

Contents

Preface	vii		
1 Radiation physics		1	
1.1 Structure of the atom	1		
1.2 Electromagnetic radiation	3		
1.3 Production of X-rays	5		
1.4 The interaction of X- and gamma rays with matter	9		
1.5 Filtration	15		
1.6 Radiation dosimetry	16		
1.7 Luminescence	19		
1.8 Summary	20		
2 Radiation hazards and protection		23	
2.1 Ionizing radiation interactions with tissue	23		
2.2 Radiation doses and units	24		
2.3 Effects of radiation	25		
2.4 Principles of radiation protection	29		
2.5 The Ionising Radiations Regulations 1999	31		
2.6 Ionising Radiation (Medical Exposure) Regulations 2000	38		
2.7 Other legislation	41		
2.8 Practical aspects of radiation protection	41		
2.9 Summary	47		
3 Imaging with X-rays		49	
3.1 Image quality	49		
3.2 Attenuation of X-rays by the patient	51		
3.3 Effect of scattered radiation	54		
3.4 Secondary radiation grids	55		
3.5 Magnification and distortion	57		
3.6 Unsharpness and blurring	57		
3.7 Limitations of the X-ray tube	58		
3.8 Summary	63		
4 Film-screen radiography			65
4.1 Film-screen radiography: image formation	65		
4.2 Characteristic curve	68		
4.3 Film-screen sensitivity	70		
4.4 Radiographic image quality	70		
4.5 Film-screen radiography in practice	73		
4.6 Mammography	74		
4.7 Linear tomography	76		
4.8 Summary	77		
5 Digital radiography			79
5.1 Digital imaging	79		
5.2 Imaging terminology	81		
5.3 Computed radiography	83		
5.4 Digital radiography	86		
5.5 Picture archiving and communication systems	88		
5.6 Summary	90		
6 Fluoroscopy			91
6.1 The image intensifier	91		
6.2 TV system	94		
6.3 Automatic brightness control	94		
6.4 Dose rates	96		

6.5 Recorded images	97	9.3 Single transducer probe	150
6.6 Image quality	98	9.4 Behaviour of a beam at an interface between different materials	153
6.7 Digital subtraction angiography	98	9.5 Attenuation of ultrasound	154
6.8 Flat plate detectors	101	9.6 A-mode (amplitude mode-echoranging)	155
6.9 Summary	101	9.7 B-mode (brightness mode imaging)	156
7 Computed tomography	103	9.8 Real-time imaging	156
7.1 Introduction	103	9.9 Image acquisition and reconstruction	160
7.2 Equipment for computed tomography scanning	105	9.10 Resolution	161
7.3 Image reconstruction	108	9.11 Artefacts	162
7.4 Helical and multislice scanning	110	9.12 M-mode scanning (time-motion)	162
7.5 Image quality	113	9.13 Doppler methods	163
7.6 Image artefacts	115	9.14 Quality assurance	167
7.7 Dose	116	9.15 Safety considerations	167
7.8 Summary	119	9.16 Summary	168
8 Gamma imaging	121	10 Magnetic resonance imaging	169
8.1 Radioactivity	121	10.1 The spinning proton	169
8.2 Radioactive transformation (decay)	122	10.2 The magnetic resonance signal	171
8.3 Radiopharmaceuticals	125	10.3 Spin-echo sequence	174
8.4 Planar imaging	128	10.4 Spatial encoding	177
8.5 Tomography with radionuclides	132	10.5 Other pulse sequence and imaging techniques	180
8.6 Characteristics and quality assurance of gamma images	137	10.6 Specialized imaging techniques	183
8.7 Dose to the patient	141	10.7 Magnetic resonance image quality	186
8.8 Precautions necessary in handling radionuclides	143	10.8 Artefacts	188
8.9 Summary	144	10.9 Quality assurance	189
9 Imaging with ultrasound	147	10.10 Magnets and coils	189
9.1 Piezoelectric effect	147	10.11 Hazards and safe practice	192
9.2 Interference	149	10.12 Summary	195
		Bibliography	197
		Subject index	199