
Contents

Part I General Nuclear Medicine

1 Principles of Nuclear Medicine	3
1.1 Principles of Nuclear Medicine	3
1.2 Basics of Nuclear Physics	4
1.2.1 Atomic Structure	4
1.2.2 Radioactivity	5
1.2.3 Interaction of Radiation with Matter	7
Further Reading	8
2 Specific Measurements, Units and Terms	9
Further Reading	11
3 Dosimetry	13
3.1 Decays of Radionuclides and Doses Calculation	13
3.1.1 Fluorine F-18	14
3.1.2 Gallium Ga-68 and Gallium Ga-67	14
3.1.3 Radioiodine I-123	14
3.1.4 Radioiodine I-124	14
3.1.5 Radioiodine I-125	14
3.1.6 Radioiodine I-131	15
3.1.7 Indium In-111	15
3.1.8 Lutetium Lu-177	15
3.1.9 Technetium-99m (Tc-99m)	16
3.1.10 Thallium Tl-201	16
3.1.11 Yttrium Y-90	16
3.2 Dose Rates to Target and Critical Organ	17
Further Reading	17
4 The Radiation Protection	19
4.1 Basic Factors in Radiation Protection	19
4.2 Staff Protection in Nuclear Medicine Units	21
4.3 General Measures to Reduce the Irradiation of Patient	21
4.4 Physical Factors in Radiation Protection	22
4.4.1 Time	22
4.4.2 Distance	22
4.4.3 Shielding	23

4.5	Special Recommendations for Patients	
	Undergoing Nuclear Medicine Procedures	23
4.5.1	For Female Patients of Childbearing	
	Age and Breastfeeding	23
4.5.2	Procedures in Case of Nuclear Events	24
	Further Reading	26
5	Equipments in Nuclear Medicine	27
5.1	Gamma Camera	27
5.1.1	Collimators	27
5.1.2	Crystals	29
5.1.3	The Photomultiplier Tubes	30
5.1.4	Imaging and Processing	30
5.2	Instruments for Thyroid Uptake Evaluation	33
5.3	Positron Emission Tomography (PET)	
	and Fusion Images Equipments (PET/CT)	34
5.4	Whole Body Counting Systems	35
5.5	Gamma Probe Equipments	35
	Further Reading	36
6	Radiopharmaceuticals	37
6.1	Introduction	37
6.2	Radiopharmaceuticals in Endocrinology	39
6.2.1	Fluorine-18 Fluorodeoxyglucose	
	(18F-FDG)	39
6.2.2	Radiopharmaceuticals with Gallium-68	
	and Gallium-67	40
6.2.3	Radiopharmaceuticals with	
	Radioiodine	40
6.2.4	Indium-111 Pentetreotide	
	(In-111 Pentetreotide)	43
6.2.5	Technetium-99m	44
6.2.6	Thallium-201 Chloride	
	(Tl-201 Chloride)	50
6.2.7	Radiopharmaceuticals for Targeted	
	Radionuclide Therapy	50
	Further Reading	50
 Part II Nuclear Endocrinology		
7	The Thyroid Gland	53
7.1	Anatomy of the Thyroid Gland	53
7.2	Physiology of the Thyroid Gland	55
7.3	Diagnosis of the Thyroid Gland	57
7.3.1	Clinical Examination	57
7.3.2	Laboratory Serum Testing	58
7.3.3	Fine Needle Aspiration Biopsy	
	(FNAB)	61
7.3.4	Imagistic Diagnostic	63
7.3.5	Nuclear Imaging Tests	64

7.4	Radioiodine Therapy in Benign Thyroid Diseases	125
7.5	Radioiodine Therapy in Malignant Thyroid Diseases	128
7.5.1	Classification of Thyroid Tumors	128
7.5.2	The TNM Staging System	131
7.5.3	Thyroid Cancer Staging	132
7.5.4	Treatment Recommendations	133
7.5.5	European Thyroid Association (ETA) and American Thyroid Association (ATA): Indications for Postsurgical Radioiodine Thyroid Ablation, Procedure and Follow-up	135
7.5.6	Radioactive Iodine Therapy	136
	References	162
8	The Parathyroid Glands	165
8.1	Anatomy of the Parathyroid Glands	165
8.1.1	Embryology	165
8.1.2	Parathyroid Vascularity	165
8.2	Physiology and Pathophysiology of the Parathyroid Glands	166
8.2.1	Pathophysiology	166
8.2.2	The Ten Parathyroid Rules of Norman	167
8.3	Diagnosis of the Parathyroid Glands	167
8.3.1	Clinical Examination	167
8.3.2	Laboratory Serum Testing	168
8.3.3	Imaging Tests	169
8.4	Radio-Guided Surgery of the Parathyroid Glands	186
8.4.1	Overview	186
8.4.2	Minimally Invasive Parathyroidectomy	186
8.4.3	The Radio-Guided Minimally Invasive Parathyroidectomy	186
8.4.4	Gamma Probe–Guided Operation Technique	188
8.4.5	Radiation Safety Considerations	189
	References	189
9	The Adrenal Glands	191
9.1	Overview	191
9.2	Pathophysiology	192
9.2.1	Pathologies of the Adrenal Cortex	192
9.2.2	Pathologies of Adrenal Medulla: The Pheochromocytoma	193
9.3	Adrenal Cortical Scintigraphy	193
9.3.1	Cushing’s Syndrome	194
9.3.2	Primary Aldosteronism	194
9.3.3	Hyperandrogenism	194
9.4	Adrenal Medullary Scintigraphy	195
9.4.1	Clinical Applications	195

9.5 Nuclear Therapy of Malignant Pheochromocytoma.....	198
Further Reading	198
10 Neuroendocrine Tumors (NET).....	201
10.1 Overview	201
10.1.1 Systems of Nomenclature and Grading	
System for Neuroendocrine Tumors	201
10.2 Nuclear Imaging of Neuroendocrine Tumors (NET)	202
10.2.1 NET Imaging with In-111 Octreoscan	203
10.3 Nuclear Therapy of Neuroendocrine Tumors	204
10.3.1 Treatment Proposed Plan.....	205
10.3.2 Radiometabolic Therapeutic Approaches	205
10.3.3 Combination Treatments	206
Further Reading	209
11 PET/CT in Endocrinology	211
11.1 Overview	211
11.2 PET/CT in Thyroid Pathology	211
11.2.1 PET/CT in the Differential Diagnosis of Benign Thyroid Nodules and Malignant Thyroid Nodules.....	212
11.2.2 PET/CT in the Follow-up of Thyroid Carcinoma	212
11.2.3 The Role of PET/CT in Other Malignancies Associated with Thyroid Carcinoma	214
11.2.4 PET/CT F-18 FDG	214
Further Reading	228
Index.....	229