

CONTENTS

I. BLOOD 15

I.1. Haematocrit	15
I.2. Blood Functions	16
I.3. Blood Volume	17
<i>I.3.1. Physiological Variations of the Blood Volume</i>	18
<i>I.3.2. Pathological Variations of the Blood Volume</i>	19
<i>I.3.3. Blood Volume Regulation</i>	19
<i>I.3.3.1. Plasma Volume Regulation</i>	19
I.3.3.1.1. Nervous Control.....	19
I.3.3.1.2. Humoral Control.....	21
<i>I.3.3.2. Globular Volume Regulation</i>	22
I.4. Physical and Chemical Properties of the Blood	23
<i>I.4.1. Blood Density</i>	23
<i>I.4.2. Blood Viscosity</i>	24
<i>I.4.3. Osmotic Pressure</i>	25
<i>I.4.4. Colloid Osmotic Pressure (Oncotic Pressure)</i>	26
<i>I.4.5. Blood pH</i>	27
<i>I.4.5.1. Physical and Chemical Mechanisms</i>	27
<i>I.4.5.2. Biological Mechanisms</i>	31
<i>I.4.5.3. Physiological Modifications of Blood pH</i>	32
<i>I.4.5.4. Pathological Modifications of Blood pH</i>	32
I.5. Plasma Proteins	34
<i>I.5.1. Plasma Proteins Types</i>	34
<i>I.5.2. Plasma Protein Regulation</i>	37
<i>I.5.3. Acute-phase Proteins</i>	38
I.6. Plasma Composition	40
I.7. Erythrocytes	41
<i>I.7.1. Erythrocyte Structure</i>	41

I.7.2. Haemoglobin (Hb)	42
I.7.2.1. Haemoglobin Structure	42
I.7.2.2. Pathological Haemoglobin	44
I.7.2.3. Catabolism of Haemoglobin	44
I.7.2.4. Reactions of Haemoglobin	45
I.7.3. Properties of the Erythrocytes	46
I.7.4. Erythropoiesis	47
I.7.4.1. Factors Necessary for Erythropoiesis	47
I.7.4.2. Reticulocytes	49
I.7.5. Iron Metabolism	50
I.7.6. Blood Groups	52
I.7.6.1. Agglutinogenes	52
I.7.6.2. Agglutinins	53
I.7.7. Rh Blood Types	54
I.8. Leukocytes (White Blood Cells)	57
I.8.1. General Characteristics of Leukocytes	58
I.8.2. Genesis of the Leukocytes	59
I.8.3. Life Span of the Leukocytes	59
I.8.4. Properties of Neutrophils, Monocytes, and Macrophages	61
I.8.4.1. Diapedesis	61
I.8.4.2. Chemotaxis	62
I.8.4.3. Margination	63
I.8.4.4. Phagocytosis	64
I.8.5. Defence Mechanisms	67
I.8.5.1. Nonspecific Immunity	67
I.8.5.2. Specific Immunity	69
I.8.5.2.1. Antigens	69
I.8.5.2.2. Lymphocytes Types	70
I.8.5.2.3. B -Lymphocytes	71
I.8.5.2.4. Antibodies	72
I.8.5.2.5. Complement System	74
I.8.5.2.6. T -Lymphocytes	76
I.8.5.2.7. The Antigen-Antibody Reaction	83
I.9. Platelets	85

I.10. Haemostasis	87
<i>I.10.1. Vasoconstriction</i>	87
<i>I.10.2. Formation of a Platelet Plug</i>	87
<i>I.10.2.1. Adhesion</i>	87
<i>I.10.2.2. Aggregation</i>	88
<i>I.10.2.3. Activation (platelets viscous metamorphosis)</i>	89
<i>I.10.3. Blood Coagulation (Clotting)</i>	92
<i>I.10.3.1. Intrinsic Pathway</i>	93
<i>I.10.3.2. Extrinsic Pathway</i>	93
<i>I.10.3.3. Common Pathway</i>	94
<i>I.10.3.4. Coagulant Factors</i>	95
<i>I.10.3.5. Anticoagulants</i>	96
<i>I.10.3.6. Thrombus (Clot)</i>	97
I.11. Fibrinolysis	98
<i>I.11.1. Plasminogen</i>	98
<i>I.11.2. Plasmin</i>	99
<i>I.11.3. Fibrinolysis Activation</i>	100
<i>I.11.3.1. Local Activation of Fibrinolysis</i>	100
<i>I.11.3.2. General Activation of Fibrinolysis</i>	100

II. HEART 103

II.1. Contractile Cells	104
<i>II.1.1. Contractile Cell Structure</i>	104
<i>II.1.2. Action Potential in Contractile Cardiac Muscle Cells</i>	106
II.2. Autorhythmic Cells	109
<i>II.2.1. Excitatory System</i>	109
<i>II.2.1.1. Sinoatrial Node (Keith-Flack)</i>	110
<i>II.2.1.2. Internodal Atrial Pathways</i>	110
<i>II.2.1.3. Anterior Interatrial Band (Bachmann's Bundle)</i>	111
<i>II.2.1.4. Atrioventricular Node (Aschoff-Tawara)</i>	111
<i>II.2.1.5. Bundle of His</i>	112
<i>II.2.1.6. Purkinje System</i>	112

II.2.2. Electrical Activity of the Heart	113
II.2.3. Spread of Cardiac Excitation	115
II.2.3.1. Atrial Depolarization	115
II.2.3.2. Ventricular Depolarization	116
II.2.4. Cardiac Muscle Refractory Period	117
II.3. Electrocardiogram (ECG)	118
II.4. Cardiac Cycle	125
II.4.1. Atria Systole	127
II.4.2. Ventricle Systole	129
II.4.2.1. Isovolumetric Contraction	129
II.4.2.2. Rapid Ventricular Ejection	129
II.4.2.3. Decreased Ventricular Ejection	130
II.4.2.4. Protodiastole	130
II.4.3. Ventricular Diastole	130
II.4.3.1. Isovolumetric Relaxation	131
II.4.3.2. Rapid Ventricular Filling	131
II.4.3.3. Decreased Ventricular Filling (Diastasis)	131
II.4.3.4. Atria Systole	131
II.5. Heart Sounds	132
II.5.1. Physiological Heart Sounds	132
II.5.1.1. First Heart Sound	132
II.5.1.2. Second Heart Sound	132
II.5.1.3. Third Heart Sound	133
II.5.2. Pathological Heart Sounds	133
II.5.2.1. Fourth Heart Sound	133
II.5.2.2. Cardiac Murmurs	133
II.6. Apex Beat	134
II.7. Cardiac Rate	135
II.8. Regulation of Heart Function	136
II.8.1. Receptors	136
II.8.1.1. Heart Receptors	136
II.8.1.2. Vessel Receptors	137

II.8.2. Heart Afferent (Sensory) Nerves	138
<i>II.8.2.1. Sympathetic Afferent Neurons</i>	138
<i>II.8.2.2. Parasympathetic Afferent Neurons</i>	139
II.8.3. Coordinating Centres	139
II.8.4. Heart Efferent Nerves	141
<i>II.8.4.1. Sympathetic Efferent Fibres (Cardioacceleratory Nerves)</i>	141
<i>II.8.4.2. Parasympathetic Efferent Fibres (Cardioinhibitory Nerves)</i> .	142
II.8.5. Reflex Areas in Heart Activity	143
<i>II.8.5.1. Carotid Sinus Reflex</i>	143
II.8.5.1.1. Baroreceptors	143
II.8.5.1.2. Chemoreceptors	144
<i>II.8.5.2. Aortic Arch Reflex</i>	145
<i>II.8.5.3. Atrial Reflex</i>	145
<i>II.8.5.4. Coronary Reflex (Coronary Chemoreflex Bezold-Jarich)</i> ...	146
<i>II.8.5.5. Trigemino-cardiac Reflex</i>	146
II.8.6. Mechanisms Involved in Heart Activity Regulation	147
<i>II.8.6.1. Intrinsic Mechanisms</i>	147
<i>II.8.6.2. Extrinsic Mechanisms</i>	147
II.8.6.2.1. Nervous Mechanism	147
II.8.6.2.2. Humoral Mechanism	148
II.9. Cardiac Output Physiological Modifications	148
II.10. Long-term Effort Adaptation of the Heart	149
II.11. Heart Nutrition	150
II.12. Cardiac Metabolism	150

III. CIRCULATORY SYSTEM 151

III.1. Blood Pressure	152
III.1.1. Factors that Influence the Blood Pressure	153
<i>III.1.1.1. Heart</i>	153
<i>III.1.1.2. Resistance Vessels</i>	153
<i>III.1.1.3. Blood</i>	154
III.1.2. Centres of Blood Pressure Regulation	155

III.1.3. Flow of Blood in Vessels	155
<i>III.1.3.1. Laminar Blood Flow</i>	155
<i>III.1.3.2. Turbulent Blood Flow</i>	156
<i>III.1.3.3. Blood Circulation Time</i>	156
<i>III.1.3.4. Changes in Blood Flow</i>	156
III.2. Arteries	157
III.2.1. Artery Wall	157
III.2.2. Arterial Pressure	158
III.2.3. Arterial Pulse	160
III.3. Arterioles	163
III.3.1. Arteriolar Wall	164
<i>III.3.1.1. Arteriolar Wall Structure</i>	164
<i>III.3.1.2. Arteriolar Tone</i>	164
III.3.2. Arteriolar Contractile Activity	165
<i>III.3.2.1. Local (Intrinsic) Control of Arteriolar Diameter</i>	165
III.3.2.1.1. Local Chemical Influences	166
III.3.2.1.2. Local Physical Influences	170
III.3.2.1.3. Reactive Hyperaemia	170
III.3.2.1.4. Pressure Autoregulation	171
<i>III.3.2.2. Extrinsic Control of Arteriolar Diameter</i>	172
III.3.2.2.1. Neural Influences	172
III.3.2.2.2. Hormonal Influences	174
III.4. Microcirculation	178
III.5. Capillaries	180
III.5.1. Capillaries Walls	180
III.5.2. Capillary Permeability	182
<i>III.5.2.1. Water and Small Molecules</i>	183
<i>III.5.2.2. Macromolecules</i>	185
<i>III.5.2.3. Substances that Modify the Capillary Permeability</i>	185
III.5.3. Flow of Blood in the Capillaries (Vasomotion)	186
III.5.4. Mechanisms of Blood Flow Control	186
<i>III.5.4.1. Acute Metabolic Control</i>	186
<i>III.5.4.2. Long-term Control of Blood Flow</i>	188
<i>III.5.4.3. Control of Circulation</i>	190

III.6. Lymphatic System	191
III.6.1. Lymph	191
III.6.2. Lymphatic Vessels	192
III.6.2.1. Initial Lymphatics	192
III.6.2.2. Collecting Lymphatics	193
III.6.3. Functions of the Lymphatic System	194
III.7. Veins	196
III.7.1. Veins Structure	196
III.7.2. Veins Properties	196
III.7.3. Veins Roles	197
III.7.4. Venous Return	197
III.7.5. Venous System Regulation	201
III.7.5.1. Nervous Regulation	201
III.7.5.2. Humoral Regulation	202
III.7.6. Venous Pulse	202
III.7.7. Venous Pressure	203
References	204