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Textbook of
PATHOLOGY
for Allied Health Sciences



Ramadas Nayak

Foreword
Poornima Baliga B

JAYPEE

Contents

SECTION 1: GENERAL PATHOLOGY

1. Introduction **3**

Normal cell structure and functions 3
Introduction to pathology 4

2. Cell Injury and Adaptation **6**

Types of cellular responses to injury 6
Cellular adaptations 6
Definitions 8
Cell injury 9
Intracellular accumulations 9
Necrosis 11
Apoptosis 14
Pathologic calcification 15
Other tissue changes 16
Pigments 17

3. Inflammation and Repair **19**

Acute inflammation 19
Sequence of events in acute inflammation 20
Chemical mediators of inflammation 22
Outcomes of acute inflammation 24
Morphological types/patterns of acute inflammation 24
Systemic effects of inflammation 25
Chronic inflammation 26
Granulomatous inflammation 26
Repair and healing 26
Cutaneous wound healing 27
Factors that influence wound healing 28
Complications of wound healing 29
Healing of a fracture 30

4. Infectious Diseases **33**

Mycobacterial diseases 33
Tuberculosis 33
Leprosy 36
Syphilis 39

Bacterial diseases 41
Viral diseases 42
Rickettsial infections 44
Chlamydial infections 45
Fungal infections and opportunistic infections 45
Parasitic diseases 45

5. Hemodynamic Disorders **50**
Hyperemia and congestion 50
Edema 52
Thrombosis 54
Embolism 56
Infarction 58
Shock 58

6. Immunopathology **61**
Immunity 61
Hypersensitivity: Immunologically mediated tissue injury 61
Immediate (type I) hypersensitivity 62
Antibody-mediated (type II) hypersensitivity 63
Immune complex-mediated (type III) hypersensitivity 63
T cell-mediated (type IV) hypersensitivity 64
Autoimmune diseases 64
Systemic lupus erythematosus 65
Acquired immunodeficiency syndrome 65
Amyloidosis 67

7. Neoplasia **72**
Classification 72
Nomenclature of neoplasms 73
Characteristics of benign and malignant neoplasms 74
Carcinoma in situ 76
Metastasis 77
Events in invasion and metastasis 78
Precancerous conditions/lesions 78
Molecular basis of cancer 79
Hallmarks of cancer 79
Etiology of cancer (carcinogenic agents) 80
Laboratory diagnosis of cancer 81
Prognosis 82
Common specific epithelial tumors 83
Mesenchymal tumors 83
Peripheral nerve sheath tumors 84
Skeletal muscle tumors 85

8. Nutritional Disorders **86**
Fat-soluble vitamins 86
Water-soluble vitamins—vitamin B complex 89
Protein-energy malnutrition 91

Obesity 92
Bulimia 93

9. Genetic Disorders 95
Genes 95
Classification of genetic disorders 95
Mendelian disorders/single-gene or monogenic disorders 95
Chromosomal aberrations 97
Trisomy 21 (Down syndrome) 97
Klinefelter syndrome 99
Turner syndrome 100

10. Radiation 101
Types of radiation 101
Quantitation of radiation 101
Main determinants of the biologic effects of ionizing radiation 102

SECTION 2: SYSTEMIC PATHOLOGY

11. Vascular Disorders 109
Arteriosclerosis 109
Atherosclerosis 109
Aneurysm and dissection 111
Hypertension 112
Vasculitis 113
Vascular tumors 113

12. Heart Disorders 115
Heart failure 116
Ischemic heart disease 118
Myocardial infarction 118
Valvular heart disease 120
Rheumatic fever and rheumatic heart disease 122
Infective endocarditis 124
Noninfected vegetations 126
Carcinoid heart disease 126
Complications of prosthetic valves 126
Cardiomyopathy 127
Congenital heart disease 127
Pathology of pericardium 129

13. Hematology 132
Disorders of red cells 134
Anemia 134
Iron deficiency anemia 136
Megaloblastic anemia 137
Pernicious anemia 139
Anemias of blood loss 139
Aplastic anemia 140

Hemolytic anemia 140
Hereditary hemolytic anemia 141
β-*thalassemia major* 142
Sickle cell anemia 143
Acquired hemolytic anemias 145
Disorders of white cells 146
Normal differential leukocyte count 146
Quantitative disorders of leukocytes 146
Acute leukemia 148
Acute lymphoblastic leukemia/lymphoma 148
Acute myelogenous leukemia 150
Chronic myelogenous leukemia 151
Chronic lymphocytic leukemia 152
Disorders of hemostasis 153
Normal hemostasis 153
Classification of hemostatic disorders 153
Immune thrombocytopenic purpura 154
Coagulation disorders 155
Hereditary coagulation disorders 155
Hemophilia 155
Acquired coagulation disorders 157
Laboratory evaluation of bleeding disorders 158
Plasma cell neoplasms 160
Multiple myeloma (plasma cell myeloma) 161
Blood transfusion 161
Spleen 164

14. Lymph Nodes **166**
Structure of lymph node 166
Lymphadenopathy 166
Lymphadenitis 167
Lymphoid neoplasms 167
Non-Hodgkin lymphoma 168
Hodgkin lymphoma 170
Metastatic carcinoma 173

15. Respiratory System **174**
Normal structure and function 174
Pulmonary infections—pneumonia 174
Tuberculosis 177
Chronic obstructive pulmonary diseases 177
Bronchial asthma 179
Bronchiectasis 180
Lung abscess 181
Chronic restrictive pulmonary disease 182
Pneumoconioses 183
Passive congestion of lung and pulmonary edema 185
Lung cancer 186
Pleura 188

16. Head and Neck **190**
Oral cavity 190
Upper airways 191
Larynx 194
Ears 196
Salivary glands 197

17. Gastrointestinal Tract Disorders **201**
Normal anatomy 201
Esophageal cancer 201
Stomach 202
Intestine 208
Tumors of intestine 211
Polyps of colon 212
Colorectal cancer: Adenocarcinoma 213
Acute appendicitis 215
Malabsorption syndrome 216
Inflammatory bowel disease 216
Peritoneum 217

18. Liver, Biliary Tract and Pancreas **219**
Normal structure and function of liver 219
Jaundice 219
Viral hepatitis 222
Alcoholic liver disease 225
Cirrhosis 225
Liver abscess 228
Hemochromatosis 229
Tumors of liver 229
Pathology of gallbladder 230
Pathology of pancreas 232

19. Urinary System **235**
Normal anatomy 235
Classification of renal diseases 236
Clinical manifestations of renal diseases 236
Congenital and developmental anomalies 236
Cystic diseases of the kidney 237
Glomerular diseases 239
Tubular and interstitial diseases 242
Pyelonephritis and urinary tract infection 244
Tuberculosis of the urinary tract 246
Diabetic nephropathy 246
Renal vascular diseases 247
Urinary tract obstruction (obstructive uropathy) 248
Chronic kidney disease 251
Renal replacement therapies 252
Malignant tumors of the kidney 253
Urothelial tumors 255

20. Male Genital System **257**
Inflammation of epididymitis and orchitis 257
Testicular tumors 258
Pathology of prostate 259
Carcinoma of penis 261

21. Female Genital System **263**
Uterine cervix 263
Uterus 265
Gestational trophoblastic disease 267
Ovary 269

22. Breast **274**
Normal anatomy 274
Mastitis 274
Benign tumors 274
Carcinoma of the breast 275

23. Bones, Joints and Soft Tissue Tumors **279**
Congenital disorders 279
Infections—osteomyelitis 280
Metabolic bone diseases 282
Bone tumors 283
Joints 286
Infectious arthritis 286
Soft tissue tumors 290
Pediatric tumors 291

24. Endocrine Disorders **293**
Pituitary gland 293
Thyroid gland 293
Parathyroid glands 301
Adrenal glands 301

25. Diabetes Mellitus **306**
Type 1 diabetes 306
Type 2 diabetes 307
Pathogenesis of the complications of diabetes 307

26. Skin **312**
Acute eczematous dermatitis 312
Psoriasis 312
Malignant tumors of skin 313

27. Peripheral Nerves and Skeletal Muscles **317**
Neuromuscular diseases 317
Diseases of peripheral nerves 317
Diseases of the neuromuscular junction 320
Diseases of skeletal muscle 320

28. Central Nervous System **323**
Infections 323
Cerebrovascular diseases 325
Intracranial hemorrhage 326
Paraplegia 327
Hemiplegia 327
Demyelinating diseases 328
Neurodegenerative diseases 328
Central nervous system tumors 329

29. Eye **333**
Normal structure 333
Eyelids 333
Orbit 334
Conjunctiva 334
Sclera 335
Cornea 335
Anterior segment 336
Uvea 337
Retina and vitreous 338
Optic nerve 341

SECTION 3: CLINICAL PATHOLOGY

30. Anticoagulants and Hemoglobin Estimation **345**
Anticoagulants 345
Collection of blood 346
Hemoglobin estimation 347

31. Blood Cell Counts **349**
Red blood cell count 349
Total WBC count 350
Platelet count 352
Absolute eosinophil count 352

32. Hematocrit, ESR Estimation and Peripheral Blood Smear Examination **354**
Hematocrit 354
Erythrocyte sedimentation rate 355
Peripheral blood smear examination 356
Stains for blood smear 356
Preparation of the peripheral blood smear 357
Fixation of the smear 357
Staining of the smear 358

33. Reticulocyte Count **359**
Methods of reticulocyte count 359

34. Bone Marrow Examination **361**
Bone marrow aspiration 361
Bone marrow trephine biopsy 362

35. Cerebrospinal Fluid Examination **363**
Method of collection 363
Examination of cerebrospinal fluid 364

36. Body Fluids, Gastric Analysis and Sputum Examination **365**
Examination of body fluids 365
Examination of synovial fluid 366
Gastric analysis 367
Sputum examination 368

37. Semen Analysis **370**
Semen analysis 370

38. Urine Analysis **373**
Physical examination 373
Chemical examination 374
Microscopic examination 378
Urine culture and sensitivity 379

39. Stool Examination **380**
Stool examination 380
Stool culture and sensitivity 382

Index ***385***

CHAPTER 1

Introduction

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CHAPTER OUTLINE

- Normal Cell Structure and Functions
- Introduction to Pathology

NORMAL CELL STRUCTURE AND FUNCTIONS

- A cell is a fundamental unit of life.
- All cells are tridimensional, although when viewed under the light microscope on a glass slide, they appear to be flat.

Components of the Cell (Fig. 1.1)

All cells share the fundamental structural components. Each cell has three essential components: (A) Cell membrane, (B) Cytoplasm and (C) Nucleus.

A. Cell Membrane/Unit Membrane

It is the outer boundary of the cell.

Light microscopy: The membrane appears at the periphery as a thin condensation.

Function of cell membrane: Cell membrane plays a critical role in virtually every aspect of cell function.

B. Cytoplasm

Cytoplasm or cytosol is the component of the cell, located between the nucleus and the cell membrane.

Light microscopy: Various products of cell metabolism may be seen in the cytoplasm, and appear as granules or vacuoles.

Cytoplasmic organelles

Ultrastructurally, the cytoplasm is composed of: (1) organized cell components, or organelles; (2) the cytoskeleton, and (3) cytoplasmic matrix.

1. Organized components of the cytoplasm: They mainly consists of: (i) membranous systems, (ii) ribosomes, (iii) mitochondria, (iv) lysosomes, and (v) centrioles.

i. **Membranous system:** It is composed of: (a) the endoplasmic reticulum, and (b) the Golgi complex.

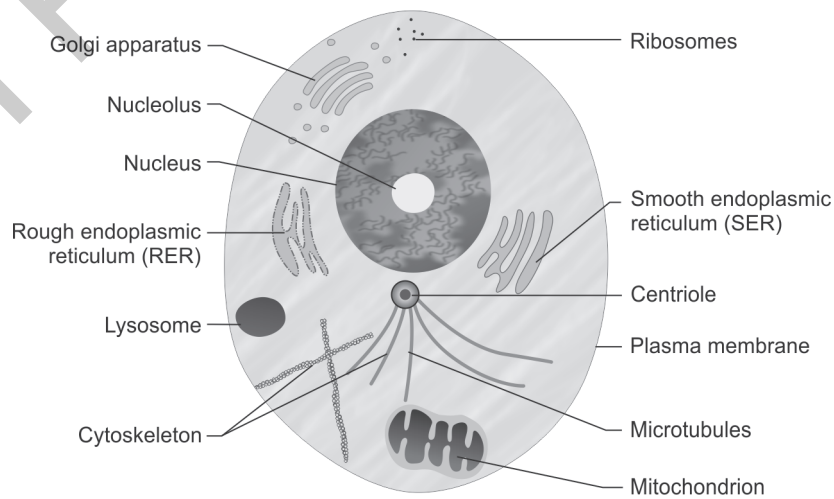

Fig. 1.1: Various constituents of cell

a. Endoplasmic reticulum:
- **Appearance:** It is a closed system of unit membranes forming tubular canals and flattened sacs or cisternae. It subdivides the cytoplasm into a series of compartments.
- **Types:** The membranes of the endoplasmic reticulum may be "rough," i.e. rough endoplasmic reticulum (RER) (i.e. covered with numerous attached granules), or "smooth" i.e. smooth endoplasmic reticulum (SER) (i.e. free of any particles).
- **Function:** Rough endoplasmic reticulum is abundant in metabolically active cells.

b. Golgi complex:
- **Appearance:** It consists of a series of parallel, doughnut-shaped flat spaces or cisternae and spherical or egg-shaped vesicles demarcated by smooth membranes.
- **Function:** They synthesize and package cell products for the cells' own use and for export.

ii. Ribosomes
- They are found in all cells.
- Two types of ribosomes namely free and attached.
- **Functions:**
  - Free ribosomes produce proteins for the cell's own use.
  - Attached ribosomes produce proteins for export.

iii. Mitochondria: They are present in all eukaryotic cells.
- **Appearance:** Each mitochondrion is composed of two membranes. The outer membrane is a continuous, closed-unit membrane. Running parallel to the outer membrane is the inner membrane that forms numerous crests or invaginations.
- **Function:** Most important function is the formation of energy-producing adenosine triphosphate (ATP) from phosphorus and adenosine diphosphate (ADP). ATP is exported into the cytoplasm and is an essential source of energy for the cell.

iv. Lysosomes: Lysosomes are intracellular organelles that contain degradative enzymes.
- **Appearance:** Electron microscopically, appear as spherical or oval structures.
- **Function:**
  - Lysosomal enzymes performs the digestion of a wide-range of macromolecules, including proteins, polysaccharides, lipids, and nucleic acids.
  - They participate in the removal of phagocytized foreign material.

v. Centrioles
- **Appearance:** They are short tubular structures, usually located in the vicinity of the concave face of the Golgi complex.
- **Function:** Play a key role during cell division.

2. The cytoskeleton: The cytoskeleton of the cells is mainly composed of three types of fibrillar proteins namely (1) the actin filaments (microfilaments, tonofilaments), (2) intermediate filaments, and (3) microtubules. Cytoskeleton maintains the physical shape of cells, involved in motion of the cells, and provide structural support to all cell functions.

3. Cytoplasmic matrix: The space within the cytoplasm, not occupied by the membranous system, the cell skeleton, or by the organelles, is called as the cytoplasmic matrix. It is composed of proteins and free ribosomes.

C. Nucleus

It is present within the cytoplasm.
- **Content:** It contains mainly deoxyribonucleic acid (DNA) that governs the genetic and functional aspects of cell activity.
- **Nucleolus:** In normal resting nuclei, the nucleoli are seen as round or oval structures occupying a small area within the nucleus.

INTRODUCTION TO PATHOLOGY

Definition: Pathology is the **scientific study (logos) of disease (pathos)**. It mainly focuses on the study of the structural and functional changes in cells, tissues, and organs in disease.

Learning Pathology

Study of pathology can be divided into general pathology and systemic pathology.
- **General pathology:** It deals with the study of mechanism, basic reactions of cells and tissues to abnormal stimuli and to inherited defects.
- **Systemic pathology:** This deals with the changes in specific diseases/responses of specialized organs and tissues.

Scientific Study of Disease

Disease process is studied under following aspects:

Etiology

The etiology of a disease is its **cause**. The causative factors of a disease can be divided into two major categories: genetic and acquired (e.g. infectious, chemical, hypoxia, nutritional, physical). Most common diseases are multifactorial due to combination of causes.

Pathogenesis

It refers to the **mechanism** by which the causative factor/s produces structural and functional abnormalities.

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Pathogenesis deals with sequence of events that occur in the cells or tissues from the beginning of any disease process.

Morphologic Changes

All diseases start with structural changes in cells. **Rudolf Virchow** (known as the **Father of modern pathology**) proposed that injury to the cell is the basis of all diseases. Morphologic changes refer to the **gross and microscopic structural changes** in cells or tissues affected by disease.

Gross

Many diseases have characteristic gross pathology and a fairly confident diagnosis can be given before light microscopy. For example, cirrhosis of liver is characterized by total replacement of liver by regenerating nodules.

Microscopy

Light microscopy: Abnormalities in tissue architecture and morphological changes in cells can be studied by light microscopy.

- **Histopathology:** Sections are routinely cut from tissues and processed by pararffin-embedding. The sections are cut from the tissue by a special instrument called microtome and examined under light microscope. In certain situations (e.g. histochemistry, rapid diagnosis), sections are cut from tissue that has been hardened rapidly by freezing (frozen section). The sections are stained routinely by hematoxylin and eosin.
  - **Pathognomonic abnormalities:** If the **structural changes are characteristic of a single disease or diagnostic of an etiologic process,** it is called as **pathognomonic.** Pathognomonic features are those features which are restricted to a single disease, or disease category. The diagnosis should not be made without them. For example, **Aschoff bodies** are pathognomonic of **rheumatic heart disease** and **Reed Sternberg cells** are pathognomonic of **Hodgkin lymphoma**.
- **Cytology:** The cells from cysts, body cavities, or scraped from body surfaces or aspirated by fine needle from solid lesions can also be studied under light microscope. This study of cells is known as cytology and is used widely, especially in diagnosis and screening of cancer.
- **Histochemistry (special stains):** Histochemistry (refer Table 2.4) is the study of the chemistry of tissues, where tissue/cells are treated with specific reagent so that the features of individual cells/structure can be visualized, e.g. **Prussian blue reaction for hemosiderin.**
- **Immunohistochemistry and immunofluorescence:** They utilize antibodies (immunoglobulins with antigen specificity) to visualize substances in tissue sections or cell preparations. Former uses **monoclonal antibodies** linked chemically to enzymes and later **fluorescent dyes**.

Electron microscopy: Electron microscopy (EM) is useful to the study changes at ultrastructural level, and to the demonstration of viruses in tissue samples in certain diseases.

Functional Derangements and Clinical Manifestations

- **Functional derangements:** The effects of genetic, biochemical, and structural changes in cells and tissues are **functional abnormalities**. For example, insufficient secretion of a cell product (e.g. insulin lack in diabetes mellitus).
- **Clinical manifestations:** The functional derangements produce two clinical manifestations of disease, namely symptoms and signs. Diseases characterized by **multiple abnormalities** (symptom complex) are called syndromes.
- **Prognosis:** The prognosis forecasts (predicts) the known or likely **course (outcome) of the disease**, and therefore, the fate of the patient.
- **Complications:** It is a **negative pathologic process** or event occurring **during the disease** which is not an essential part of the disease. It usually aggravates the illness. For example, perforation and hemorrhage are complications which may develop in typhoid ulcer of intestine.

SELF-ASSESSMENT EXERCISE

I. Short Note

1. Components of cell.

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Textbook of

PATHOLOGY

for Allied Health Sciences

Salient Features

- Provides basic concepts of diseases required to be known by students of allied health sciences. These courses include BMLT, BSc Anesthesia Technology, BASLP, BSc Cardiac Care Technology, BCVT, BSc MRT, BSc OT Technology, BSc OPT, BSc Perfusion Technology, BPT, BSc RTT, BSc Renal Dialysis Technology and BSc Respiratory Care Technology
- Includes the course contents needed for BAMS, BHMS and BSMS. This book can also be used as a LMR (last minute reading) for even medical and dental students
- Provides knowledge in a simple, lucid and easily understandable and reproducible format
- Richly illustrated
- Book is divided into three sections namely General Pathology, Systemic Pathology and Clinical Pathology
- Concise text in bullet form for easy review and recollection
- Key points are provided in bold letters so that it will help the student to just brush through the entire book within a few hours before the examination or viva voce
- Provides usual questions asked in the examination
- Text enhanced with numerous illustrations, gross photographs, photomicrographs, tables, flowcharts and X-rays.



Ramadas Nayak MBBS MD was graduated from Mysore Medical College, Mysuru, Karnataka, India, in the year 1979 and completed his postgraduation in Pathology from Kasturba Medical College, Mangaluru, Karnataka. Presently, he is Professor and Head, Department of Pathology, Yenepoya Medical College, Yenepoya University (Accredited by NACC with "A"grade), Mangaluru. In his illustrious teaching career of 34 years, he was Head, Department of Pathology, Kasturba Medical College, Manipal University, Mangaluru, for a span of 5 years. Apart from publishing over 82 scientific papers in both national and international journals, he serves as an examiner for both undergraduate and postgraduate examinations in several universities. He has worked as project officer for Development of Cancer Atlas in India—a project conducted by Indian Council of Medical Research (ICMR) sponsored by World Health Organization (WHO). He was the editorial Committee Member of South Asia Edition of *British Medical Journal*. He is also the author of seven more books entitled *Essentials in Hematology and Clinical Pathology, Textbook of Pathology and Genetics for Nurses, Rapid Review of Hematology, Exam Preparatory Manual for Undergraduates in Pathology, Exam Preparatory Manual for Undergraduates—Pathology for Dental Students, Textbook of Pathology for BPT Students,* and *Exam Preparatory Manual for Undergraduates in Medicine*. Twice he secured "Good Teacher Award" and eight times "Best Audiovisual Award" in Kasturba Medical College, Mangaluru. Above all, he is loved and admired by his students.

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