diagnosis of CML.

**Possible questions that might be asked at the end of the week's program:**

1. What did the patient complain of?
2. Which clinical signs and symptoms might suggest chronic myeloid leukaemia during the first routine examination?
3. Which further investigations are desirable at this stage?
4. Which other investigations are necessary during the acute phase?
5. What is the normal course of the disease?
6. Which genes are concerned in the Philadelphia translocation?

**Key case B: Vaccination in a case of splenectomy**

A 35-year-old man sustained serious injuries following a motor vehicle accident. As a result of these injuries, his spleen was severely damaged and had to be surgically removed (splenectomy). The patient recovered and was discharged from hospital after an appropriate vaccine had been administered.

**Possible questions you should be able to answer at the end of the week's program:**

1. Why is the spleen such an important organ for protecting humans against infection?
2. Which types of infections are especially likely to occur in people who have no spleen and why are these persons at higher risk for these specific types of infection?
3. What was the most likely vaccine administered to the patient described above?
4. How long will this vaccine provide protection and what advice would you give this patient regarding future vaccinations?
5. Why is the ongoing development of new vaccines of this type important?

**SUB-UNITS:**

- 5.1 Population genetics
- 5.2 Embryologic aspects of the placenta and vascular system
- 5.3 Histological aspects of blood cells and hemopoietic tissues
- 5.4 Immunology of vaccination

**SUB-UNIT THEMES:**

- 5.1.1 Population genetics
- 5.2.1 Development of the placenta
- 5.2.2 Vascular system
- 5.2.3 Correlation between embryological and adult system
- 5.3.1 Blood
- 5.3.2 Hemopoietic tissue
- 5.4.1 Antibodies
- 5.4.2 Types of immunisation

**SPECIFIC OUTCOMES FOR SUB-UNIT THEMES:**

The student should be able to demonstrate the knowledge as listed under each of the following sub-unit themes:

**5.1.1 Population genetics**

- explain the Hardy-Weinberg equilibrium, give examples, and indicate when a population is in a Hardy-Weinberg equilibrium. You should be able to do this regarding dominant and recessive and X-linked conditions;
- indicate the genetic load in populations, as well as the effects, such as paternal age and mutation selection balance, that might influence it;
- give a synopsis of medical intervention on disease-gene frequency.

**5.2.1 Development of the placenta**

- Explain the developmental connection between the trophoblast, primitive utero-placental circulation and the placenta with reference to the change in nutritional needs;
- Describe the development of the villi with reference to the origin, blood vessels, structure, and distribution;
- Describe, or draw an annotated diagrammatic sketch, of the structure and division of the chorion;
- Describe the structure of the placenta;
- Annotate a drawing of a section through the placenta;
- Write brief notes on the full-term placenta;
- Describe the placental barrier, as well as the changes with age;
- Explain the functions of the placenta;
- Concerning the foetal membranes briefly explain in writing what will happen to the following:
  - chorion, amnion, decidua capsularis and parietalis;
  - amniotic cavity and chorionic cavity;
  - uterine cavity.

**5.2.2 Vascular system**

- Give a brief, general description of the development of the blood vessels;
- Briefly describe the fetal circulation [intra and extraembryonic];
- Tabulate the adult homologue and remnants to the fetal structure in the fetal circulation and give a report on its position;
- Annotate given drawings.

### 5.2.3 Correlation of fetal/adult structures

- Give an integrated answer from the information gathered during the various lectures, regarding the development of the following:
  - primitive gut;
  - body cavities;
  - paraxial mesoderm;
  - umbilicus, umbilical cord, and placenta;
  - extra-embryonic mesoderm;
  - zygote and conceptus.

### 5.3.1 Blood

- Describe erythrocytes;
- Classify leukocytes:
  - Granular leukocytes
    - describe neutrophils;
    - describe eosinophils;
    - describe basophils;
  - Agranular leukocytes
    - describe lymphocytes;
    - describe monocytes;
- Describe platelets.

### 5.3.2 Haemopoietic tissue

- Describe myeloid tissue;
- Explain why haemopoiesis occur in bone cavities;
- Describe the stroma of bone marrow in myeloid tissue;
- Describe the pluripotential stem cells in myeloid tissue;
- Describe myeloid tissue by means of a scheme of the development of the various blood cell lines;
- Describe erythropoiesis;
- Describe the development of neutrophils during granulopoiesis;
- Describe the development of eosinophils during granulopoiesis;
- Describe the development of basophils during granulopoiesis;
- Describe the development of monocytes during agranulopoiesis;
- Describe the development of lymphocytes during agranulopoiesis;
- Describe thrombopoiesis.

### 5.4.1 Antibodies

- Know the characteristics and functions of antibodies.
- Understand the role of antibodies in immunisation.

### 5.4.2 Immunisation

- Know and describe four types of immunisation.
- Describe immunisation with regard to general infective micro-organisms
- Know the risks involved in active immunisation

### NEW TERMINOLOGY:

Angiogenesis, cotyledon, barrier, umbilical, chorion, frondosum, laeve, obliterate.

Erythrocytes, leucocytes, neutrophils, polymorph, azurophil, eosinophil, basophil, bilobular, lymphocytes, monocytes, thrombocytes, hyalomere, granulomere, myeloid, lymphoid, red bone marrow, yellow bone marrow, pluripotential, KVE, stem cell, precursor cells, proerythroblast, polychromatophylic erythroblast, normoblast, reticulocyte, promyelocyte, myelocyte, metamyelocyte, megakaryoblast.

**PREPARATION FOR FOLLOWING SESSIONS:**

Read through all the references of each sub-unit theme before the next lecture. The idea is that questions might arise regarding concepts and terminology you don't understand, you should get the answer **during** the lectures.

**REFERENCES:**

Turnpenny & Ellard:	123-130
Mueller & Young:	113-119
Langman:	43,46, 52-57, 80-83, 101-102, 125-138, 267-273
Jacobs, Greyling & Meiring:	30-37
Netter:	216, 225, 245
Grant's:	56, 112
Coetzee et al:	91-106
Wheater:	46-64
Ross:	214-245
Stevens:	67-69, 71-80
Anderson et al:	Notes: "Introduction to Immunology"

**PROGRAMMES/ACTIVITIES DURING THE BLOCK:**

Slides, video and CBE programmes - see Organisational Component

**ASSIGNMENTS:**

1. Study the references in order to know the study unit on the level indicated in the outcomes and references.
2. Convert each of the outcomes into a question and answer it correctly to determine if you have reached the outcomes.
3. Draw annotated diagrammatic sketches of each of the cells and parts of cells, dealt with in study unit theme 5.3.1.
4. Draw an annotated diagrammatic sketch of each of the developing cells dealt with in study unit 5.3.2.
5. Draw a graph to demonstrate primary and secondary humoral (antibody) responses.

**SELF TEST: [5]3**

I:

1.
  - a) Describe the role of antibodies in immunisation.
  - b) Explain the difference between active, passive, natural and artificial immunisation. Supply an example of each.
  - c) Name examples of microbial and viral vaccines.
2. Briefly describe the most outstanding properties of all the blood cells.
3. Briefly describe the morphology of platelets.
4. Which organelles are very conspicuous in developing erythrocytes? What is their function? Which structure degenerates during the developmental process?
5. What are the morphologically recognisable stages of granulopoiesis?

6. Briefly explain the origin of platelets. From which cells do they develop?

II: To determine if you have mastered certain basic concepts in population genetics, complete the following calculations:

1. An autosomal recessive disease has a prevalence [differentiate between prevalence and incidence] of 1/625. What is the frequency of heterozygotic carriers? The three genotypes are AA [homozygotic normal], AS [carriers], and SS [homozygotic abnormal].
2. Hunter syndrome, a X-linked recessive disease, occurs in 1:100 000 males. What is the frequency of female carriers?
3. Explain the apparent paradox in the statement: More or less 90 percent of all cases of achondroplasia originate as new mutations, but the frequency of new mutations of the normal gene at this locus is only 1/100 000.

III: To determine if you have mastered the subject, decide which of the following statements are true or false. Give reasons for your answers:

1. The \_\_\_\_\_ bypasses the fetal liver
  - a. ductus arteriosus
  - b. umbilical vein
  - c. umbilical arteries
  - d. ductus venosus
2. Blood carrying the most oxygen will be found in the fetal circulation in the:
  - a. umbilical arteries
  - b. ductus arteriosus
  - c. aorta
  - d. umbilical vein
3. The \_\_\_\_\_ become(s) functional for the first time at birth:
  - a. kidneys
  - b. lungs
  - c. heart
4. The embryonic membrane that eventually surrounds the embryo and contains a watery fluid, is the:
  - a. yolk sac
  - b. amnion
  - c. allantois
  - d. chorion
5. The development of the tertiary villi occur at the same time as the completion of growth of the blood vessels in the connecting stalk and the start of the heart beat.
6. The early definitive placental barrier consists of 4 layers of cells, of which 2 layers later disappear.
7. The placenta develops from the chorion of maternal origin.
8. The placental membrane [barrier] is not a real barrier because substances move freely through it.

**PRACTICALS, DEMONSTRATIONS AND WORKSHOPS:**

Histology practical:

- Students need the Histology Practical Guide: Tissues and Organs by Coetzee et al, as well as colour pencils. The students must also prepare the practical on blood.
- Examples of the various blood cells will be demonstrated to the students on the TV screens during the practical.
- After the demonstration it is expected of the students to study each blood cell under the light microscope. Each cell must then be drawn in your "Praktiese Handleiding" and the questions answered.
- A video spot test will be written by the students during the practical of the following Wednesday or Thursday.

# **SUBJECT GNK 124 : Cell to Tissue**

## **UNIT 6 [week 4]**

Personal notes:

**UNIT 6 [week 4] :****SPECIFIC OUTCOMES** for UNIT 6:

On completion of this unit, students will be able to demonstrate knowledge, insight and understanding of:

1. The background aspects of conditions following interference with normal embryological development.
2. The possible effects of drugs on normal embryological development.
3. Developmental genetics and the genetics of congenital abnormalities.
4. That normal human development can go wrong, the reasons that may cause this, the abnormal (pathogenic) mechanisms underlying abnormal development, and how it presents clinically in a patient.
5. The morphology and action of muscle and nervous tissue, the interdependency between muscle and nerves, as well as the role of nervous tissue in the intellectual processes, sensory impulses, and the consequent voluntary and involuntary actions.

**Key case A: Rubella**

A young, married woman visits her GP and complains that she has had a fever for three days and doesn't feel well. She has also just noticed a mild rash on her body and limbs. When the doctor remarks that she might have rubella, she mentions that her last menstrual period is one month late. On the question whether she was ever immunised against rubella, she remembers that she had an injection at the age of 12, which she suspects might have been for rubella.

The doctor confirms by means of sonar that she is already six weeks pregnant; and after an examination, that she has rubella. The risk exists that the fetus might have contracted congenital rubella.

**Possible questions regarding case study A that might have to be answered at the end of the week's program:**

1. Give a synonym for rubella. What is congenital rubella?
2. What is the underlying mechanism of transmission from mother to foetus, with respect to the risk of congenital rubella?
3. Which organs/tissue in the foetus can be affected during the developmental stage?
4. Which clinical abnormalities can be present at birth due to congenital rubella? [See question three].
5. Is there a relationship between the type of abnormality and the stage of embryological development?
6. What lesson can be learned from the connection between the embryology of the germ discs and the disease rubella, as indicated in the case study?
7. How could the doctor confirm that the patient has rubella, or that she had been vaccinated against rubella?
8. If she had been vaccinated against rubella, which circumstances could give rise to her having not developed immunity against the disease?
9. What are the underlying pathological mechanisms of rubella?
10. Which clinical signs could be present at birth due to the disease?

### **Key case B: A developmental gene disorder**

You are the doctor on duty in Grootboek Hospital and is called to examine a newborn baby girl with multiple congenital abnormalities. On arrival you find a crying, active baby, who on close inspection has an abnormal skull shape with a prominent forehead and a very flat nasal bridge. Her hands and feet are severely abnormal with fusion of the fingers and non-separation of the toes. The nursing sisters are concerned and ask you to explain the causes of this to the mother.

Possible questions that you should be able to answer at the end of this week's programme:

1. What type of defective gene would explain these abnormalities?
2. What is the risk for the mother to have another child with this disorder?
3. Give other examples of developmental disorders due to defects in the same gene family.
4. What do you understand by the term "new" mutation?
5. What is germline mosaicism?

### **SUB-UNITS:**

- 6.1 Congenital abnormalities (Embryology)
- 6.2 Morphology and action of muscle and nervous tissue (Histology)
- 6.3 Developmental genetics and the genetics of congenital abnormalities (Genetics)

### **SUB-UNIT THEMES:**

- 6.1.1 Introduction to congenital abnormalities
- 6.1.2 Drug-induced embryopathy
- 6.2.1 Skeletal muscle
- 6.2.2 Cardiac and smooth muscle
- 6.2.3 Neurons and neuroglia
- 6.2.4 Peripheral nerves and endings
- 6.3.1 Developmental genetics
- 6.3.2 Genetics of congenital abnormalities

### **SPECIFIC SUB-UNIT OUTCOMES**

The student should be able to demonstrate the knowledge as listed under each of the following sub-unit themes:

- 6.1.1 **Introduction to congenital abnormalities**
  - understand the extent [stats] of early embryonic deaths in spontaneous abortions;
  - name the 4 levels on which congenital abnormalities occur;
  - discuss 4 types of structural abnormalities;
  - define the following terms: teratology, teratogens, embryopathy, anomalies, etiology;
  - explain the classification of the causes of congenital abnormalities (Aetiology);
  - explain the reasons why teratogens cause death in the first two weeks after conception, large congenital structural defects in the embryonic period, and functional defects, as well as smaller structural defects, during the fetal period;
  - explain the basic principles that have to be considered in the determination of the teratogenicity of a teratogen.
  - Give a classification of human teratogens and discuss the main features of each.
  - Discuss rubella and alcohol as teratogens in detail.

### 6.1.2 **Drug-induced embryopathy**

- give reasons for the difficulty in determining the role of chemical agents, eg. pharmacological drugs, as possible reasons for congenital abnormalities;
- develop insight and understanding into the norms and values maintained in this regard;
- know about the following types of drugs, and discuss the possibility of abnormalities resulting from them:
  - Warfarin (anti-coagulant)
  - Anticonvulsants, eg. phenytoin
  - Oncotherapeutics
  - Antimicrobial drugs
  - Androgens and progestins
  - Drugs containing lithium.
  - Angiotensin-conversion enzyme [ACE] inhibitors and Angiotensin II antagonists
  - Derivatives of Vitamin A, eg. cis retinoic acid and etrynit
  - Thyroid drugs, eg. iodine, radio-active iodine, carbimazole
- Nicotine and social drugs.

### 6.2.1 **Skeletal muscles**

- describe the general properties of skeletal muscle;
- describe the morphology of skeletal muscle as seen under the light microscope;
- describe the morphology as seen under the electron microscope;
- explain the bands seen in skeletal muscle;
- explain the mechanism of contraction;
- describe the sarcolemma;
- describe the sarcoplasmic reticulum;
- describe the components of connective tissue.

### 6.2.2 **Cardiac and Smooth muscle**

- describe the general morphology of cardiac muscle;
- describe the morphology of cardiac muscle as seen under the light microscope;
- describe the general electron microscopic morphology of cardiac muscle;
- describe intercalated discs;
- explain the mechanism of contraction of cardiac muscle;
- describe the connective tissue components of cardiac muscle;
- describe the morphology of smooth muscle cells as seen under light microscope;
- describe the morphology of smooth muscle cells as seen under the electron microscope;
- describe the arrangement of smooth muscle cells;
- describe the innervation of smooth muscle cells.

### 6.2.3 **Neurons and Neuroglia**

- describe the general morphology of a neuron;
- classify and describe the various types of neurons;
- describe the morphology of the cell body of a neuron as seen under the light and electron microscopes;
- describe the morphology of the dendrites of a neuron;
- describe the morphology of the axon of a neuron;
- describe the axonal endings of a neuron in the central nervous system;
- describe the morphology of the various types of astrocytes, and explain their role in the blood-brain barrier;
- describe the morphology of oligodendrocytes;
- describe the morphology of microglia;
- describe the morphology of ependymal cells.

#### 6.2.4 **Peripheral nerves and endings**

- describe the morphology of the various types of support cells in peripheral nerves;
- describe the general morphology of myelinated fibres of peripheral nerves;
- describe the morphology of myelin sheaths and Schwann cells as seen under the electron microscope;
- describe the morphology of non-myelinated fibres of peripheral nerves;
- describe the myelinated fibres of the **central** nervous system;
- classify the sensory endings of peripheral nerves according to the type of energy they are sensitive to, as well as according to their distribution and function in the body;
- classify the sensory endings of peripheral nerves, and describe them according to structure;
- describe the motor endings of peripheral nerves.

#### 6.3.1 **Developmental genetics**

- Know that there are several gene families that play important roles in human morphogenesis (development).
- Name the gene families involved in early developmental processes.
- Know the developmental disorders associated with mutations in fibroblast growth factor receptors.

#### 6.3.2 **Genetics of congenital abnormalities**

- Etiology of congenital abnormalities:  
Know, name and discuss with reference to idiopathic and multifactorial conditions, single gene defects, the chromosomal abnormalities, teratogens, and constraint.
- Pathogenesis and congenital abnormalities:  
Discuss malformation, disruption, deformation and dysplasia.
- Clinical presentation of congenital malformations:  
The student must know how to define syndromes, sequences, and associations.

#### **NEW TERMINOLOGY:**

Teratogens, congenital, induce, non-separation of chromosomes, trisomy.

Congenital abnormality, dysmorphology, idiopathic, teratogen, malformation, disruption, deformation, dysplasia, syndrome, sequence, association, maternal, intrauterine, single gene aberrations.

Sarcoplasm, sarcolemma, sarcoplasmic reticulum, sarcosome, dense bodies, myofilaments, actin, myosin, Z line, caveolae, A band, I band, H band, M line.  
T-tubules, T-system, myoglobin, sarcomere, alpha actin, triad, terminal cisterns, epimysium, perimysium, endomysium, syncitium, intercalated discs [Eberth lines], Purkinje cells.

Dendrite, axon, unipolar, bipolar, multipolar, pseudo-unipolar, amacrine, Nissl substance, spinae, gemmulae, synapse, pre and post-synaptic, neuroglia, astrocytes, perivascular foot processes, oligodendrocytes, microglia, ependymal cells, amphicytes.

Schwann cells [neurilemma], myelin sheath, Schmidt-Lanterman incisures, Ranvier nodes, epineurium, perineurium, endoneurium.

Non-myelinated nerve endings, encapsulated nerve endings, touch receptor, muscle spindle, Golgi tendon body, neurotendinous body.

**REFERENCES:**

Langman:	79, 111, 137, 142, 145, 149-164, 189-192, 237, 242-244, 249-254, 259, 310, 380, 394, 424, 445, 470-471
Jacobs, Greyling & Meiring:	38-48
Coetzee et al:	107-145
Wheater:	97-115, 117-142
Ross:	246-325
Di Fiore:	60-63, 65-75
Stevens:	57-66, 206-216, 220-221, 230-231, 361
Turnpenny & Ellard:	83-94, 247-262
Mueller & Young:	81-88, 225-233

**SELF TESTS:** [6]4

I: To determine whether you have mastered the subject, answer the following questions:

1. During which period of embryonic development is the embryo most vulnerable for the development of abnormalities?
2. Give possible reasons for the higher incidence of congenital abnormalities in the baby of a woman older than 35 years;
3. Which developmental period is the most critical for the embryo to be affected by a teratogen?
4. How can the embryological timetables, that represent the critical periods in human development during which the embryo is vulnerable and can easily be affected by teratogens, be used?
5. Why must you have knowledge of teratogens?
6. Explain the difference between embryopathy and teratology.
7. Why would the pre-implantation period be considered fairly safe, and would exposure to teratogenic agents not result in congenital abnormalities?
8. Which mechanism underlies the drug-induced embryopathy after the intake of anticoagulants and cancer drugs?
9. How do teratogens achieve their effects?
10. Does the dose of a drug play a role in embryopathy?
11. Name structural abnormalities due to mechanical factors present in the uterus.
12. Name the types of skeletal muscle.
13. Name the various cross-striations in the skeletal and cardiac muscle.
14. What causes the cross-striations?
15. Explain the difference between the sarcoplasmic reticulum and the T-tubule system in skeletal and cardiac muscle.
16. Where are the nuclei of the three types of muscle fibres found?
17. What are caveolae?

II: To determine if you have mastered the nervous tissue, consider which of the following statements are true or false. Give reasons for your answers:

18. Neurons possess one or more axons that resemble dendrites.
19. The end bulb and motor end plates have many similar properties.
20. Three types of neurons exist.
21. There are no differences between protoplasmic and fibrous astrocytes.
22. The oligodendrocytes and Schwann cells have nothing in common.
23. Although nodes of Ranvier and Schmidt-Lanterman incisures look different, both represent the same myelin phenomenon.
24. Non-myelinated endings form the largest majority of sensory receptors in the skin.

25. In both muscle spindles and neuro-tendinous body, the axons surround both the muscle and collagen fibres.

III: To help you to determine if you have mastered the subject of muscle and nervous tissue, carry out the following:

1. Draw an annotated diagrammatic sketch of the structures studied in sub-unit themes 6.2.1 to 6.2.4.
2. Compare the resemblance and difference between smooth muscle, skeletal muscle, and cardiac muscle in a table.
3. Compare the various neuroglia.
4. Compare the support cells of the peripheral nerves.
5. Compare the various encapsulated nerve endings.