Color Atlas of Physiology

Stefan Silbernagl Agamemnon Despopoulos

6th edition

basic science



Table of Contents

1 Fundamentals and Cell Physiology

Flow Properties of Blood ··· 92 Plasma, Ion Distribution ··· 92

	The Body: an Open System with an Internal Environment ··· 2 Control and Regulation ··· 4 The Cell ··· 8 Transport In, Through and Between Cells ··· 16 Passive Transport by Means of Diffusion ··· 20 Osmosis, Filtration and Convection ··· 24 Active Transport ··· 26 Cell Migration ··· 30 Electrical Membrane Potentials and Ion Channels ··· 32 Role of Ca²+ in Cell Regulation ··· 36 Energy Production and Metabolism ··· 38	
2	Nerve and Muscle, Physical Work	42
	Neuron Structure and Function ··· 42 Resting Membrane Potential ··· 44 Action Potential ··· 46 Propagation of Action Potentials in Nerve Fiber ··· 48 Artificial Stimulation of Nerve Cells ··· 50 Synaptic Transmission ··· 50 Motor End-plate ··· 56 Motility and Muscle Types ··· 58 Motor Unit of Skeletal Muscle ··· 58 Contractile Apparatus of Striated Muscle ··· 60 Contraction of Striated Muscle ··· 62 Mechanical Features of Skeletal Muscle ··· 66 Smooth Muscle ··· 70 Energy Supply for Muscle Contraction ··· 72 Physical Work ··· 74 Physical Fitness and Training ··· 76	
3	Autonomic Nervous System (ANS)	78
	Organization of the Autonomic Nervous System (ANS) ··· 78 Acetylcholines and Cholinergic Transmission ··· 82 Catecholamines, Adrenergic Transmission and Adrenoceptors ··· 84 Adrenal Medulla ··· 86 Non-cholinergic, Non-adrenergic Transmitters ··· 86	
4	Blood	88
	Composition and Function of Blood ··· 88 Iron Metabolism and Erythropoiesis ··· 90	

Table of Contents

5 Respiration

6

7

Immune System · · · 94

Blood Groups ··· 100 Hemostasis ··· 102

Hypersensitivity Reactions (Allergies) ... 100

Fibrinolysis and Thromboprotection · · · 104

	Lung Function, Respiration ··· 106 Mechanics of Breathing ··· 108 Purification of Respiratory Air ··· 110 Artificial Respiration ··· 110 Pneumothorax ··· 110 Lung Volumes and their Measurement ··· 112 Dead Space, Residual Volume, Airway Resistance ··· 114 Pressure–Volume Curve, Respiratory Work ··· 116 Surface Tension, Surfactant ··· 118 Dynamic Lung Function Tests ··· 118 Pulmonary Gas Exchange ··· 120 Pulmonary Blood Flow, Ventilation–Perfusion Ratio ··· 122 CO ₂ Transport in Blood ··· 124 CO ₂ Binding in Blood, CO ₂ in CSF ··· 126 CO ₂ in Cerebrospinal Fluid ··· 126 Binding and Transport of O ₂ in Blood ··· 128 Internal (Tissue) Respiration, Hypoxia ··· 130 Respiratory Control and Stimulation ··· 132 Effects of Diving on Respiration ··· 134 Effects of High Altitude on Respiration ··· 136 Oxygen Toxicity ··· 136	
F	pH, pH Buffers, Acid–Base Balance ··· 138	138
	Bicarbonate/Carbon Dioxide Buffer ··· 140 Acidosis and Alkalosis ··· 142 Assessment of Acid–Base Status ··· 146	
k	Gidneys, Salt, and Water Balance	148
	Kidney Structure and Function ··· 148 Renal Circulation ··· 150 Glomerular Filtration and Clearance ··· 152 Transport Processes at the Nephron ··· 154 Reabsorption of Organic Substances ··· 158 Excretion of Organic Substances ··· 160 Reabsorption of Na* and Cl- ··· 162 Reabsorption of Water, Formation of Concentrated Urine ··· 164 Body Fluid Homeostasis ··· 168 Salt and Water Regulation ··· 170 Diuresis and Diuretics ··· 174 The Kidney and Acid—Base Balance ··· 176	

106

	Reabsorption and Excretion of Phosphate, Ca ²⁺ and Mg ²⁺ ··· 180 Potassium Balance ··· 182 Tubuloglomerular Feedback, Renin–Angiotensin System ··· 186	
8	Cardiovascular System	188
	Overview ··· 188 Blood Vessels and Blood Flow ··· 190 Cardiac Cycle ··· 192 Cardiac Impulse Generation and Conduction ··· 194 Electrocardiogram (ECG) ··· 198 Excitation in Electrolyte Disturbances ··· 200 Cardiac Arrhythmias ··· 202 Ventricular Pressure–Volume Relationships ··· 204 Cardiac Work and Cardiac Power ··· 204 Regulation of Stroke Volume ··· 206 Venous Return ··· 206 Arterial Blood Pressure ··· 208 Endothelial Exchange Processes ··· 210 Myocardial Oxygen Supply ··· 212 Regulation of the Circulation ··· 214 Circulatory Shock ··· 220 Fetal and Neonatal Circulation ··· 222	
9	Thermal Balance and Thermoregulation	224
	Thermal Balance ··· 224 Thermoregulation ··· 226	
10	Nutrition and Digestion	228
	Nutrition ··· 228 Energy Metabolism and Calorimetry ··· 230 Energy Homeostasis and Body Weight ··· 232 Gastrointestinal (GI) Tract: Overview, Immune Defense, Blood Flow ··· 234 Neural and Hormonal Integration ··· 236 Saliva ··· 238 Deglutition ··· 240 Vomiting ··· 240 Stomach Structure and Motility ··· 242 Gastric Juice ··· 244 Small Intestinal Function ··· 246 Pancreas ··· 248 Bile ··· 250 Excretory Liver Function, Bilirubin ··· 252 Lipid Digestion ··· 254 Lipid Distribution and Storage ··· 256 Digestion and Absorption of Carbohydrates and Protein ··· 260 Vitamin Absorption ··· 262	

Water and Mineral Absorption ··· 264 Large Intestine, Defecation, Feces ··· 266

11 Hormones and Reproduction

Integrative Systems of the Body · · · 268

Hormones ··· 270

Humoral Signals: Control and Effects · · · 274

Cellular Transmission of Signals from Extracellular Messengers · · · 276

Hypothalamic–Pituitary System · · · 282

Carbohydrate Metabolism and Pancreatic Hormones · · · 284

Thyroid Hormones · · · 288

Calcium and Phosphate Metabolism · · · 292

Biosynthesis of Steroid Hormones · · · 296

Adrenal Cortex and Glucocorticoid Synthesis · · · 298

Oogenesis and the Menstrual Cycle ... 300

Hormonal Control of the Menstrual Cycle · · · 302

Estrogens, Progesterone · · · 304

Progesterone, Prolactin, Oxytocin ... 305

Hormonal Control of Pregnancy and Birth ... 306

Androgens and Testicular Function ... 308

Sexual Response, Intercourse and Fertilization ... 310

12 Central Nervous System and Senses

Central Nervous System · · · 312

Cerebrospinal Fluid ... 312

Stimulus Reception and Processing · · · 314

Sensory Functions of the Skin ... 316

Proprioception, Stretch Reflex ... 318

Nociception and Pain ··· 320

Polysynaptic Reflexes ... 322

Synaptic Inhibition ... 322

Central Conduction of Sensory Input ... 324

Movement ··· 326

Hypothalamus, Limbic System ... 332

Cerebral Cortex, Electroencephalogram (EEG) ··· 334

Circadian Rhythms, Sleep-Wake Cycle ... 336

Consciousness, Sleep ··· 338

Learning, Memory, Language ... 340

Glia ... 344

Sense of Taste · · · 344

Sense of Smell ... 346

Sense of Balance · · · 348

Eye Structure, Tear Fluid, Aqueous Humor ... 350

Optical Apparatus of the Eye ... 352

Visual Acuity, Photosensors · · · 354

Adaptation of the Eye to Different Light Intensities ... 358

Retinal Processing of Visual Stimuli · · · 360

Color Vision ··· 362

Visual Field, Visual Pathway, Central Processing of Visual Stimuli ... 364

Eye Movements, Stereoscopic Vision, Depth Perception · · · 366

Physical Principles of Sound—Sound Stimulus and Perception ... 368

Conduction of Sound, Sound Sensors ... 370

312

Central Processing of Acoustic Information ··· **374**Voice and Speech ··· **376**

13 Appendix

378

Dimensions and Units ··· 378

Powers and Logarithms ··· 386

Logarithms, Graphic Representation of Data ··· 387

Reference Values in Physiology ··· 390

Important Equations in Physiology ··· 394

Further Reading

397

Index

399