

TABLE OF CONTENTS

Preface

xiii

Chapter 1 Introduction to Cell and Molecular Biology

1

Introduction

1

The Cellular basis of Life

2

What is cell theory?

3

The History of Cell Theory

6

The Nature and Function of Cells

12

The Molecules of Cells

12

The Genetic Information of Cells

19

The Organization of Cells

21

Different Cell Types

24

Different Types of Cells in the Human Body

29

Techniques and Methods of Studying Cells

42

Tools and Techniques of Cell Biology

43

Microscopy

43

Principles of Light Microscopy

45

Types of Light Microscopes

46

Phase Contrast Microscopy

51

Confocal Microscopy

53

Electron Microscopy (EM)

60

Fluorescence Microscopy

60

Analytical-Flow Cytometry

62

Spectrophotometry

64

Mass Spectrometry

66

Separation-Sub-cellular Fractionation

68

Differential and Density Gradient Centrifugation

68

Chromatography

69

Affinity Chromatography

74

Some Other Techniques

76

Summary

82

Multiple Choice Questions

84

Review Questions	84
References	86
Chapter 2 Biochemistry of the Cell	87
Introduction	87
Water the Aqueous Environments	88
Aqueous Solution	89
Biomolecules and their Properties	91
The Molecular Composition of Cells	92
Nucleic Acids	94
Proteins	96
Lipids	103
Carbohydrates	105
Summary	110
Multiple Choice Questions	111
Review Questions	111
References	113
Chapter 3 The Cell Surface and the Extracellular Matrix	115
Introduction	115
Nature and Composition of Plasma Membrane	116
Functions and Actives of Cell Membrane	117
Cell Adhesion	119
Signal Transduction	121
Vacuole Formation	124
The Extracellular Environment	126
Extracellular Matrix	127
Adhesion Molecules	130
Signaling Complexes	131
Signaling at the Cell's Surface	132
Cell Signals	133
Receptors for Cell Signals	137
Agonists versus Antagonists	141
Cells Signal One Another With Chemicals	146
Types of Cell Signaling	147
Receptors That Act as Gene Regulators	149
Receptors	150
G-Protein-Linked Receptors	151
Anchoring Junctions	157
Gap Junctions in Animals	158

Summary	162
Multiple Choice Questions	164
Review Questions	164
References	166

Chapter 4 The Nucleus 167

Introduction	167
Chromosome Structure and Genes	168
The Chromosomes	170
Mitosis	175
Meiosis	177
Cellular Differentiation and Proliferation	179
Cell Cycle and DNA Replication	181
The Cell Cycle	182
DNA Replication	184
Transcription and RNA Processing	189
Nucleolus Processing	190
Processing of rRNA	191
Nuclear Matrix	193
Transport across Nuclear Envelope	194
Chromatin	195
Histones	196
Chromatin Immunoprecipitation (ChIP)	202
Organization and Evaluation of the Nuclear Genome	203
Role in Nuclear Organization	205
Nuclear Organization and Genome Function	206
Molecular Organization	206
Nuclear Envelope	208
Regulation of Gene Expression	211
Importance of Regulation of Gene Expression	213
Define the term Regulation as it applies to Genes	216
Gene Regulation makes Cells Different	217
Summary	222
Multiple Choice Questions	224
Review Questions	224
References	226

Chapter 5 Membrane-bond Organelles 227

Introduction	227
The ER and its Derivatives	228
Targeting Proteins to the Endoplasmic Reticulum	229
Targeting Proteins to Mitochondria	231

Importing proteins into peroxisomes and Zellweger's Syndrome	233
The Golgi Complex	233
Foundation of Vesicles	236
Golgi apparatus Functions	237
Tagging Cellular Products	238
Membrane-bound Organelles Function	240
Membrane-Bound Organelles in Eukaryotic Cells	244
Translation	247
Post-Translation Modification	251
Protein Transport	252
Membrane Flow and sorting (trafficking)	256
Summary	259
Multiple Choice Questions	260
Review Questions	260
References	262

Chapter 6 The Cytoskeleton and Cell Motility 265

Introduction	265
Overview of Cytoskeleton	266
Importance of Cytoskeleton	268
Cytoskeleton: Structure and Movement	269
Prokaryotic Cytoskeleton	270
Intermediate Filaments	273
Microfilaments	276
Actin Microfilaments	276
Microtubules	278
Cell Motility	292
Importance of Cell Motility	293
Extensions of Cell Motility	298
Filament-Driven Motility	300
Modeling Polymerization Forces	302
Motor-Driven Motility	304
Summary	307
Multiple Choice Questions	308
Review Questions	308
References	309

Chapter 7 Cellular Metabolism 311

Introduction	311
Concepts of Mitochondria and Cellular Respiration	312
Structure of Mitochondria	313

Function of Mitochondria	314
What is Mitochondrial DNA?	316
Mitochondrial DNA Analysis	318
Mitochondrial Membrane	320
Cellular Respiration	329
Chloroplast and Photosynthesis	333
Chloroplast	334
Chloroplast Function in Photosynthesis	336
Photosynthesis	338
Overall Reaction of Photosynthesis	339
Summary	341
Multiple Choice Questions	343
Review Questions	343
References	345

Chapter 8 Current Trends in Cellular and Molecular Biology 347

Introduction	347
Recombinant DNA Technology	348
Properties of organisms containing recombinant DNA	350
Processes of Recombinant DNA Technology	351
Current Research Progress	352
Uses Recombinant DNA	355
Gene Cloning	357
The Identification and Analysis of Genes and Gene Products	360
RNA Interference	361
Importance of RNA Interference	362
RNAi in Nature	363
RNAi in Research and Medicine	364
Nanotechnology	365
Nanotechnology Research: Nanomaterials	368
Biomedicine and Health Care	370
Assistive Devices and Tissue Engineering	373
Summary	382
Multiple Choice Questions	384
Review Questions	385
References	386

Index 387