



# Contents

<i>Preface</i> .....	vii
<i>Acknowledgments</i> .....	ix

## 1 The Cell 1

<i>GRAPHIC 1-1</i> The Cell .....	6
1-2 The Organelles .....	7
1-3 Membranes and Membrane Trafficking .....	8
1-4 Protein Synthesis and Exocytosis .....	9
<i>PLATE 1-1</i> Typical Cell .....	10
1-2 Cell Organelles and Inclusions .....	12
1-3 Cell Surface Modifications .....	14
1-4 Mitosis, Light and Electron Microscopy .....	16
1-5 Typical Cell, Electron Microscopy .....	18
1-6 Nucleus and Cytoplasm, Electron Microscopy .....	20
1-7 Nucleus and Cytoplasm, Electron Microscopy .....	22
1-8 Golgi Apparatus, Electron Microscopy .....	23
1-9 Mitochondria, Electron Microscopy .....	24

## 2 Epithelium and Glands 25

<i>GRAPHIC 2-1</i> Junctional Complex .....	30
2-2 Salivary Gland .....	31
<i>PLATE 2-1</i> Simple Epithelia and Pseudostratified Epithelium .....	32
2-2 Stratified Epithelia and Transitional Epithelium .....	34
2-3 Pseudostratified Ciliated Columnar Epithelium, Electron Microscopy .....	36
2-4 Epithelial Junctions, Electron Microscopy .....	38
2-5 Glands .....	40
2-6 Glands .....	42

## 3 Connective Tissue 45

<i>GRAPHIC 3-1</i> Collagen .....	52
3-2 Connective Tissue Cells .....	53
<i>PLATE 3-1</i> Embryonic and Connective Tissue Proper I .....	54
3-2 Connective Tissue Proper II .....	56
3-3 Connective Tissue Proper III .....	58

3-4	Fibroblasts and Collagen, Electron Microscopy .....	60
3-5	Mast Cell, Electron Microscopy .....	61
3-6	Mast Cell Degranulation, Electron Microscopy .....	62
3-7	Developing Fat Cell, Electron Microscopy .....	63

## 4

### Cartilage and Bone

65

<i>GRAPHIC</i> 4-1	Compact Bone .....	72
4-2	Endochondral Bone Formation .....	73
<i>PLATE</i> 4-1	Embryonic and Hyaline Cartilages .....	74
4-2	Elastic and Fibrocartilages .....	76
4-3	Compact Bone .....	78
4-4	Compact Bone and Intramembranous Ossification .....	80
4-5	Endochondral Ossification .....	82
4-6	Endochondral Ossification .....	84
4-7	Hyaline Cartilage, Electron Microscopy .....	86
4-8	Osteoblasts, Electron Microscopy .....	87
4-9	Osteoclast, Electron Microscopy .....	88

## 5

### Blood and Hemopoiesis

89

<i>PLATE</i> 5-1	Circulating Blood .....	95
5-2	Circulating Blood .....	96
5-3	Blood and Hemopoiesis .....	97
5-4	Bone Marrow and Circulating Blood .....	98
5-5	Erythropoiesis .....	100
5-6	Granulocytopoiesis .....	101

## 6

### Muscle

103

<i>GRAPHIC</i> 6-1	Molecular Structure of Skeletal Muscle .....	108
6-2	Types of Muscle .....	109
<i>PLATE</i> 6-1	Skeletal Muscle .....	110
6-2	Skeletal Muscle, Electron Microscopy .....	112
6-3	Myoneural Junction, Light and Electron Microscopy .....	114
6-4	Myoneural Junction, Scanning Electron Microscopy .....	116
6-5	Muscle Spindle, Light and Electron Microscopy .....	117
6-6	Smooth Muscle .....	118
6-7	Smooth Muscle, Electron Microscopy .....	120
6-8	Cardiac Muscle .....	122
6-9	Cardiac Muscle, Electron Microscopy .....	124

## 7

### Nervous Tissue

125

<i>GRAPHIC</i> 7-1	Spinal Nerve Morphology .....	132
7-2	Neurons and Myoneural Junction .....	133
<i>PLATE</i> 7-1	Spinal Cord .....	134
7-2	Cerebellum, Synapse, Electron Microscopy .....	136
7-3	Cerebrum, Neuroglial Cells .....	138
7-4	Sympathetic Ganglia, Sensory Ganglia .....	140

7-5	Peripheral Nerve, Choroid Plexus .....	142
7-6	Peripheral Nerve, Electron Microscopy .....	144
7-7	Neuron Cell Body, Electron Microscopy .....	146

## **8** Circulatory System **147**

<i>GRAPHIC</i> 8-1	Artery and Vein .....	154
8-2	Capillary Types .....	155
<i>PLATE</i> 8-1	Elastic Artery .....	156
8-2	Muscular Artery, Vein .....	158
8-3	Arterioles, Venules, Capillaries, Lymph Vessels .....	160
8-4	Heart .....	162
8-5	Capillary, Electron Microscopy .....	164
8-6	Freeze Etch, Fenestrated Capillary, Electron Microscopy .....	165

## **9** Lymphoid Tissue **167**

<i>GRAPHIC</i> 9-1	Lymphoid Tissues .....	175
9-2	Lymph Node, Thymus, and Spleen .....	176
9-3	B Memory and Plasma Cell Formation .....	177
9-4	Cytotoxic T Cell Activation and Killing of Virally Transformed Cells .....	178
9-5	Macrophage Activation by T <sub>H</sub> 1 Cells .....	179
<i>PLATE</i> 9-1	Lymphatic Infiltration, Lymphatic Nodule .....	180
9-2	Lymph Node .....	182
9-3	Lymph Node, Tonsils .....	184
9-4	Lymph Node, Electron Microscopy .....	186
9-5	Thymus .....	188
9-6	Spleen .....	190

## **10** Endocrine System **193**

<i>GRAPHIC</i> 10-1	Pituitary Gland and Its Hormones .....	201
10-2	Endocrine Glands .....	202
10-3	Sympathetic Innervation of the Viscera and the Medulla of the Suprarenal Gland .....	203
<i>PLATE</i> 10-1	Pituitary Gland .....	204
10-2	Pituitary Gland .....	206
10-3	Thyroid Gland, Parathyroid Gland .....	208
10-4	Suprarenal Gland .....	210
10-5	Suprarenal Gland, Pineal Body .....	212
10-6	Pituitary Gland, Electron Microscopy .....	214
10-7	Pituitary Gland, Electron Microscopy .....	215

## **11** Integument **217**

<i>GRAPHIC</i> 11-1	Skin and Its Derivatives .....	224
11-2	Hair, Sweat Glands, Sebaceous Glands .....	225
<i>PLATE</i> 11-1	Thick Skin .....	226
11-2	Thin Skin .....	228

11-3	Hair Follicles and Associated Structures, Sweat Glands	230
11-4	Nail, Pacinian and Meissner's Corpuscles	232
11-5	Sweat Gland, Electron Microscopy	234

## **12** Respiratory System **235**

<i>GRAPHIC</i> 12-1	Conducting Portion of the Respiratory System	242
12-2	Respiratory Portion of the Respiratory System	243
<i>PLATE</i> 12-1	Olfactory Mucosa, Larynx	244
12-2	Trachea	246
12-3	Respiratory Epithelium and Cilia, Electron Microscopy	248
12-4	Bronchi, Bronchioles	250
12-5	Lung Tissue	252
12-6	Blood-Air Barrier, Electron Microscopy	254

## **13** Digestive System I—Oral Region **255**

<i>GRAPHIC</i> 13-1	Tooth and Tooth Development	260
13-2	Tongue and Taste Bud	261
<i>PLATE</i> 13-1	Lip	262
13-2	Tooth and Pulp	264
13-3	Periodontal Ligament and Gingiva	266
13-4	Tooth Development	268
13-5	Tongue	270
13-6	Tongue and Palate	272
13-7	Teeth and Nasal Aspect of the Hard Palate	274

## **14** Digestive System II—Alimentary Canal **277**

<i>GRAPHIC</i> 14-1	Stomach and Small Intestine	285
14-2	Large Intestine	286
<i>PLATE</i> 14-1	Esophagus	288
14-2	Stomach	290
14-3	Stomach	292
14-4	Duodenum	294
14-5	Jejunum, Ileum	296
14-6	Colon, Appendix	298
14-7	Colon, Electron Microscopy	300
14-8	Colon, Scanning Electron Microscopy	301

## **15** Digestive System III—Digestive Glands **303**

<i>GRAPHIC</i> 15-1	Pancreas	308
15-2	Liver	309
<i>PLATE</i> 15-1	Salivary Glands	310
15-2	Pancreas	312
15-3	Liver	314
15-4	Liver, Gallbladder	316
15-5	Salivary Gland, Electron Microscopy	318
15-6	Liver, Electron Microscopy	320
15-7	Islet of Langerhans, Electron Microscopy	321

## **16 Urinary System 323**

<i>GRAPHIC</i> 16-1	Urineriferous Tubules .....	330
16-2	Renal Corpuscle .....	331
<i>PLATE</i> 16-1	Kidney, Survey and General Morphology .....	332
16-2	Renal Cortex .....	334
16-3	Glomerulus, Scanning Electron Microscopy .....	336
16-4	Renal Corpuscle, Electron Microscopy .....	337
16-5	Renal Medulla .....	338
16-6	Ureter and Urinary Bladder .....	340

## **17 Female Reproductive System 343**

<i>GRAPHIC</i> 17-1	Female Reproductive System .....	350
17-2	Placenta and Hormonal Cycle .....	351
<i>PLATE</i> 17-1	Ovary .....	352
17-2	Ovary and Corpus Luteum .....	354
17-3	Ovary and Oviduct .....	356
17-4	Oviduct, Light and Electron Microscopy .....	358
17-5	Uterus .....	360
17-6	Uterus .....	362
17-7	Placenta and Vagina .....	364
17-8	Mammary Gland .....	366

## **18 Male Reproductive System 369**

<i>GRAPHIC</i> 18-1	Male Reproductive System .....	376
18-2	Spermiogenesis .....	377
<i>PLATE</i> 18-1	Testis .....	378
18-2	Testis and Epididymis .....	380
18-3	Epididymis, Ductus Deferens, and Seminal Vesicle .....	382
18-4	Prostate, Penis, and Urethra .....	384
18-5	Epididymis, Electron Microscopy .....	386

## **19 Special Senses 387**

<i>GRAPHIC</i> 19-1	Eye .....	394
19-2	Ear .....	395
<i>PLATE</i> 19-1	Eye, Cornea, Sclera, Iris, and Ciliary Body .....	396
19-2	Retina, Light and Scanning Electron Microscopy .....	398
19-3	Fovea, Lens, Eyelid, and Lacrimal Glands .....	400
19-4	Inner Ear .....	402
19-5	Cochlea .....	404
19-6	Spiral Organ of Corti .....	406

## **Index 409**