

|               |          |   |           |
|---------------|----------|---|-----------|
| INTRODUCTION  | <b>1</b> | <b>Laboratory Safety 1</b>                            |           |
|               |          | Lab Report Laboratory Safety                          | 7         |
| ANATOMY       | <b>2</b> | <b>Introduction to the Human Body</b>                 | <b>9</b>  |
|               | 1        | Organization of the Body                              | 10        |
|               | 2        | Anatomical Position and Directional Terminology       | 12        |
|               | 3        | Regional Terminology                                  | 14        |
|               | 4        | Planes and Sections                                   | 16        |
|               | 5        | Body Cavities   | 18        |
|               |          | Lab Report Introduction to the Human Body             | 23        |
| ORGAN SYSTEMS | <b>3</b> | <b>Organ Systems Overview</b>                         | <b>27</b> |
|               | 1        | Introduction to Organ Systems                         | 27        |
|               | 2        | Gross Anatomy of the Cat                              | 30        |
|               |          | Lab Report Organ Systems Overview                     | 35        |
| MICROSCOPY    | <b>4</b> | <b>Use of the Microscope</b>                          | <b>37</b> |
|               | 1        | Parts and Care of the Compound Microscope             | 37        |
|               | 2        | Using the Microscope                                  | 40        |
|               | 3        | Depth of Field Observation                            | 43        |
|               | 4        | Relationship Between Magnification and Field Diameter | 44        |
|               | 5        | Using the Oil-Immersion Objective Lens                | 46        |
|               |          | Lab Report Use of the Microscope                      | 47        |
| EXERCISE      | <b>5</b> | <b>Anatomy of the Cell and Cell Division</b>          | <b>49</b> |
|               | 1        | Anatomy of the Cell                                   | 50        |
|               | 2        | Cell Division   | 54        |
|               |          | Lab Report Anatomy of the Cell and Cell Division      | 59        |
| EXERCISE      | <b>6</b> | <b>Movement Across Cell Membranes</b>                 | <b>63</b> |
|               | 1        | Brownian Movement                                     | 64        |
|               | 2        | Diffusion of a Liquid                                 | 65        |
|               | 3        | Diffusion of a Solid in a Gel                         | 66        |
|               | 4        | Osmosis   | 67        |
|               | 5        | Concentration Gradients and Osmotic Rate              | 70        |
|               | 6        | Observation of Osmosis in Cells                       | 71        |
|               | 7        | Active Transport Processes                            | 72        |
|               |          | Lab Report Movement Across Cell Membranes             | 75        |

|          |   |           |
|----------|---|-----------|
| <b>7</b> | <b>Epithelial Tissue</b>                    | <b>79</b> |
| 1        | Simple Epithelia                            | 81        |
| 2        | Stratified Epithelia                        | 84        |
| 3        | Pseudostratified and Transitional Epithelia | 87        |
|          | Lab Report Epithelial Tissue                | 89        |

|          |                              |           |
|----------|------------------------------|-----------|
| <b>8</b> | <b>Connective Tissue</b>     | <b>93</b> |
| 1        | Embryonic Connective Tissue  | 94        |
| 2        | Connective Tissue Proper     | 95        |
| 3        | Fluid Connective Tissue      | 100       |
| 4        | Supportive Connective Tissue | 101       |
|          | Lab Report Connective Tissue | 105       |

|          |                          |            |
|----------|--------------------------|------------|
| <b>9</b> | <b>Muscle Tissue</b>     | <b>109</b> |
| 1        | Skeletal Muscle          | 109        |
| 2        | Cardiac Muscle           | 113        |
| 3        | Smooth Muscle            | 114        |
|          | Lab Report Muscle Tissue | 115        |

|           |                          |            |
|-----------|--------------------------|------------|
| <b>10</b> | <b>Neural Tissue</b>     | <b>117</b> |
| 1         | Neuron Structure         | 117        |
| 2         | Neuroglia                | 120        |
|           | Lab Report Neural Tissue | 121        |

|           |                                     |            |
|-----------|-------------------------------------|------------|
| <b>11</b> | <b>The Integumentary System</b>     | <b>123</b> |
| 1         | Epidermis and Dermis                | 123        |
| 2         | Accessory Structures of the Skin    | 127        |
|           | Lab Report The Integumentary System | 131        |

|           |                           |            |
|-----------|---------------------------|------------|
| <b>12</b> | <b>Body Membranes</b>     | <b>133</b> |
| 1         | Mucous Membranes          | 133        |
| 2         | Serous Membranes          | 137        |
| 3         | Cutaneous Membrane        | 138        |
| 4         | Synovial Membranes        | 139        |
|           | Lab Report Body Membranes | 141        |

|           |  |            |
|-----------|--|------------|
| <b>13</b> | <b>Organization of the Skeletal System</b>     | <b>143</b> |
| 1         | Bone Structure                                 | 143        |
| 2         | Histological Organization of Bone              | 145        |
| 3         | The Skeleton                                   | 148        |
| 4         | Bone Classification and Bone Markings          | 148        |
|           | Lab Report Organization of the Skeletal System | 153        |

## **14    The Axial Skeleton    157**

- 1    Cranial Bones    157
  - 2    Facial Bones    169
  - 3    Hyoid Bone    174
  - 4    Paranasal Sinuses of the Skull    174
  - 5    Fetal Skull    176
  - 6    Vertebral Column    177
  - 7    Thoracic Cage    184
- Lab Report    The Axial Skeleton    187

## **15    The Appendicular Skeleton    191**

- 1    Pectoral Girdle    191
  - 2    Upper Limb    194
  - 3    Pelvic Girdle    199
  - 4    Lower Limb    202
- Lab Report    The Appendicular Skeleton    207

## **16    Articulations    211**

- 1    Joint Classification    211
  - 2    Structure of Synovial Joints    215
  - 3    Types of Diarthroses    216
  - 4    Skeletal Movement at Diarthrotic Joints    218
  - 5    Selected Synovial Joints: Elbow and Knee Joints    224
- Lab Report    Articulations    227

## **17    Organization of Skeletal Muscles    231**

- 1    Skeletal Muscle Organization    231
  - 2    The Neuromuscular Junction    237
  - 3    Naming Muscles    239
- Lab Report    Organization of Skeletal Muscles    241

## **18    Muscles of the Head and Neck    245**

- 1    Muscles of Facial Expression    246
  - 2    Muscles of the Eye    250
  - 3    Muscles of Mastication    251
  - 4    Muscles of the Tongue and Pharynx    253
  - 5    Muscles of the Anterior Neck    255
- Lab Report    Muscles of the Head and Neck    257

## **19    Muscles of the Vertebral Column, Abdomen, and Pelvis    261**

- 1    Muscles of the Vertebral Column    261
  - 2    Oblique and Rectus Muscles    265
  - 3    Muscles of the Pelvic Region    270
- Lab Report    Muscles of the Vertebral Column, Abdomen, and Pelvis    273



## 20 Muscles of the Pectoral Girdle and Upper Limb 275

- 1 Muscles That Move the Pectoral Girdle 275
  - 2 Muscles That Move the Arm 279
  - 3 Muscles That Move the Forearm 281
  - 4 Muscles That Move the Wrist and Hand 286
- Lab Report Muscles of the Pectoral Girdle and Upper Limb 291


## 21 Muscles of the Pelvic Girdle and Lower Limb 295

- 1 Muscles That Move the Thigh 295
  - 2 Muscles That Move the Leg 299
  - 3 Muscles That Move the Ankle and Foot 302
- Lab Report Muscles of the Pelvic Girdle and Lower Limb 309

## 22 Muscle Physiology 313

- 1 Biochemical Nature of Muscle Contraction 314
  - 2 Types of Muscle Contraction 317
  - 3 Isometric and Isotonic Contractions 320
  - 4 Muscles as Lever Systems 322
  - 5 BIOPAC: Electromyography—Standard and Integrated EMG Activity 324
  - 6 BIOPAC: Electromyography—Motor Recruitment and Fatigue 329
- Lab Report Muscle Physiology 335
-  Lab Report BIOPAC: Electromyography—Standard and Integrated EMG Activity 337
-  Lab Report BIOPAC: Electromyography—Motor Recruitment and Fatigue 339

## 23 Organization of the Nervous System 341

- 1 Histology of the Nervous System 343
  - 2 Anatomy of a Nerve 346
  - 3 BIOPAC: Reaction Time and Learning 348
- Lab Report Organization of the Nervous System 355
-  Lab Report BIOPAC: Reaction Time and Learning 357

## 24 The Spinal Cord, Spinal Nerves, and Reflexes 361

- 1 Gross Anatomy of the Spinal Cord 361
  - 2 Spinal Meninges 365
  - 3 Spinal and Peripheral Nerves 367
  - 4 Spinal Reflexes 370
  - 5 Dissection of the Spinal Cord 373
- Lab Report The Spinal Cord, Spinal Nerves, and Reflexes 375

## 25 Anatomy of the Brain 377

- 1 Cranial Meninges and Ventricles of the Brain 378
- 2 Regions of the Brain 382

- 3 Cranial Nerves 389
- 4 Sheep Brain Dissection 395
- Lab Report Anatomy of the Brain 399

## 26 Autonomic Nervous System 403

- 1 The Sympathetic (Thoracolumbar) Division 405
- 2 The Parasympathetic (Craniosacral) Division 410
- Lab Report Autonomic Nervous System 413

## 27 General Senses 415

- 1 General-Sense Receptors 416
- 2 Two-Point Discrimination Test 419
- 3 Distribution of Tactile Receptors 420
- 4 Distribution of Thermoreceptors 421
- 5 Receptor Adaptation 422
- 6 Referred Pain 423
- 7 Proprioception 424
- Lab Report General Senses 425


## 28 Special Senses: Olfaction and Gustation 427

- 1 Olfaction 427
- 2 Olfactory Adaptation 429
- 3 Gustation 430
- 4 Relationship between Olfaction and Gustation 434
- Lab Report Special Senses: Olfaction and Gustation 435

## 29 Anatomy of the Eye 437

- 1 External Anatomy of the Eye 437
- 2 Internal Anatomy of the Eye 440
- 3 Cellular Organization of the Retina 442
- 4 Observation of the Retina 445
- 5 Dissection of the Cow or Sheep Eye 447
- Lab Report Anatomy of the Eye 449

## 30 Physiology of the Eye 451

- 1 Visual Acuity 451
- 2 Astigmatism Test 452
- 3 Blind-Spot Mapping 453
- 4 Accommodation 454
- 5 BIOPAC: Electrooculogram 457
- Lab Report Physiology of the Eye 467
-  Lab Report BIOPAC: Physiology of the Eye: Electrooculogram 469

## 31 Anatomy of the Ear 473

- 1 External and Middle Ear 473
- 2 Inner Ear 476
- 3 Examination of the Tympanic Membrane 481
- Lab Report Anatomy of the Ear 483

## 32 Physiology of the Ear 485

- 1 Equilibrium 485
- 2 Nystagmus 488
- 3 Hearing 489
- Lab Report Physiology of the Ear 493

## 33 The Endocrine System 495

- 1 Pituitary Gland 496
- 2 Thyroid Gland 498
- 3 Parathyroid Glands 501
- 4 Thymus Gland 502
- 5 Suprarenal Glands 504
- 6 Pancreas 506
- 7 Testes and Ovaries 508
- Lab Report The Endocrine System 511

## 34 Blood 515




- 1 Composition of Whole Blood 515
- 2 ABO and Rh Blood Groups 521
- 3 Hematocrit (Packed Red Cell Volume) 525
- 4 Coagulation 527
- Lab Report Blood 529

## 35 Anatomy of the Heart 531

- 1 Heart Wall 531
- 2 External and Internal Anatomy of the Heart 534
- 3 Coronary Circulation 539
- 4 Conducting System of the Heart 541
- 5 Sheep Heart Dissection 542
- Lab Report Anatomy of the Heart 545

## 36 Anatomy of the Systemic Circulation 547

- 1 Comparison of Arteries, Capillaries, and Veins 547
- 2 Arteries of the Head, Neck, and Upper Limb 549
- 3 Arteries of the Abdominopelvic Cavity and Lower Limb 555
- 4 Veins of the Head, Neck, and Upper Limb 559
- 5 Veins of the Abdominopelvic Cavity and Lower Limb 562
- 6 Fetal Circulation 566
- Lab Report Anatomy of the Systemic Circulation 569

|           |   |            |
|-----------|---|------------|
| <b>37</b> | <b>Cardiovascular Physiology</b>  | <b>573</b> |
| 1         | Listening to Heart Sounds   | 574        |
| 2         | Determining Blood Pressure  | 576        |
| 3         | Measuring the Pulse   | 579        |
| 4         | BIOPAC: Electrocardiography   | 580        |
| 5         | BIOPAC: Electrocardiography and Blood Volume  | 590        |
|           | Lab Report Cardiovascular Physiology  | 597        |
|           |  Lab Report BIOPAC: Electrocardiography                  | 599        |
|           |  Lab Report BIOPAC: Electrocardiography and Blood Volume | 601        |
| <b>38</b> | <b>Lymphoid System</b>  | <b>603</b> |
| 1         | Lymphatic Vessels   | 604        |
| 2         | Lymphoid Tissues and Lymph Nodes  | 607        |
| 3         | The Spleen  | 609        |
|           | Lab Report Lymphoid System  | 611        |
| <b>39</b> | <b>Anatomy of the Respiratory System</b>  | <b>613</b> |
| 1         | Nose and Pharynx  | 613        |
| 2         | Larynx  | 616        |
| 3         | Trachea and Primary Bronchi   | 617        |
| 4         | Lungs and Bronchial Tree  | 619        |
|           | Lab Report Anatomy of the Respiratory System  | 625        |
| <b>40</b> | <b>Physiology of the Respiratory System</b>   | <b>627</b> |
| 1         | Lung Volumes and Capacities   | 629        |
| 2         | BIOPAC: Volumes and Capacities  | 634        |
|           | Lab Report Physiology of the Respiratory System   | 643        |
|           |  Lab Report BIOPAC: Volumes and Capacities             | 645        |
| <b>41</b> | <b>Anatomy of the Digestive System</b>  | <b>647</b> |
| 1         | Mouth   | 649        |
| 2         | Pharynx and Esophagus   | 653        |
| 3         | Stomach   | 654        |
| 4         | Small Intestine   | 657        |
| 5         | Large Intestine   | 660        |
| 6         | Liver and Gallbladder   | 663        |
| 7         | Pancreas  | 665        |
|           | Lab Report Anatomy of the Digestive System  | 667        |
| <b>42</b> | <b>Digestive Physiology</b>   | <b>671</b> |
| 1         | Digestion of Carbohydrate   | 673        |
| 2         | Digestion of Lipid  | 676        |

- 3 Digestion of Protein 677  
Lab Report Digestive Physiology 681

## 43 Anatomy of the Urinary System 683

- 1 Kidney 683  
2 Nephron 685  
3 Blood Supply to the Kidney 688  
4 Ureter, Urinary Bladder, and Urethra 690  
5 Sheep Kidney Dissection 693  
Lab Report Anatomy of the Urinary System 695

## 44 Physiology of the Urinary System 697

- 1 Physical Analysis of Urine 700  
2 Chemical Analysis of Urine 702  
3 Microscopic Examination of Urine 704  
Lab Report Physiology of the Urinary System 707

## 45 Anatomy of the Reproductive System 709

- 1 Male: Testes and Spermatogenesis 709  
2 Male: Epididymis and Ductus Deferens 713  
3 Male: Accessory Glands 714  
4 Male: Penis 716  
5 Female: Ovaries and Oogenesis 717  
6 Female: Uterine Tubes and Uterus 722  
7 Female: Vagina and Vulva 725  
8 Female: Mammary Glands 726  
Lab Report Anatomy of the Reproductive System 727

## 46 Development 731

- 1 First Trimester: Fertilization, Cleavage, and Blastocyst Formation 732  
2 First Trimester: Implantation and Gastrulation 734  
3 First Trimester: Extraembryonic Membranes and the Placenta 738  
4 Second and Third Trimesters and Birth 740  
Lab Report Development 743

## 47 Surface Anatomy 745

- 1 Head, Neck, and Trunk 745  
2 Shoulder and Upper Limb 750  
3 Pelvis and Lower Limb 752  
Lab Report Surface Anatomy 755

APPENDIX: Weights and Measures 757

PHOTO CREDITS 759

INDEX 761