

# Contents

## Section 1: General Physiology

### 1. Introduction to Physiology and General Principles in Physiology 1

- PH, Acid/Base and Buffer 1
- Acid-base Disorders (Acidosis and Alkalosis) 2
- Osmosis 3
- Osmotic Pressure 3
- Osmolality and Osmolarity 3
- Tonicity 3
- Diffusion 4
- Forces Acting on Ions 5

### 2. The Body Fluid Compartments 7

- Total Body Water 7
- Distribution of Body Fluids 7
- Measurement of Body Fluid Volumes 8
- Body Electrolytes 8
- Intravenous Fluid Therapy 8

### 3. Homeostasis 11

- Control Systems of the Body 11
- Feedback Systems 12
- Role of Different Systems in the Body in Homeostasis 13
- Homeostatic Imbalance 13

### 4. Cell Physiology 15

- Parts of a Cell 15
- Plasma Membrane 15
- Cytoplasm 15
- Nucleus 15
- Plasma Membrane 15

#### Cytoplasm 17

- Cytosol 17
- Cell Organelles 19

#### Nucleus 22

#### Genetics 22

- Genes 22
- Genetics and Disease 23
- Cloning 25

#### Cell Division 26

- Somatic Cell Division 26
- Reproductive Cell Division or Meiosis 27

#### Apoptosis 29

- Mechanism of Apoptosis 29
- Significance of Apoptosis 29

#### Intercellular Connections 30

- Cell Adhesion Molecules 30
- Intercellular Connections 30

### 5. Transport Processes across Cell Membrane 34

- Types of Transport across Cell Membrane 34

### 6. Nerve Physiology and Bioelectrical Potentials 44

#### Neuron 44

- Classification of Neurons 44
- Morphology of a Typical Neuron 45
- Processes of the Neuron 46
- Properties of Nerve Fibers 48

#### Bioelectrical Potentials 48

- Resting Membrane Potential 48
- Graded Potentials 50
- Action Potential 50
- Excitability 54
- Conduction of Nerve Impulse or Propagation of Action Potential 56
- Classification of Nerve Fibers 57
- Nerve Injury 58
- Response of Neurons to Injury 58
- Injury to the Axon 59

### 7. Skeletal Muscle Physiology 65

- Skeletal Muscle 65
- Motor Point and Motor Unit 72
- Electromyography 73
- Muscle Metabolism and Energy Source 73
- Applied Physiology 75

### 8. Neuromuscular Junction or Myoneural Junction 79

- Structure of Neuromuscular Junction 79
- Effects of Denervation of Muscle 82

### 9. Cardiac Muscle 85

- Structure of Cardiac Muscle 85
- Electrical Activity of Cardiac Muscle 85
- Properties of Cardiac Muscle 88

### 10. Smooth Muscle 90

- Functional Anatomy 90
- Neuromuscular Junction in Smooth Muscle 91
- Electrical Responses in Smooth Muscle 91
- Tonus 92
- Mechanism of Smooth Muscle Contraction and Relaxation 92
- Length–Tension Relationship in Smooth Muscle 93
- Similarities between Cardiac and Visceral Smooth Muscle 93

## Section 2: Hematology

### 11. Blood 99

- Circulating Body Fluids 99
- Blood 99

### 12. Plasma 102

- Composition 102
- Plasma Proteins 102
- Plasmapheresis 103
- Albumin-globulin Ratio 104

### 13. Red Blood Corpuscles or Erythrocytes and Hemoglobin 106

- Morphology of Mature RBC 106
- Packed Cell Volume or Hematocrit 107
- Special Properties of Erythrocytes 108
- Metabolism in RBC 110
- RBC Count 111
- Hemoglobin 111
- Blood Indices 113
- Life Span of RBC 114
- Destruction of RBC 114
- Hematopoiesis 116
- Erythropoiesis 116
- Erythropoietin 119
- Factors Regulating Erythropoiesis 120
- Anemia 122

### 14. White Blood Corpuscles or Leukocytes 131

- Granulocytes 132
- Agranulocytes 133
- Properties of Leukocytes 134
- Functions of Leukocytes 134
- Disorders of Phagocytic Function 135
- Variations in WBC Count 136
- Leukopoiesis 138

### 15. Spleen and Reticuloendothelial System 141

- Spleen 141
- Reticuloendothelial System or Tissue Macrophage System 142

### 16. Immune System 144

- Cytokines, Chemokines and the Complement System 144
- Immune Response 146
- Immunity 146
- Innate Immunity 147
- Development of Immune System 148
- Acquired Immunity or Specific Immunity 150
- Humoral Immunity 153
- Immunological Memory 155
- Immunological Tolerance or Recognition of Self 156
- Immunological Disorders 157

### 17. Platelets 159

- Structure of Platelet 159
- Variations in the Platelet Count 160
- Properties of Platelets 160
- Functions of Platelet 162
- Von Willebrand Factor 162
- Thrombopoiesis 162

### 18. Hemostasis 164

- Primary Hemostasis 164
- Secondary Hemostasis 165
- Factors that Prevent Intravascular Coagulation or Intravascular Anticoagulants 169
- Fibrinolytic System 170
- Fibrinolysis Inhibitors 171
- Anticoagulants 171
- Bleeding Disorders 172
- Purpura 174
- Thromboembolic Conditions in Human 174

### 19. Tissue Fluid and Lymph 177

- Tissue Fluid 177
- Lymph 179

### 20. Blood Volume 183

- Measurement of Blood Volume 183
- Variations in Blood Volume 183
- Regulation of Blood Volume 184

### 21. Blood Groups and Blood Transfusion 186

- ABO Blood Group System 186
- RH System 190
- Blood Transfusion 193

## Section 3: Cardiovascular System

### 22. Functional Anatomy of the Heart 201

- Heart 202
- Specialized Excitatory and Conducting System of Heart 205
- Properties of Cardiac Muscle 208

### 23. Recording of Electrical Activity of Heart 210

- Electrocardiography 210
- Electrocardiogram 212
- Normal Pattern of ECG 213
- Intervals in ECG 214
- Pattern of ECG in Other Leads 215
- Mean Electrical Axis 215
- Clinical Application of ECG 217

### 24. Cardiac Cycle 224

- Phases of Cardiac Cycle 224
- Pressure Changes during Cardiac Cycle 227
- Volume Changes during Cardiac Cycle 229
- Heart Sounds 230

### 25. Hemodynamics 234

- Relation between Pressure, Flow and Resistance 235
- Methods for Measuring Blood Flow 235
- Laminar Flow 235
- Flow Continuity Equation 235
- Critical Velocity 236
- Circulation Time 237
- Resistance to Flow of Blood 237
- Tests to Assess Cardiac Function 240

### 26. Heart Rate 243

- Factors Affecting Heart Rate 243
- Afferents to the Cardiac Centers 246

- Chemical Factors Affecting Heart Rate 249
- Physical Factors 250
- Age and Sex 250
- Regulation of Heart Rate 250
- Regulation of Transplanted Heart 250
- Sympathovagal Balance 250
- Heart Rate Variability 251

## 27. Cardiac Output 253

- Measurement of Cardiac Output 253
- Variations in Cardiac Output 255
- Cardiac Reserve 255
- Factors Affecting Cardiac Output 255
- Regulation of Cardiac Output 255
- Regulation of Stroke Volume 255
- Regulation of Heart Rate 257
- Neural Factors 257
- Physical Factors Regulating Heart Rate 257

## 28. Vascular System and Arterial Blood Pressure 261

- Vascular System 261
- Arterial Blood Pressure 263
- Measurement of Arterial Blood Pressure 264
- Variations in Blood Pressure 264
- Determinants of Arterial Blood Pressure 266
- Regulation of Peripheral Resistance 267
- Regulation of Blood Pressure 270
- Factors Affecting Blood Pressure 271
- Factors Affecting Cardiac Output 271
- Factors Affecting Peripheral Resistance 271
- Circulatory Shock 272
- Cardiac Failure or Heart Failure 275

## 29. Arterial and Venous Pulse 281

- Arterial Pulse 281
- Jugular Venous Pulse 283

## 30. Cardiovascular Adjustments in Exercise 285

- Increase in Sympathetic Discharge 285
- Increase in Arterial Pressure 285
- Increase in Cardiac Output 286
- Local Mechanisms 286
- Effect of Training 286

## 31. Effect of Acceleratory Forces on Circulatory System 288

- Effects of Positive "G" On Circulatory System 288
- Effects of Negative "G" 288
- Effect of Gravity on Circulatory System 288
- Compensatory Cardiovascular Adjustments in Prolonged Standing 289
- Effects of Zero Gravity in the Body (Weightlessness) 289

## 32. Circulation through Special Regions 290

- Capillary Circulation 290
- Structural Organization of Capillaries 290
- Cutaneous Circulation 292
- Coronary Circulation 293
- Measurement of Coronary Blood Flow 294
- Cerebral Circulation 299
- Splanchnic Circulation 303
- Intestinal Microcirculation 303

- Hepatic Portal Circulation 304
- Fetal Circulation 305

## Section 4: Respiratory System

### 33. Structure and Functions of Respiratory System 313

- Functions of the Respiratory Tract 313
- Functional Anatomy of the Respiratory System 315
- Innervation of Lungs 318
- Bronchoscopy 318
- Bronchography 318
- Pleura 318
- Blood Supply to Lungs 319

### 34. Mechanics of Ventilation 321

- Patterns of Breathing 321
- Boundaries of the Thoracic Cage 321
- Muscles of Respiration 321
- Mechanism of Ventilation of Lungs 322
- Movements of the Thoracic Cage 322
- Breath Sounds 322
- Pressure Changes during Respiratory Cycle 324
- Elastic behavior of Lungs or Reasons for Recoil of Lung 325
- Surfactant 325
- Application of Law of Laplace in Lung 327
- Alveolar Stability 327
- Effects of Cigarette Smoking 327

### 35. Methods of Study of Respiratory Movements 331

- Direct Technique to Study Respiratory Movements 331
- Indirect Techniques 331
- Lung Volumes and Capacities 332
- Pulmonary Ventilation and Alveolar Ventilation 335
- Respiratory Dead Space 336
- Compliance (Pressure–Volume Relationship) 337
- Work of Breathing 339

### 36. Pulmonary Circulation 343

- Pulmonary Blood Pressure 344
- Measurement of Pulmonary Blood Flow 345
- Regional Variation in Distribution of Ventilation and Perfusion 345
- Effect of Gravity in Pulmonary Circulation 346
- Relationship between Pulmonary Artery Pressure and Pulmonary Venous Pressure in Pulmonary Capillary Blood Flow 347
- Ventilation-perfusion Ratio 348

### 37. Pulmonary Gas Exchange 351

- Partial Pressure of Gases 351
- Techniques of Collection of Alveolar Air or Sampling of Alveolar Air 351
- Methods of Analysis of the Collected Alveolar Gas 352
- Reasons for the Difference in the Composition of Atmospheric Air and Alveolar Air 352
- Mechanism of Gas Exchange at Lung Level (External Respiration) 352
- Internal Respiration 354

• Respiratory Quotient or Respiratory Exchange Ratio 355		
<b>38. Transport of Gases</b>	<b>357</b>	
• Transport of Oxygen 357		
• Carbon Dioxide Transport 361		
<b>39. Regulation of Respiration</b>	<b>366</b>	
<b>Neural Control of Respiration 366</b>		
• Voluntary Control 366		
• Automatic Control 366		
• Reflex Control of Respiration 368		
<b>Chemical Regulation of Respiration 370</b>		
• Chemoreceptors 370		
• Interaction of Chemical Factors in Regulation of Respiration 374		
• Abnormalities in Regulation of Respiration 375		
• Hypoxia 378		
• Cyanosis 381		
<b>40. Environmental Physiology</b>	<b>386</b>	
• High Altitude Physiology 386		
<b>Effects of Barometric Pressure on Respiratory System 386</b>		
• Effects of Decreased Barometric Pressure 386		
• Factors other than Barometric Pressure at High Altitude 388		
• Effects of Increased Barometric Pressure 388		
• Barotrauma 390		
<b>Space Physiology 390</b>		
• Weightlessness in Space 390		
• Diseases due to Ionizing Radiation 392		
<b>41. Respiratory Adjustments in Exercise</b>	<b>395</b>	
• Fatigue 397		
<b>42. Artificial Respiration and Cardiopulmonary Resuscitation</b>	<b>398</b>	
• Cardiopulmonary Resuscitation 399		
<b>43. Pulmonary Function Tests</b>	<b>401</b>	
<b>Section 5: Gastrointestinal System</b>		
<b>44. Introduction to Digestive System</b>	<b>405</b>	
• Functions of Gastrointestinal System 405		
• Digestion 406		
• Innervation of Gut 407		
• Gut-brain Axis 409		
<b>45. Salivary Glands and Esophagus</b>	<b>413</b>	
• Functional Anatomy 413		
• Histology of Salivary Gland 413		
• Blood Supply 414		
• Innervation of Salivary Glands 415		
• Composition of Saliva 416		
• Functions of Saliva 416		
• Mechanism of Secretion of Saliva 417		
• Regulation of Salivary Secretion 418		
• Nature of Saliva 418		
• Salivary Reflexes 418		
• Disturbances of Salivary Secretion 419		
• Esophagus 420		
<b>46. Stomach</b>	<b>422</b>	
• Functions of Stomach 422		
• Functional Anatomy of Stomach 422		
• Histology 423		
• Gastric Mucosal Barrier 424		
• Innervation of Stomach 425		
• Gastric Juice 425		
• Phases of Gastric Juice Secretion 429		
• Gastrin 430		
• Abnormalities of Gastric Secretory Function 432		
<b>47. Exocrine Pancreas</b>	<b>438</b>	
• Innervation 438		
• Composition of Pancreatic Juice 438		
• Mechanism of Secretion of Pancreatic Juice 440		
• Regulation of Secretion of Pancreatic Juice 440		
• Phases of Pancreatic Juice Secretion 441		
<b>48. Liver and Biliary System</b>	<b>443</b>	
• Functions of Liver 443		
• Biliary System 444		
• Jaundice or Icterus 446		
• Regulation of Biliary Secretion 447		
• Gallbladder 447		
• Investigations of Liver and Gallbladder 448		
<b>49. Small Intestine</b>	<b>451</b>	
• Functional Anatomy 451		
• Parts of Small Intestine 451		
• Small Intestinal Juice or Succus Entericus 452		
• Functions of Small Intestine 452		
• Regulation of Small Intestinal Secretion 453		
<b>50. Large Intestine</b>	<b>455</b>	
• Dietary Fiber 456		
<b>51. Movements of Gastrointestinal Tract</b>	<b>459</b>	
• Types of Movements 459		
• Gastric Movements 462		
• Movements of Small Intestine 464		
• Movements of Large Intestine 466		
• Defecation 466		
<b>52. Digestion and Absorption of Food</b>	<b>469</b>	
• Digestion and Absorption of Carbohydrates 469		
• Digestion and Absorption of Proteins and Nucleic Acids 471		
• Vitamins 474		
<b>53. Gastrointestinal Hormones</b>	<b>477</b>	
• Amine Precursor Uptake and Decarboxylation (APUD) Cells 477		
• Incretins 477		
• Glucagon-like Peptide-I 478		
• Glucose-dependent Insulinotropic Polypeptide 478		
<b>Section 6: Renal Physiology</b>		
<b>54. Functional Anatomy of Kidney</b>	<b>483</b>	
• Kidney 483		
<b>55. Mechanism of Formation of Urine</b>	<b>494</b>	
• Glomerular Filtration 494		
• Glomerular Filtration Rate 495		

<b>56. Lower Urinary Tract</b>	<b>519</b>	<b>65. Thyroid Gland</b>	<b>591</b>
<ul style="list-style-type: none"> <li>Innervation of the Bladder 519</li> <li>Micturition 520</li> <li>Abnormalities of Bladder Function 521</li> <li>Cystometry 521</li> <li>Diuresis and Diuretics 522</li> </ul>		<b>66. Calcium and Phosphate Homeostasis</b>	<b>608</b>
<b>57. Renal Function Tests</b>	<b>524</b>	<ul style="list-style-type: none"> <li>Physiology of Bone 608</li> <li>Body Calcium 609</li> <li>Phosphorus Metabolism 610</li> <li>Parathyroid Glands 610</li> <li>Parathormone 610</li> <li>Calcitriol or 1,25-Hydroxycholecalciferol 615</li> </ul>	
<ul style="list-style-type: none"> <li>Urine Analysis 524</li> <li>Blood Examination 525</li> <li>Miscellaneous Tests 525</li> </ul>		<b>67. Adrenal Gland</b>	<b>620</b>
<b>Section 7: Skin and Temperature Regulation</b>		<ul style="list-style-type: none"> <li>Functional Anatomy of Adrenal Gland 620</li> <li>Glucocorticoids 622</li> <li>Mineralocorticoids 628</li> <li>Adrenal Medulla 632</li> </ul>	
<b>58. Skin</b>	<b>529</b>	<b>68. Endocrine Pancreas</b>	<b>640</b>
<ul style="list-style-type: none"> <li>Structure of Skin 529</li> <li>Appendages of Skin 529</li> <li>Blood Supply of the Skin 531</li> <li>Skin Color 531</li> <li>Functions of Skin 531</li> </ul>		<ul style="list-style-type: none"> <li>Functional Anatomy 640</li> <li>Insulin 641</li> <li>Obesity and Metabolic Syndrome or Syndrome-X 648</li> <li>Houssay Animal 649</li> <li>Glucagon 649</li> <li>Somatostatin 649</li> <li>Pancreatic Polypeptide 650</li> <li>Control of Blood Glucose 650</li> </ul>	
<b>59. Temperature Regulation</b>	<b>533</b>	<b>69. Other Endocrine Organs and Local Hormones</b>	<b>654</b>
<ul style="list-style-type: none"> <li>Measurement of Body Temperature 533</li> <li>Mechanisms of Heat Gain and Heat Loss from the Body 534</li> <li>Variations in Body Temperature 540</li> <li>Effects of Exposure of the Body to Extremes of Temperature 542</li> </ul>		<ul style="list-style-type: none"> <li>Thymus 654</li> <li>Kidney 655</li> <li>Heart 656</li> <li>Local Hormones 656</li> <li>Endothelium 658</li> <li>Endothelins 659</li> </ul>	
<b>Section 8: Endocrine System</b>		<b>Section 9: Reproductive System</b>	
<b>60. Organization of the Endocrine System</b>	<b>547</b>	<b>70. Introduction to Reproductive Physiology</b>	<b>663</b>
<ul style="list-style-type: none"> <li>Relation between Endocrine System and Nervous System 548</li> <li>Endocrine Glands 548</li> <li>Radioimmunoassay 550</li> <li>Clinical Syndromes Related to Endocrine Functions 550</li> </ul>		<ul style="list-style-type: none"> <li>Characteristics which Differentiate an Adult Human Male from an Adult Female 663</li> </ul>	
<b>61. Mechanism of Cellular Action of Hormones</b>	<b>552</b>	<b>71. Sexual Development in the Embryo</b>	<b>665</b>
<ul style="list-style-type: none"> <li>Hormone Receptors 552</li> </ul> <b>Intercellular Communication 554</b> <ul style="list-style-type: none"> <li>G-Proteins 554</li> <li>Mechanism by which Combination of Hormone with Receptor Triggers Cellular Function 555</li> <li>Genomic and Nongenomic Effects of Hormones 561</li> <li>Regulation of Hormone Secretion 561</li> </ul>		<ul style="list-style-type: none"> <li>Sex Determination 665</li> <li>Sex Differentiation 666</li> <li>Abnormalities in Sexual Differentiation 668</li> <li>Puberty 670</li> </ul>	
<b>62. Anterior Pituitary Gland and Hypothalamus</b>	<b>565</b>	<b>72. Male Reproductive System</b>	<b>673</b>
<ul style="list-style-type: none"> <li>Pituitary Gland 565</li> <li>Hormones of the Pituitary Gland 566</li> <li>Anterior Pituitary 567</li> <li>Physiology of Growth and Development 573</li> <li>Hypothalamus 579</li> </ul>		<ul style="list-style-type: none"> <li>Functional Anatomy of Male Reproductive System 673</li> <li>Spermatogenesis 674</li> <li>Erection and Ejaculation 677</li> <li>Endocrine Function of Testis 678</li> </ul>	
<b>63. Posterior Pituitary</b>	<b>582</b>	<b>73. Female Reproductive System</b>	<b>684</b>
<ul style="list-style-type: none"> <li>Hormones of Posterior Pituitary 582</li> <li>Oxytocin 584</li> </ul>		<ul style="list-style-type: none"> <li>Functional Anatomy 684</li> <li>Secondary Sexual Organs in Female 685</li> <li>Oogenesis 685</li> <li>Female Reproductive Cycle or Menstrual Cycle 686</li> <li>Changes in the Breast 690</li> <li>Endocrine Function of Ovary 690</li> <li>Control of Ovarian Function 693</li> <li>Abnormalities of Menstruation 694</li> <li>Tests of Ovulation 696</li> </ul>	
<b>64. Pineal Gland</b>	<b>587</b>		
<ul style="list-style-type: none"> <li>Functional Anatomy 587</li> <li>Circadian Rhythm 589</li> </ul>			



• Menopause 696		• Muller's Doctrine of Specific Nerve Energies 766	
• Physiology of Human Sexual Responses 696		• Law of Projection 766	
<b>74. Fertilization and Pregnancy 701</b>		• Cortical Plasticity 766	
• Changes in the Sperm before Fertilization 701		• Superficial Senses 766	
• Fertilization 702		• Cortical Sensations 767	
• Functions of Placenta 703		• Lateral Inhibition or Surround Inhibition 767	
• Pregnancy Tests 705		• Synthetic Cutaneous Senses 768	
• Amniocentesis 706			
• Parturition or Labor 706		<b>82. Ascending Sensory Pathways 770</b>	
• Puerperium 707		• Dorsal Column Pathway or Medial Lemniscal System 771	
<b>75. Cardiorespiratory Adjustments of the Baby after Birth 710</b>		• Spinothalamic Pathway or Anterolateral System 771	
• Respiratory Adjustments after Birth 710		• Ascending Tracts of Spinal Cord 772	
• Cardiovascular Adjustments 710		• Sensory Tracts 773	
<b>76. Lactation 711</b>		• Nonsensory Tracts 773	
• Milk Secretion 712		• Sensory Cortical Area 774	
• Milk Ejection 712		• Sensory Association Area 775	
• Lactation and Menstruation 712		• Sense of Touch 775	
<b>77. Contraception and Infertility 714</b>		• Pathway for Temperature Sensation 778	
• Contraception 714		• Kinesthetic Sensation (Kinesthesia) or Proprioception 779	
• Infertility 717		• Itching and Tickling 780	
		• Visceral Sensations 781	
		• Pain Sensation 781	
<b>Section 10: Nervous System</b>		<b>83. Thalamus 794</b>	
<b>78. Organization of Nervous System 721</b>		• Functional Anatomy of Thalamus 794	
• Functions of Nervous System 721		• Anatomical Classification of Thalamic Nuclei 794	
• Organization of Nervous System 722		• Functional Classification of Thalamic Nuclei 795	
• Basis of Neural Activity 722		• Connections of Thalamus 795	
• Centers of Nervous System 723		• Functions of Thalamus 795	
• Processing of Sensory Information 723		• Lesions of Thalamus 796	
• Functional Anatomy of the Brain 724		<b>84. Motor Division of Nervous System 798</b>	
• Cranial Nerves 724		• Somatic Nervous System 798	
• Structure of Central Nervous System 724		• Muscle Tone 798	
• Structure of Spinal Cord 726		• Upper Motor Neuron Pathways 799	
<b>79. Physiology of Nervous System 731</b>		• Voluntary Motor Activity 800	
• Synapse 731		• Motor Areas of Cerebral Cortex 801	
• Mechanism of Transmission at the Excitatory Chemical Synapse 734		• Mirror Neurons 801	
• Electrical Events at Synapses 735		• Pyramidal Tract 801	
• Properties of Synapse 736		• Extrapyramidal Tracts 804	
• Effect of Environmental Factors on Synaptic Transmission 742		• Cortically Originating Extrapyramidal Fibers 804	
• Neurotransmitters and Neuromodulators 742		• Applied Physiology 805	
<b>80. Reflex Action 747</b>		<b>85. Lesions of Spinal Cord 810</b>	
• Reflex ARC 747		• Types of Lesions of Spinal Cord 810	
• Classification of Reflexes 748		• Complications of Spinal Cord Transection 812	
• General Properties of Reflexes 757		• Section of Posterior Nerve Root in Spinal Cord 813	
<b>81. Sensory Division of Nervous System 761</b>		• Section of Anterior Nerve Root 813	
• Sensation 761		• Section of Peripheral Nerve 813	
• Sensory Receptors 762		• Diseases Affecting Spinal Cord 813	
• Pacinian Corpuscle 763		<b>86. Basal Ganglia or Basal Nuclei 815</b>	
• Generator Potential or Receptor Potential 763		• Functional Anatomy 815	
• Properties of Receptors 764		• Connections of Basal Ganglia 816	
• Sensory Unit 764		• Putamen Circuit and the Caudate Circuit 819	
• Intensity Discrimination by Cerebral Cortex 765		• Functions of Basal Ganglia 820	
• Weber-Fechner Law 765		• Effects of Lesions of Basal Ganglia 820	
• Coding of Sensory Information (Sensory Coding) 765		• Parkinson's Disease or Paralysis Agitans 820	
		• Huntington's Disease 822	
		• Hemiballism or Hemiballismus 823	

• Wilson's Disease or Progressive Hepatolenticular Degeneration 823	
• Kernicterus 823	
<b>87. Cerebellum</b>	<b>825</b>
• Functional Anatomy 825	
• Parts of Cerebellum 825	
• Phylogenetic Classification 826	
• Functional Classification 826	
• Cerebellar Cortex 826	
• Connections of Cerebellum 828	
• Peduncles of Cerebellum 829	
• Functions of Cerebellum 830	
• Lesions of Cerebellum 831	
<b>88. Reticular Formation</b>	<b>835</b>
• Connections of Reticular Formation 835	
• Functions of Reticular Formation 836	
<b>89. Vestibular Apparatus</b>	<b>838</b>
• Functional Anatomy of Vestibular Apparatus 838	
• Vestibular Pathway 841	
• Mechanism of Control of Equilibrium 841	
• Functions of Vestibular Apparatus 842	
• Vestibular Function Tests 843	
• Vestibular Dysfunction 844	
• Effects of Removal of Vestibular Apparatus 844	
<b>90. Posture and Equilibrium</b>	<b>845</b>
• Postural Reflexes 845	
<b>91. Cerebral Cortex</b>	<b>849</b>
• Functional Anatomy of Cerebral Cortex 849	
• Methods of Study of Cerebrocortical Function 851	
• Functionally Important Areas of Cerebral Cortex 852	
<b>92. Hypothalamus</b>	<b>855</b>
• Functional Anatomy 855	
<b>93. Limbic System</b>	<b>860</b>
• Parts of Limbic System 860	
• Functions of Limbic System 861	
<b>94. Autonomic Nervous System</b>	<b>863</b>
• General Organization of ANS 863	
• Functional Anatomy of Sympathetic Nervous System 864	
• Functional Anatomy of Parasympathetic Nervous System 865	
• Types of Transmission in the Autonomic Nervous System 866	
• Functions of Autonomic Nervous System 869	
• Disorders of Autonomic Nervous System 870	
• General Adaptation Syndrome 870	
<b>95. Electroencephalography, Sleep, Yoga and Meditation</b>	<b>873</b>
• Electroencephalography 873	
• Sleep 874	
• Physiology of Sleep-Wake Cycles 877	
• Yoga and Meditation 878	
<b>96. Higher Functions of Brain</b>	<b>882</b>
• Unconditioned Reflex 882	
• Conditioned Reflex 882	

- Learning and Memory 884
- Thought 886
- Neuroplasticity or Cortical Plasticity 886
- Speech and Language 887
- Intercortical Transfer of Learning 889

<b>97. Cerebrospinal Fluid</b>	<b>891</b>
• Anatomy of the Ventricles of Brain and their Connections 891	
• Cerebrospinal Fluid 892	

## Section 11: Special Senses

<b>98. Vision</b>	<b>901</b>
• Functional Anatomy of Eyeball 901	
• Ophthalmoscopy 904	
• Contents of the Eyeball 904	
• Intraocular Pressure 905	
• Glaucoma 905	
• Lens 906	
• Vitreous Body 906	
• Extraocular Muscles 906	
• Lacrimal Apparatus 907	
• Physical Optics 907	
• Refractive Index 908	
• Refractive Power 908	
• Refraction in the Eye 909	
• Accommodation 909	
• Near Response or Near Reflex 910	
• Optical Defects in the Eye 912	
• Optical Aberrations 913	
• Cataract 914	
• Visual Acuity (Resolving Power of Eye) 914	
• Field of Vision or Visual Field 915	
• Retina 917	
• Visual Receptor Mechanism 920	
• Electrophysiological Changes in Retinal Receptors 922	
• Experimental Evidence to Show that Rods are Responsible for Dim Light Vision 923	
• Adaptation in the Visual System 924	
• Lateral Inhibition in the Visual Pathway 926	
• Visual Pathway 927	
• Lesions of Visual Pathway 930	
• Pupillary Reflexes 930	
• Color Vision 932	
• Mechanism of Color Vision 933	
• Theories of Color Vision 933	
• Tests for Color Vision 935	
• Color Blindness 935	
• Electroretinogram 937	
• Visual Evoked Potential 937	
<b>99. Audition</b>	<b>943</b>
• Functional Anatomy of the Ear 943	
• Physiology of Hearing or Audition 949	
• Mechanism of Hearing 951	
• Mechanism of Appreciation of Frequency, Intensity and Localization of Sound 952	
• Auditory Pathway 954	
• Cochlear Microphonics 956	
• Applied Aspects 957	
• Hearing Aids 958	
• Audiometry 959	

100. Gustation or Taste Sensation

965

- Taste Buds 965
- Taste Pathway 966
- Basic Taste Modalities or Primary Taste Sensations 967
- Abnormalities of Taste Sensation 968

101. Olfaction

969

- The Olfactory Apparatus 969
- Olfactory Pathway 971
- Vomeronasal Organ 973
- Variations in the Sense of Smell 973

Section 12: Integrated Physiology

102. Integrated Physiology

977

- Physiology of Infancy 977
- Applied Physiology 978

- Physiology of Aging 979
- Free Radicals and Antioxidants 980
- Brain Death 982
- Cardiorespiratory and Metabolic Adjustments during Exercise 982
- Cardiorespiratory Changes in Isotonic and Isometric Exercises 984
- Effect of Exercise Under Different Environmental Conditions (Heat and Cold) 985
- Consequences of Sedentary Life Style 985

Important Questions

987

Index

1015



# Competency Table

Number	Competency: The student should be able to	Core(Y/N)	Chapter Number	Page Number
PY1.1	Describe the structure and functions of a mammalian cell	Y	4	15
PY1.2	Describe and discuss the principles of homeostasis	Y	3	11
PY1.3	Describe intercellular communication	Y	61	554
PY1.4	Describe apoptosis – programmed cell death	Y	4	29
PY1.5	Describe and discuss transport mechanisms across cell membranes	Y	5	34
PY1.6	Describe the fluid compartments of the body, its ionic composition and measurements	Y	2 20	7 183
PY1.7	Describe the concept of pH and Buffer systems in the body	Y	1	1
PY1.8	Describe and discuss the molecular basis of resting membrane potential and action potential in excitable tissue	Y	6	48
PY2.1	Describe the composition and functions of blood components	Y	11	99
PY2.2	Discuss the origin, forms, variations, and functions of plasma proteins	Y	12	102
PY2.3	Describe and discuss the synthesis and functions of hemoglobin and explain its breakdown. Describe variants of hemoglobin	Y	13	111
PY2.4	Describe RBC formation (erythropoiesis and its regulation) and its functions	Y	13	116
PY2.5	Describe different types of anemias and jaundice	Y	13 48	122 446
PY2.6	Describe WBC formation (granulopoiesis) and its regulation	Y	14	138
PY2.7	Describe the formation of platelets, functions, and variations	Y	17	159
PY2.8	Describe the physiological basis of hemostasis, and anticoagulants. Describe bleeding and clotting disorders (Hemophilia, purpura)	Y	18	164
PY2.9	Describe different blood groups and discuss the clinical importance of blood grouping, blood banking and transfusion	Y	21	186
PY2.10	Define and classify different types of immunity. Describe the development of immunity and its regulation	Y	16	146
PY2.12	Describe test for ESR, osmotic fragility, hematocrit. Note the findings and interpret the test results, etc.	Y	13	107 108 110
PY3.1	Describe the structure and functions of a neuron and neuroglia; Discuss nerve growth factor and other growth factors/cytokines	Y	6	44
PY3.2	Describe the types, functions and properties of nerve fibers	Y	6	44
PY3.3	Describe the degeneration and regeneration in peripheral nerves	Y	6	58
PY3.4	Describe the structure of neuro-muscular junction and transmission of impulses	Y	8	79
PY3.5	Discuss the action of neuro-muscular blocking agents	Y	8	81
PY3.6	Describe the pathophysiology of myasthenia gravis	Y	8	82
PY3.7	Describe the different types of muscle fibers and their structure	Y	7	65
PY3.8	Describe action potential and its properties in different muscle types (skeletal and smooth)	Y	7 10	68 91
PY3.9	Describe the molecular basis of muscle contraction in skeletal and in smooth muscles	Y	7 10	69 92
PY3.10	Describe the mode of muscle contraction (isometric and isotonic)	Y	7	71
PY3.11	Explain energy source and muscle metabolism	Y	7	73
PY3.12	Explain the gradation of muscular activity	Y	7	75

Number	Competency: The student should be able to	Core(Y/N)	Chapter Number	Page Number
PY3.13	Describe muscular dystrophy: myopathies	Y	7	75
PY3.17	Describe strength-duration curve	Y	6	55
PY4.1	Describe the structure and functions of digestive system	Y	44	405
PY4.2	Describe the composition, mechanism of secretion, functions, and regulation of saliva, gastric, pancreatic, intestinal juices and bile secretion	Y	45 46 47 48 49 50	416 425 438 444 452 455
PY4.3	Describe GIT movements, regulation and functions. Describe defecation reflex. Explain role of dietary fiber	Y	50 51	456 459
PY4.4	Describe the physiology of digestion and absorption of nutrients	Y	52	469
PY4.5	Describe the source of GIT hormones, their regulation and functions	Y	53	477
PY4.6	Describe the Gut-Brain axis	Y	44	409
PY4.7	Describe and discuss the structure and functions of liver and gallbladder	Y	48	443, 447
PY4.8	Describe and discuss gastric function tests, pancreatic exocrine function tests and liver function tests	Y	47 48	441 448
PY4.9	Discuss the physiology aspects of: peptic ulcer, gastroesophageal reflux disease, vomiting, diarrhea, constipation, adynamic ileus, Hirschsprung's disease	Y	46 51	432 463, 466
PY5.1	Describe the functional anatomy of heart including chambers, sounds; and pacemaker tissue and conducting system	Y	22	202
PY5.2	Describe the properties of cardiac muscle including its morphology, electrical, mechanical and metabolic functions	Y	9 22	85 208
PY5.3	Discuss the events occurring during the cardiac cycle	Y	24	224
PY5.4	Describe generation, conduction of cardiac impulse	Y	22	205
PY5.6	Describe abnormal ECG, arrhythmias, heart block and myocardial infarction	Y	23	212 217
PY5.7	Describe and discuss hemodynamics of circulatory system	Y	25	234
PY5.8	Describe and discuss local and systemic cardiovascular regulatory mechanisms	Y	26 28	243 261
PY5.9	Describe the factors affecting heart rate, regulation of cardiac output and blood pressure	Y	26 27 28	243 253 263
PY5.10	Describe and discuss regional circulation including microcirculation, lymphatic circulation, coronary, cerebral, capillary, skin, fetal, pulmonary and splanchnic circulation	Y	19 32 36	179 290 343
PY5.11	Describe the patho-physiology of shock, syncope and heart failure	Y	28	272
PY5.12	Record blood pressure and pulse at rest and in different grades of exercise and postures in a volunteer or simulated environment	Y	29	281
PY5.16	Record arterial pulse tracing using finger plethysmography in a volunteer or simulated environment	N	29	281
PY6.1	Describe the functional anatomy of respiratory tract	Y	33	315
PY6.2	Describe the mechanics of normal respiration, pressure changes during ventilation, lung volume and capacities, alveolar surface tension, compliance, airway resistance, ventilation, V/P ratio, diffusion capacity of lungs	Y	34 35 36 37	322 331 348 351
PY6.3	Describe and discuss the transport of respiratory gases: Oxygen and Carbon dioxide	Y	38	357
PY6.4	Describe and discuss the physiology of high altitude and deep sea diving	Y	40	386
PY6.5	Describe and discuss the principles of artificial respiration, oxygen therapy, acclimatization and decompression sickness	Y	39 40 42	380 389 398
PY6.6	Describe and discuss the pathophysiology of dyspnea, hypoxia, cyanosis asphyxia; drowning, periodic breathing	Y	39	378
PY6.7	Describe and discuss lung function tests and their clinical significance	Y	43	401
PY7.1	Describe structure and function of kidney	Y	54	483

Number	Competency: The student should be able to	Core(Y/N)	Chapter Number	Page Number
PY7.2	Describe the structure and functions of juxtaglomerular apparatus and role of renin-angiotensin system	Y	54	487
PY7.3	Describe the mechanism of urine formation involving processes of filtration, tubular reabsorption and secretion; concentration and diluting mechanism	Y	55	494
PY7.4	Describe and discuss the significance and implication of renal clearance	Y	55	496 509
PY7.5	Describe the renal regulation of fluid and electrolytes and acid-base balance	Y	55	498
PY7.6	Describe the innervations of urinary bladder, physiology of micturition and its abnormalities	Y	55 56	509 519
PY7.7	Describe artificial kidney, dialysis and renal transplantation	Y	55	514
PY7.8	Describe and discuss renal function tests	Y	57	524
PY7.9	Describe cystometry and discuss the normal cystometrogram	Y	56	521
PY8.1	Describe the physiology of bone and calcium metabolism	Y	66	608
PY8.2	Describe the synthesis, secretion, transport, physiological actions, regulation and effect of altered (hypo and hyper) secretion of pituitary gland, thyroid gland, parathyroid gland, adrenal gland, pancreas and hypothalamus	Y	62 63 65 66 67 68	565, 579 582 591 610 620 640
PY8.3	Describe the physiology of thymus and pineal gland	Y	64 69	587 654
PY8.4	Describe function tests: Thyroid gland; adrenal cortex, adrenal medulla and pancreas	Y	65 67 68	599 620 640
PY8.5	Describe the metabolic and endocrine consequences of obesity and metabolic syndrome, stress response. Outline the psychiatry component pertaining to metabolic syndrome	Y	68	648
PY8.6	Describe and differentiate the mechanism of action of steroid, protein and amine hormones	Y	61	552 555
PY9.1	Describe and discuss sex determination; sex differentiation and their abnormalities and outline psychiatry and practical implication of sex determination	Y	71	665
PY9.2	Describe and discuss puberty: onset, progression, stages; early and delayed puberty and outline adolescent clinical and psychological association	Y	71	670
PY9.3	Describe male reproductive system: functions of testis and control of spermatogenesis and factors modifying it and outline its association with psychiatric illness	Y	72	673
PY9.4	Describe female reproductive system: (a) functions of ovary and its control; (b) menstrual cycle—hormonal, uterine and ovarian changes	Y	73	684
PY9.5	Describe and discuss the physiological effects of sex hormones	Y	72 73	678 690
PY9.6	Enumerate the contraceptive methods for male and female. Discuss their advantages and disadvantages	Y	77	714
PY9.7	Describe and discuss the effects of removal of gonads on physiological functions	Y	72	680
PY9.8	Describe and discuss the physiology of pregnancy, parturition and lactation and outline the psychology and psychiatry—disorders associated with it	Y	74 76	701, 706 711
PY9.9	Interpret a normal semen analysis report including (a) sperm count, (b) sperm morphology, and (c) sperm motility, as per WHO guidelines and discuss the results	Y	72	678
PY9.10	Discuss the physiological basis of various pregnancy tests	Y	74	705
PY9.11	Discuss the hormonal changes and their effects during perimenopause and menopause	Y	73	696
PY9.12	Discuss the common causes of infertility in a couple and role of IVF in managing a case of infertility	Y	77	717
PY10.1	Describe and discuss the organization of nervous system	Y	78	721
PY10.2	Describe and discuss the functions and properties of synapse, reflex, receptors	Y	79 80 81	731 747 761

Number	Competency: The student should be able to	Core(Y/N)	Chapter Number	Page Number
PY10.3	Describe and discuss somatic sensations and sensory tracts	Y	80	747
			81	761
			82	770
PY10.4	Describe and discuss motor tracts, mechanism of maintenance of tone, control of body movements, posture and equilibrium and vestibular apparatus	Y	84	798
			89	838
			90	845
PY10.5	Describe and discuss structure and functions of reticular activating system, autonomic nervous system (ANS)	Y	88	835
			94	863
PY10.6	Describe and discuss spinal cord, its functions, lesion and sensory disturbances	Y	85	810
PY10.7	Describe and discuss functions of cerebral cortex, basal ganglia, thalamus, hypothalamus, cerebellum and limbic system and their abnormalities	Y	83	794
			86	815
			87	825
			91	849
			92	855
			93	860
PY10.8	Describe and discuss behavioral and EEG characteristics during sleep and mechanism responsible for its production	Y	95	873
PY10.9	Describe and discuss the physiological basis of memory, learning and speech	Y	96	882
PY10.13	Describe and discuss perception of smell and taste sensation	Y	100	965
			101	969
PY10.14	Describe and discuss patho-physiology of altered smell and taste sensation	Y	100	965, 968
			101	973
PY10.15	Describe and discuss functional anatomy of ear and auditory pathways and physiology of hearing	Y	99	943
PY10.16	Describe and discuss pathophysiology of deafness. Describe hearing tests	Y	99	957
PY10.17	Describe and discuss functional anatomy of eye, physiology of image formation, physiology of vision including color vision, refractive errors, color blindness, physiology of pupil and light reflex	Y	98	901
PY10.18	Describe and discuss the physiological basis of lesion in visual pathway	Y	98	930
PY10.19	Describe and discuss auditory and visual evoke potentials	Y	99	960
PY11.1	Describe and discuss mechanism of temperature regulation	Y	59	534
PY11.2	Describe and discuss adaptation to altered temperature (heat and cold)	Y	59	540
PY11.3	Describe and discuss mechanism of fever, cold injuries and heat stroke	Y	59	540
PY11.4	Describe and discuss cardio-respiratory and metabolic adjustments during exercise; physical training effects	Y	30	285
			41	395
			102	977
PY11.5	Describe and discuss physiological consequences of sedentary lifestyle	Y	102	977
PY11.6	Describe physiology of infancy	N	102	977
PY11.7	Describe and discuss physiology of aging; free radicals and antioxidants	N	102	977
PY11.8	Discuss and compare cardio-respiratory changes in exercise (isometric and isotonic) with that in the resting state and under different environmental conditions (heat and cold)	Y	102	977
PY11.11	Discuss the concept, criteria for diagnosis of brain death and its implications	Y	102	977
PY11.12	Discuss the physiological effects of meditation	N	95	878
PY11.14	Demonstrate basic life support in a simulated environment	Y	42	399