

# Contents

*Preface* v

**Introduction** xi

- I. Radiological Physics xi
- II. Review Book Structure xii

## Part 1: Foundational Concepts

**1** Foundations of Radiological Physics 3

- I. Foundational Concepts 3
- II. X-Ray Production 6
- III. X-Ray and Gamma Ray Interactions 8
- IV. X-Ray Quantity and Quality 11

*Review Test* 15

*Answers and Explanations* 17

**2** X-Ray Imaging 19

- I. Scattered X-Rays 19
- II. Digital Detectors 23
- III. Digital Imaging 25
- IV. Image Theory and Informatics 27

*Review Test* 31

*Answers and Explanations* 33

**3** Foundations of Image Quality 35

- I. Contrast 35
- II. Noise 37
- III. Resolution 40
- IV. Diagnostic Performance 44

*Review Test* 47

*Answers and Explanations* 49

**4 Patient Dosimetry 51**

- I. Incident and Absorbed Radiation 51
- II. Patient Absorbed Doses 53
- III. Biological Doses 54
- IV. Effective Doses in Radiology 58

*Review Test 62*

*Answers and Explanations 64*

**5 Radiation Risks 65**

- I. Radiation Biology 65
- II. Deterministic Risks 67
- III. Carcinogenic Risks 69
- IV. Hereditary and Conceptus Risks 72

*Review Test 75*

*Answers and Explanations 77*

**6 Radiation Protection 79**

- I. Measuring Radiation 79
- II. Regulatory Limits 81
- III. Protecting Patients 83
- IV. Protecting Workers 86

*Review Test 90*

*Answers and Explanations 92*

## Part 2: X-Ray Imaging Modalities

**7 Radiography 95**

- I. X-Ray Tubes 95
- II. Radiographic Imaging 98
- III. Imaging Protocols 100
- IV. Image Quality and Dose 102

*Review Test 105*

*Answers and Explanations 107*

**8 Mammography 109**

- I. Digital Mammography I 109
- II. Digital Mammography II 112
- III. Mammography Adjuncts 114
- IV. Image Quality and Dose 117

*Review Test 119*

*Answers and Explanations 121*

**9 General Fluoroscopy 123**

- I. Imaging Chain 123
- II. Fluoroscopic Imaging 124
- III. Dose Factors 126
- IV. Image Quality and Dose 130

*Review Test 134*

*Answers and Explanations 136*

- 10** Interventional Radiology 139
- I. IR Imaging 139
  - II. IR Skin Doses 141
  - III. IR Patient and Operator Effective Doses 144
  - IV. IR Radiation Protection 147
- Review Test* 150  
*Answers and Explanations* 152

- 11** Computed Tomography I 155
- I. Imaging Chain 155
  - II. Theory 157
  - III. Images 159
  - IV. CT Output 162
- Review Test* 165  
*Answers and Explanations* 167

- 12** Computed Tomography II 169
- I. Clinical Imaging 169
  - II. Miscellaneous CT 172
  - III. Image Quality 174
  - IV. Dosimetry 176
- Review Test* 181  
*Answers and Explanations* 183

## Part 3: Advanced Modalities

- 13** Nuclear Medicine I 187
- I. Nuclei 187
  - II. Radiopharmaceuticals 190
  - III. Radiation Detectors 192
  - IV. Planar Imaging 194
- Review Test* 200  
*Answers and Explanations* 202

- 14** Nuclear Medicine II 205
- I. SPECT and SPECT/CT 205
  - II. Positron Emission Tomography/Computed Tomography I 208
  - III. Positron Emission Tomography/Computed Tomography II 211
  - IV. Dosimetry and Protection 213
- Review Test* 217  
*Answers and Explanations* 219

- 15** Magnetic Resonance I 221
- I. Magnetism and Resonance 221
  - II. Relaxation Times 224
  - III. Imaging 226
  - IV. Instrumentation 230
  - V. Spin Echo and Gradient-Recalled Echo 233
- Review Test* 237  
*Answers and Explanations* 239

**16** Magnetic Resonance II 241

- I. Signal Suppression and SWI 241
- II. Flow and Diffusion 244
- III. Advanced Magnetic Resonance 247
- IV. Image Quality 249
- V. Safety 251

Review Test 255  
 Answers and Explanations 257

**17** Ultrasound I 259

- I. Sound 259
- II. Interactions 261
- III. Transducer Elements 264
- IV. Transducer Arrays 266

Review Test 271  
 Answers and Explanations 273

**18** Ultrasound II 275

- I. Clinical Imaging 275
- II. Advanced Techniques 278
- III. Doppler 279
- IV. Image Quality and Safety 282

Review Test 286  
 Answers and Explanations 288

Examination Guide 289  
 Physics Equations 315  
 Glossary 317  
 Bibliography 329  
 Appendices 331  
 Index 333

**19** Mammography 109

- I. Digital Mammography I 109
- II. Digital Mammography II 110
- III. Mammography Computed Tomography I 111
- IV. Mammography Computed Tomography II 112

Review Test 119  
 Answers and Explanations 121

**20** General Fluoroscopy 123

- I. Imaging Chain 123
- II. Fluoroscopic Imaging 124
- III. Dose Factors 126
- IV. Image Quality and Dose 130

Review Test 134  
 Answers and Explanations 136

**21** Interventional Radiology 139

- I. IR Imaging 139
- II. IR Skin Doses 141
- III. IR Patient and Operator Effective Doses 144
- IV. IR Radiation Protection 147

Review Test 150  
 Answers and Explanations 152

**22** Computed Tomography I 155

- I. Imaging Chain 155
- II. Theory 157
- III. Images 159
- IV. CT Output 162

Review Test 165  
 Answers and Explanations 167

**23** Computed Tomography II 169

- I. Clinical Imaging 169
- II. Miscellaneous CT 172
- III. Image Quality 174
- IV. Dosimetry 176

Review Test 181  
 Answers and Explanations 183

**24** Nuclear Medicine I 187

- I. Nuclei 187
- II. Radiopharmaceuticals 190
- III. Radiation Detectors 192
- IV. Planar Imaging 194

Review Test 200  
 Answers and Explanations 202

**25** Nuclear Medicine II 205

- I. SPECT and SPECTCT 205
- II. Positron Emission Tomography/Computed Tomography I 208
- III. Positron Emission Tomography/Computed Tomography II 211
- IV. Dosimetry and Protection 213

Review Test 217  
 Answers and Explanations 219

**26** Magnetic Resonance I 221

- I. Magnetism and Resonance 221
- II. Relaxation Times 224
- III. Imaging 226
- IV. Instrumentation 230
- V. Spin Echo and Gradient-Recalled Echo 233

Review Test 237  
 Answers and Explanations 239