

CONTENTS

SECTION 1: GENERAL CYTOLOGY

CHAPTER 1: Cell	3
Eukaryotic Versus Prokaryotic Cells	3
Cell Membrane	3
Cytoplasmic Organelles	9
Nucleus	17
Deoxyribonucleic Acid	20
CHAPTER 2: Cell Cycle and Cell Proliferation	26
Cell Cycle	26
Cell Division	27
Cell Cycle Checkpoint	29
Cell Cycle Regulator Proteins	30
Cell Cycle Control and Cancer	31
Cell Proliferation Markers	32
Stem Cell	35
CHAPTER 3: Cellular Reaction to Injury and Cell Death	38
Cellular Adaptation	38
Reversible Cell Injury	39
Irreversible Cell Injury	39
Autophagy	45
Necrosis	48
Programmed Necrosis: Necroptosis	48
Pyroptosis	50
Ferroptosis	50
Inflammation	51
CHAPTER 4: Molecular Genetics: Basic Principles and Clinical Applications	53
Chromosome	53
Cytogenetics	57
Molecular Cytogenetic Techniques	58
CHAPTER 5: Neoplasm	65
Benign Neoplasm	65
Biological Characteristics of Malignant Tumor or Cancer	66
Hallmarks of Cancer	66
Cancer Stem Cells	69
Molecular Basis of Cancer	70
Oncogenes and Cancer	71
Functional Properties of Oncogene	72
Microribonucleic Acid and Cancer	73
Genomic Instability	74
Tumor Suppressor Genes	77

Tumor Microenvironment 80
 Preneoplastic Lesions 82
 Morphology of Cancer Cell 82
 Cell and Cytoplasm 83
 Nucleus 83
 Characterization of Type of Cancer Cell 87
 Diagnostic Pitfalls of Malignancy 89

CHAPTER 6: Tissue and Cell Organization	92
Epithelial Tissue	92
Connective Tissue	94

SECTION 2: CLINICAL CYTOLOGY (EXFOLIATIVE)

CHAPTER 7: Normal Anatomy, Histology and Cytology of Female Genital Tract	101
Vulva	101
Vagina	101
Histology	101
Uterus	101
Ovaries	103
Fallopian Tubes	103
Normal Cells in Cervical Smear	103
Changes of Squamous Epithelium	105
Bethesda System of Reporting	108
CHAPTER 8: Cervical Carcinogenesis, Preneoplastic and Neoplastic Condition	119
Human Papillomavirus and Cervical Carcinogenesis	119
Cervical Preneoplastic Lesions	121
CHAPTER 9: Cervical Cancer Screening Program	140
Parameters to Measure the Validity of Screening Tests	140
Screening Guidelines	140
Types of Modalities for Cervical Cancer Screening	141
Essential Elements for Successful Cervical Cancer Screening	143
HPV Vaccination	144
CHAPTER 10: Effusion Cytology	147
Anatomy and Histology of Body Cavities	147
Effusion	147
Specimen Collection and Processing	148
Benign Cell Population in Effusion	149
Effusion Due to Non-neoplastic Causes	152
Malignant Effusion	154
Metastatic Tumors	157
Primary Serosal Tumor	169
CHAPTER 11: Urine Cytology	178
Anatomy and Histology	178
Normal Cytology	180
Specimen Collection	182

Processing of Urinary Sample	183
Crystals and Casts in the Urine	183
Non-neoplastic Lesions in the Urinary Tract	184
Neoplastic Lesions	187
Paris System of Classification	188
Cytology of Malignancy in Urine	190
Ancillary Techniques	194
Diagnostic Accuracy of Urine Cytology	196
CHAPTER 12: Respiratory Cytology	198
Normal Anatomy and Histology	198
Sampling Techniques	199
Normal Cytology	201
Benign Cellular Abnormalities	203
Infections	205
Lung Carcinomas	209
Classification of Lung Cancer	209
Individual Tumors	213
CHAPTER 13: Gastrointestinal Tract	225
Sampling Techniques	225
Esophagus	226
Stomach	231
Small and Large Intestine	237
Large Intestine	238
Anal Cytology	238
CHAPTER 14: Cerebrospinal Fluid	240
Anatomy	240
Gross Appearance of Cerebrospinal Fluid	240
Cytology	240
Sampling of Cerebrospinal Fluid	240
Infective Conditions	242
Demyelinating Diseases	243
Neoplasm	243
Primary Central Nervous System Lymphoma	246
Other Primary Central Nervous System Tumor	246
Diagnostic Accuracy	247

SECTION 3: LABORATORY TECHNIQUES

CHAPTER 15: Basic Technique and Approach to Fine-needle Aspiration Cytology	251
Fine-needle Aspiration Technique	252
Fine-needle Sampling	254
Staining of The Smear	255
Ancillary Techniques	256
FNAC of Deep-seated Lesions	256
Suboptimal Material in FNAC	258
Evaluation of FNAC Smear	258

CHAPTER 16: Routine Laboratory Techniques	260
Sample Collection	260
Fixation	262
Preservation of the Sample Prior to Processing	263
Processing of Laboratory Samples	263
Processing	264
Staining	267
Dehydration and Clearing of the Smear	269
Mounting	269
Coverslip	269
Storage	269
CHAPTER 17: Special Stains and Immunocytochemistry	271
Special Stains	271
Immunocytochemistry	273
Samples for Immunocytochemistry	274
Diagnostic Immunocytochemistry	278
CHAPTER 18: Light microscope	288
Visible Light	288
Image Formation in Human Eye	288
Light Microscope	289
Image Formation in a Compound Microscope	289
Care and Handling of the Microscope	290
Fluorescence Microscopy	290
Confocal Microscopy	291
CHAPTER 19: Digital Pathology	293
Workflow of Digital Pathology	293
Essential Components of a Digital Pathology Laboratory	293
Advantages of Digital Pathology	294
Limitations of Digital Pathology	294
Whole Slide Imaging	295
Artificial Neural Network	298
CHAPTER 20: Flow Cytometry	302
Brief History of Flow Cytometry	302
Basic Principles of Flow Cytometry	302
The Instrument at a Glance	303
Fluorescence-activated Cell Sorter	303
Control	304
Flow Cytometric Immunophenotyping	304
Immunophenotyping of Lymphoma	305
DNA Content and Ploidy Analysis	309
Future of Flow Cytometry	311
CHAPTER 21: Automation and Liquid-based Cytology	312
Liquid-based Cytology	312
Automation in Screening	315
Automated Screening Devices	315
Available Automated Screening Devices	315

Comparison of Manual and Automated Devices	316
Problems of Implementing Automation	316
CHAPTER 22: Polymerase Chain Reaction and Next Generation Sequencing	318
Components of Polymerase Chain Reaction	318
Steps of Polymerase Chain Reaction	318
Types of Polymerase Chain Reaction	319
Applications of Polymerase Chain Reaction	320
DNA Sequencing	321
First-generation Sequencing	321
CHAPTER 23: Quality Control and Laboratory Organization	327
Preanalytical Phase	327
Analytical Phase	327
Postanalytic Phase	328
Interlaboratory Comparison	328
External Quality Assurance	329
Laboratory Organization	329
Laboratory Safety	331
COVID-19 (Sars-Cov-2) Infection and Biosafety	332

SECTION 4: FINE-NEEDLE ASPIRATION CYTOLOGY

CHAPTER 24: Head, Neck, and Orbit	337
Head and Neck	337
Cystic Lesions	337
Branchial Cyst	337
Thyroglossal Cysts	338
Epidermal Inclusion Cyst	338
Cystic Hygroma	338
Mucocele	338
Neoplastic Lesions	339
Nasopharyngeal Carcinoma	340
Ameloblastoma	341
Parathyroid Tumors	341
Meningioma	342
Olfactory Neuroblastoma	343
Orbital Lesions	344
Malignant Neoplasm of Eyelid	345
Lesions of the Lacrimal Gland	345
Intraorbital Tumors	345
CHAPTER 25: Salivary Gland	349
Anatomy and Histology of the Salivary Gland	349
Indications of FNAC of the Salivary Glands	349
Contraindications	350
Complications	350
Fine-needle Aspiration Cytology: Technical Consideration	350
Overview of the Diagnostic Challenges	350

Normal Salivary Gland Cells	351
Salivary Gland Lesions	352
Neoplastic Lesions	354
The Milan System of Reporting the Cytology of Salivary Gland	355
CHAPTER 26: Thyroid	372
Approach to Fine-needle Aspiration Cytology of the Thyroid	372
Techniques	372
Anatomy and Histology	373
Diagnostic Accuracy	374
Bethesda Terminology	374
Normal Aspirated Material	375
Diseases of Thyroid	375
Ancillary Techniques	394
Management of Post-FNAC Diagnosis of Thyroid Lesion	395
CHAPTER 27: Breast	399
Indications of FNAC of Breast	399
Contraindications	399
Diagnostic Accuracy	399
Limitations of FNAC	400
Clinical History	400
Triple Test	401
Core Needle Biopsy Versus FNAC	401
Adequacy of the Sample	401
Histology of Breast	402
Normal Cytology of Breast	402
Inflammatory Lesions	402
Benign Noninflammatory Lesions	405
Proliferative Breast Disease	408
Ductal Carcinoma In Situ	410
Carcinoma	413
Other Types	415
Male Breast Lesions	421
Ancillary Investigations on Breast Aspiration Material	422
Reporting of Breast FNAC	422
Ancillary Techniques	423
Molecular Classification of Breast Carcinoma	424
Nipple Discharge	425
CHAPTER 28: Lymph Node	429
Normal Anatomy and Histology of the Lymph Node	429
Approach of Lymph Node FNAC	431
Aspiration	431
Normal Component of a Lymph Node	431
Diagnostic Accuracy	431
Benign Lesions in the Lymph Node	432
Metastatic Malignancy	441
Lymphomas	443
Lymphoma Classification	443

Lymphomas of Large Cells	450
Hodgkin Lymphoma	455
Approach to Diagnosis of Lymph Node Lesions	458
Leukemic Infiltration	460
CHAPTER 29: Mediastinum	463
Anatomy of the Mediastinum and General Considerations	463
Clinical History	463
Techniques	463
Lesions	464
Approach to the Diagnosis of Mediastinal Tumors	471
CHAPTER 30: Liver and Spleen	473
Liver	473
Normal Cells	473
Liver Lesions	474
Spleen	485
Non-neoplastic Process	485
CHAPTER 31: Pancreas	488
Pancreas	488
Cysts of Pancreas	489
Neoplastic Lesion of Pancreas	490
Carcinoma	491
Neuroendocrine Tumor	493
Neuroendocrine Carcinoma	495
CHAPTER 32: Kidney and Adrenal	499
Normal Cells	499
Renal Lesions	500
Renal Neoplasms	500
Metastatic Tumors of Kidney	506
Pediatric Renal Tumors	507
Adrenal	510
Adrenocortical Neoplasm	510
Pheochromocytoma	511
Metastatic Tumors	513
CHAPTER 33: Gonads and Prostate	516
Testis	516
Female Genital System	521
Prostate	525
CHAPTER 34: Soft Tissue Lesions	529
Diagnostic Accuracy	529
FNAC Technique and Information Needed for Diagnosis	530
Ancillary techniques	530
Individual Soft-tissue Tumors	531
CHAPTER 35: The Skin	548
Non-neoplastic Lesions	548
Rare Benign Diseases of the Skin	548

Neoplastic Lesions of the Skin	549
Malignant Tumors of the Skin	552
CHAPTER 36: Bone	558
Normal Cells	558
Bone Forming Tumor	559
Cartilage Forming Tumor	561
CHAPTER 37: Round Cell Tumor	572
Diagnostic Approach	572
Cytomorphology	572
CHAPTER 38: Infection	577
Common Samples	577
Stains and Other Tests	577
Bacterial	577
Parasites	579
Fungal Infection	581
Viral Infections	583
REVIEW QUESTIONS	585
INDEX	621

VIDEO CONTENTS

Indexing of the videos on Laboratory Techniques for the book of Diagnostic Cytology (3rd edition)

1. Fluorescent in situ hybridization technique: *Chapter 4*
2. Fine needle aspiration cytology: *Chapter 15*
3. Fluid processing by simple centrifugation: *Chapter 16*
4. Cytospin technique: *Chapter 16*
5. Millipore filtration technique: *Chapter 16*
6. Cell block technique: *Chapter 16*
7. Papanicolaou's staining: *Chapter 16*
8. May–Grünwald–Giemsa staining: *Chapter 16*
9. Automated and manual immunocytochemistry: *Chapter 17*
10. Flow cytometry: *Chapter 20*
11. Liquid based cytology of cervical smear: *Chapter 21*
12. Liquid based cytology of Non-gynecological sample: *Chapter 21*
13. Polymerase chain reaction technique: *Chapter 22*
14. Next Generation Sequencing: *Chapter 22*

Low Power	LP	Nuclear matrix proteins	NMP
Lupus erythematosus	LE	Nuclear pore complex	NPC
Lymphoblastic lymphoma	LBL	Nucleocytoplasmic	N/C
Lymphocytic and/or histiocytic	L & H	Nucleolar organizing regions	NOR
Lymphoepithelial sialadenitis	LESA	Numerical aperture	NA
Lymphoglandular body	LGB	Oil immersion	OI
Lymphoplasmacytic lymphoma	LPL	Open reading frames	ORF
Malignant fibrous histiocytoma	MFH	Oral contraceptive pill	OCP
Malignant mesothelioma	MM	Orange G	OG
Malignant peripheral nerve sheath tumor	MPNST	Origin recognition complex	ORC
Malignant round cell tumor	MRCT	Outer nuclear membrane	ONM
Mantle cell lymphoma	MCL	p53-binding protein 1	53BP1
Marginal zone lymphoma	MZL	Pancreatic endocrine tumor	PET
Matrix attachment region	MAR	Papillary neoplasia of low malignant potential	PUNLMP
May–Grünwald–Giemsa	MGG	Papillary thyroid carcinoma	PTC
Mediator of DNA damage checkpoint 1	MDC1	Periodic acid–Schiff's	PAS
Medium Power	MP	Peripheral neuroectodermal tumor	PNET
Medullary carcinoma	MCL	Peripheral T-cell lymphoma	PTCL
Messenger RNA	m-RNA	peritoneal mucinous carcinomatosis	PMCA
Micro RNA	miRNA	Phosphatidylinositol 3-phosphate	PI3P
Micronucleus	MN	Phosphatidylserine	PtdSer
Microsatellite instability	MSI	Phycoerythrin	PE
Mitochondria	MT	Phyllodes tumor	PT
Mucinous cystic neoplasia	MCN	Placental alkaline phosphatase	PLAP
Mucoepidermoid carcinoma	MEC	Plasma cell myeloma	PCM
Mucosa associated lymphoma	MALT	Platelet-derived growth factor	PDGF
Multicolor FISH	M-FISH	Pleomorphic adenoma	PA
Multiple endocrine neoplasia	MEN	Polyclonal carcinoembryonic antigen	p-CEA
Myxoid Liposarcoma	MLS	Polymerase chain reaction	PCR
Nasopharyngeal carcinoma	NPC	Polymorphous low-grade adenocarcinoma	PLGA
National Health Service, United Kingdom	NHS UK	pre replicative	pre-RC
Natural killer T	NKT	Precursor miRNA	pre-miRNA
Negative for intraepithelial lesion or malignancy	NILM	Primary effusion lymphoma	PEL
Neuroblastoma	NB	Primary mediastinal large B-cell lymphoma	PMLBCL
Neuron-specific enolase	NSE	Primary miRNA	pri-miRNA
Nodular lymphocytic predominant HL	NLPHL	Primitive neuroectodermal tumor	PNET
Non-Hodgkin lymphoma	NHL	Progesterone receptor	PR
Nontuberculous mycobacteria	NTM	Programmed cell death	PCD

Proliferating cell nuclear antigen	PCNA	Spindle assembly check point	SAC
Proliferative breast disease	PBD	Squamous cell carcinomas	SQC
Prostate-specific antigen	PSA	Squamous intraepithelial lesion	SIL
Psammoma bodies	PB	Standard operating protocol	SOP
Rhabdomyosarcoma	RMS	Synovial sarcoma	SS
Reactive lymphoid hyperplasia	RLH	Syringocystadenoma papilliferum	SCAP
Reed-Sternberg's	RS	Systemic lupus erythematosus	SLE
Renal cell carcinoma	RCC	TATA-binding protein	TBP
Replication licensing factors	RLF	Telomeric repeat amplification protocol	TRAP
Retinoblastoma	Rb	Terminal deoxynucleotidyl transferase mediated dUTP Nick End Labeling	TUNEL
Reverse transcriptase PCR	RT-PCR	The Bethesda System	TBS
Rhabdomyoma	RM	Thyroid-stimulating hormone	TSH
Rhabdomyosarcoma	RMS	Thyroid-stimulating immunoglobulin	TSI
Ribonucleic acid	RNA	Thyroid transcription factor	TTF
Ribosomal RNA	rRNA	Transbronchial fine-needle aspiration cytology	TBNA
Ring finger-binding protein	RFBP	Transfer RNA	tRNA
Rough endoplasmic reticulum	RER	Transitional cell carcinoma	TCC
Scavenger receptors	SR	Trichomonas vaginalis	TV
Sebaceous carcinoma	SC	Tumor necrosis factor–receptors	TNF-receptors
Single strand conformation polymorphism	SSCP	Ultrasonography	USG
Sinus histiocytosis with massive lymphadenopathy	SHML	Upstream regulatory region	URR
Small cell carcinoma	SCC	Urothelial carcinoma	UC
Small lymphocytic lymphoma	SLL	Vascular endothelial growth factor	VEGF
Smooth endoplasmic reticulum	SER	Vascular permeability factor	VPF
Soft tissue sarcoma	STS	Visual inspection of cervix with acetic acid	VIA
Solid and cystic papillary neoplasm	SCPN	Wilms' tumor	WT
Spectral karyotyping	SKY	World Health Organization	WHO