

Contents

Four steps to exam success ix

Chapter 1

Introduction to cell biology 1

- 1.1 The discovery of cells 1
- 1.2 Classification of organisms 3
- 1.3 Evolution of cells 8
- 1.4 Composition of cells 9

Chapter 2

Methods of studying cells 12

- 2.1 Culturing cells 12
- 2.2 Flow cytometry or cell sorting 19
- 2.3 Examining cells by microscopy 20
- 2.4 Cell fractionation 33
- 2.5 Studying biological molecules 43

Chapter 3

Biological membranes 45

- 3.1 Components of membranes 46
- 3.2 Structure of membranes 47
- 3.3 Structure of archaeal membranes 57
- 3.4 Membrane asymmetry 57
- 3.5 Functions of the membrane lipid bilayer 60
- 3.6 Roles of biological membranes 61

Chapter 4

Structure and activities of prokaryotic cells 86

- 4.1 Prokaryotic cell walls 87
- 4.2 Bacterial cytoplasmic membrane 91
- 4.3 Prokaryotic cytoplasm 98
- 4.4 Nucleoid and prokaryotic DNA packaging 101
- 4.5 Prokaryotic genomes 102
- 4.6 Prokaryotic surface structures 104
- 4.7 Bacterial motility 105

Contents

Chapter 5

Molecular biology of the prokaryotes 111

- 5.1 Reproduction of prokaryotic cells 111
- 5.2 Binary division in bacteria 112
- 5.3 Replication in archaea 121
- 5.4 Key points of gene expression 122
- 5.5 Transcription in bacteria 123
- 5.6 Transcription in archaea 127
- 5.7 Post-transcriptional modifications 128
- 5.8 Translation in prokaryotes 129
- 5.9 Translation in bacteria 135
- 5.10 Translation in archaea 142

Chapter 6

The nucleus 145

- 6.1 Chromosomes and chromatin 147
- 6.2 Replication of nuclear DNA 152
- 6.3 Transcription in the nucleus 157
- 6.4 Pre-mRNA processing 160
- 6.5 Nucleoli and other intranuclear inclusions 164
- 6.6 Nuclear envelope and nuclear pores 166
- 6.7 Nuclear skeleton 174
- 6.8 Evolution of the nucleus 174

Chapter 7

The cytosol and cytoskeleton 176

- 7.1 Composition of the cytosol 176
- 7.2 Key functions of the cytosol 178
- 7.3 The cytoskeleton 190

Chapter 8

The endoplasmic reticulum 203

- 8.1 Structure of the endoplasmic reticulum 204
- 8.2 Key activities of the smooth endoplasmic reticulum 207
- 8.3 Key activities of the rough endoplasmic reticulum 211

Chapter 9

Golgi apparatus, the endosomal-lysosomal system, and vacuoles 219

- 9.1 Structure of the Golgi apparatus 219
- 9.2 Formation of the Golgi apparatus 221
- 9.3 Movement through a Golgi stack 223
- 9.4 Key roles of the Golgi apparatus 224

9.5 Lysosomes 227

9.6 Vacuoles 234

Chapter 10

Chloroplasts and photosynthesis 238

10.1 Chloroplast structure 240

10.2 Mechanism of photosynthesis in plants 242

10.3 Other chloroplast functions 258

10.4 Evolution and development of chloroplasts 259

Chapter 11

Mitochondria, hydrogenosomes, and mitosomes 264

11.1 Key functions of mitochondria 267

11.2 Evolutionary origins of mitochondria 278

11.3 Hydrogenosomes 284

11.4 Mitosomes 286

Chapter 12

Microbodies 288

12.1 Key features of peroxisomes 289

12.2 Key activities of peroxisomes 290

12.3 Key features of glyoxysomes 294

12.4 Glycosomes 296

Chapter 13

Eukaryotic cell walls 300

13.1 Plant cell walls 302

13.2 Algal cell walls 312

13.3 Fungal cell walls 313

13.4 Yeast cell walls 314

Chapter 14

Extracellular matrix and connective tissues 317

14.1 Key functions of the extracellular matrix 319

14.2 Major cells of the extracellular matrix 319

14.3 Key glycoproteins and proteins of the extracellular matrix 320

14.4 Connective tissues 333

Chapter 15

Cell signalling 338

15.1 Local and long-distance signalling 339

15.2 Signalling molecules 341

15.3 Receptors and second messengers 347

Contents

15.4 Examples of cell signal transduction pathways 353

15.5 Neuronal signalling 370

Chapter 16

Eukaryotic cell cycle, mitosis, and meiosis 383

16.1 The eukaryotic cell cycle 385

16.2 Variations on mitotic cell division 394

16.3 Control of the cell cycle 403

16.4 Evolution of mitosis 410

Chapter 17

Cell death 412

17.1 Apoptosis and necrosis 412

17.2 Roles of apoptosis 416

17.3 Inducing apoptosis 419

Chapter 18

Viruses 428

18.1 Discovery of viruses 429

18.2 Sizes and structures of virus particles 430

18.3 Different types of virus symmetries 432

18.4 Nomenclature and classification of viruses 436

18.5 Replication of viruses 440

18.6 Origin and evolution of viruses 449

Index 451