

# Index

- acquired immune deficiency 126, 160
- acute phase response (APR) 40–41
- AD, *see* Alzheimer's disease
- ADA, *see* adenosine deaminase deficiency
- adaptive immune functions 99
- adaptive immunity 11–12, 15, 20, 30, 38, 42, 97, 147
- ADCC, *see* antibody-dependent cellular cytotoxicity
- enhanced 187–188
- ADCs, *see* antibody–drug conjugates
- adenosine deaminase deficiency 116–117
- adenosine deaminase deficiency (ADA) 116–117, 123, 126–127
- adoptive immunotherapy 152–155
- affinity maturation 30, 173
- AFP, *see* alpha-fetoprotein
- alkaline phosphatase (AP) 176, 203–204
- alloantigenic sites 76, 78
- alpha-fetoprotein (AFP) 140–141
- ALPS, *see* autoimmune lymphoproliferative syndrome
- Alzheimer's disease (AD) 102
- amino acids 23, 25, 37, 73–76, 78–79, 82–83, 88, 144–145, 187, 189
- anaphylaxis 3, 7–8, 44
- angiogenesis 146, 150, 181
- anthrax 2, 7
- anti-antibodies 202
  - radiolabeled 210
- anti-CD20 antibodies 155, 181, 187–188
  - second-generation 181
  - type II 187
- anti-tetanus serum (ATS) 218–219, 221
- antibodies
  - anti-CD25 157
  - anti-CD52 155
  - anti-TNF 181
  - antibacterial 43
  - antivirus 156
  - BiTER 184
  - engineered antitumor 185
  - enzyme-linked 205–206
  - generating 173, 176
  - glycoengineered 187, 196
  - human 170
  - humanized 187, 192
  - insulin 211
  - membrane-bound 13
  - multispecific 196
  - polyclonal 176, 180, 196, 201
  - polyreactive 119
  - protein 28
  - therapeutic 169, 178, 180–181, 190–192, 194–196
  - unbound secondary 204
- antibody binding sites 180, 226
- antibody-dependent cellular cytotoxicity (ADCC) 155, 181, 187–189
- antibody engineering 177, 192–193
- antibody library screening 180

- antibody–drug conjugates (ADCs) 182, 185
- antigen–antibody binding affinity 232
- antigen–antibody reactions 3
- antigen binding 190–191
- antigen-binding affinity 189
- antigen-binding sites 174
- antigen blast 227
- antigen expression 147
- antigen presentation 13, 25, 27, 69, 71, 79, 84–85, 89, 93, 105
- antigen presenting cell (APCs) 5, 13–14, 23–24, 26–27, 69, 71–72, 77, 79, 82–86, 89–90, 92–93, 97, 101, 105, 147
- antigen-presenting cells, functions of 84
- antigen processing 25, 69, 84, 88, 90, 147
- antigen recognition 69, 85
- antigen specificity 14, 172
- antigen stimulation threshold 120
- antigen–antibody complexes 206
- antigen–antibody interaction 174, 193, 210
- antigenic characterization 179
- antigenic determinants 4, 90, 142, 180
- antigenic masking 147
- antigens
  - cancer 179
  - cell-bound 183
  - cytosolic 89
  - embryonic 140
  - endogenous 14, 23–27, 77, 82, 89, 97
  - exogenous 14, 23–24, 26–27, 69, 144
  - extracellular 89
  - germline 138–139
  - H-2 68
  - histocompatibility leukocyte 228
  - HLA 68–70, 72–73, 93–94
  - human leukocyte 67–68
  - infectious pathogenic 179
  - major histocompatibility 68
  - melanoma-associated 139
  - microbial 84, 91, 208
  - minor histocompatibility 68
  - overexpressed 139
  - pancreatic islet cell 95
  - parasitic 194
  - pathogen 195
  - peptide 23, 68, 77, 79, 90
  - phagocytosed 84
  - polysaccharide 174
  - protein 29, 83–84, 86
  - T-dependent 29
  - T-Independent 30
  - thyroid 95
  - tumor-associated 140
  - viral 88, 180
- antitumor immunity
  - dampening 148
  - improving 148
- antitumor immunotherapy 152
- antitumor responses 151, 155, 158
- antitumor vaccination 156
  - active-specific 156
- AP, *see* alkaline phosphatase
- APCs, *see* antigen presenting cell
- apoptosis 124, 133–134, 139, 147, 157, 190
- APR, *see* acute phase response
- arginine metabolism 149–150
- aspartate 95
- assays
  - enzyme-linked immunosorbent 176, 212
  - immunobinding 202
  - immunometric 202, 210

- astrocytes 99–100, 103–106
- atherosclerosis 162, 223
- ATS, *see* anti-tetanus serum
- nucleic acids 84
- autoimmune lymphoproliferative syndrome (ALPS) 227
- autoimmunity 95–96, 115
  - preventing 148, 157
- B-cell-activating factor 120
- B-cell activation 14, 29–30
- B cell receptor (BCR) 28, 73, 120, 143
- B-cells
  - memory 28
  - naive 28–29
- B-lymphocytes 14, 20, 22, 176
- Bacillus Calmette Guerin (BCG) 215, 218, 221–222
- bacterial infections 40, 106, 119
- bacterial polypeptide 35
- bacterial superantigens 91
- bacteriolytic activity 43
- bacteriophages 180
- bare lymphocyte syndrome 116–117
- basophiles 175
- BBB, *see* blood–brain barrier
- BCG, *see* Bacillus Calmette Guerin
- BCR, *see* B cell receptor
- bevacizumab 181, 188
- bioinformatics 225
  - structural 226, 233
- blood 2–3, 13, 22, 85, 149
- blood–brain barrier (BBB) 99–100, 104
- body serums 22, 27–28
- bone marrow 13, 23, 27, 90, 119, 179
- brain 99–104, 106, 192
- brain Inflammation 107
- Bruton's tyrosine kinase (BTK) 119
- bsAbs 182–185
  - conjugated 184
- BTK, *see* Bruton's tyrosine kinase
- C-reactive protein (CRP) 34, 40–41, 46–47
- calnexin 25, 88–89
- calreticulin 25, 89
- cancer 7, 134, 136, 140, 142–143, 147, 150, 158, 160–162, 179, 181, 186, 223
  - cervical 133, 140
  - cells 133–137, 139, 141–147, 149, 151, 153, 158–162, 177, 181
  - origin of 133
- cancer immunoediting 158–159
- cancer immunosurveillance hypothesis 141
- cancer immunosurveillance theory 142
- cancer immunotherapy 151, 156
- cancer metastasis 150
- cancer therapy 154–155, 192
- carbohydrates 49–50, 208
- carcino-embryonic antigen (CEA) 140–141, 162
- carcinogens 137, 147, 158, 161
- CD8 Tc cells 24
- CEA, *see* carcino-embryonic antigen
- cell-mediated immunity 4, 22, 143
- cells
  - aberrant 142
  - allogenic 58
  - apoptotic 44
  - bacterial 54, 208
  - cancerous 134, 162
  - cytotoxic 144

- ependymal 100
- eukaryotic 24, 88
- hematopoietic 117
- heteromyeloma 178
- histoincompatible 79
- immortal 178
- immortal heteromyleoma 177
- immune-competent 101
- immunosuppressive 151, 158
- invasive metastatic 195
- liver parenchymal 74
- malignant 134, 148, 159
- myeloid-derived suppressor 146, 150, 162
- myeloma 177
- natural killer 136, 161, 171
- nonnucleated 71
- nucleated 13, 68, 72, 86
- phagocytic 7, 55, 173, 175
- polymorphonuclear 44
- red blood 46, 71
- resting microglia 101
- thyroid 95
- white blood 4, 22
- central nervous system (CNS) 72, 99–104, 106, 117
- chaperones 25, 88
- chemical carcinogens 138–140, 142, 161
- chemokines 5, 58, 85, 100, 102–103, 105, 149
- cholera 21, 222
- chromosome 67–68, 70, 72, 75, 78, 120
- Class II antigens 72, 79–80, 92
- Class II genes 73, 93
- Class II MHC 13–14, 68, 90
- Class II MHC antigens 68, 80
- Class II MHC molecules 14, 73, 79, 97
- Class II MHC proteins 68, 86
- Class II proteins 69, 86
- Class III antigens 73
- Clostridium tetani* 218–220
- CNS, *see* central nervous system
- CNS autoimmune diseases 102
- common variable immune deficiency (CVID) 119–121
- complement activation 29, 34, 48, 51–55, 181
  - alternative pathway of 54
  - regulation of 57–58
- complement deficiencies 115
- complement pathways 34, 45, 170
  - classical 44
- complement receptor 52, 57
- CRP, *see* C-reactive protein
- CTLs, *see* cytotoxic T-lymphocyte
- CVID, *see* common variable immune deficiency
- cytokines 14, 33, 42, 58, 71, 85, 100–103, 106, 147, 149–150, 152–153, 155, 185, 230
  - anti-inflammatory 103
  - immunosuppressive 146, 148, 151
  - pro-inflammatory 38, 102–103, 105–107
- cytoplasm 58, 88, 139, 160–161, 185
- cytotoxic T-lymphocyte (CTLs) 14, 24, 139, 144–145
- DAF, *see* delay accelerating factor
- DCs, *see* dendritic cells
- delay accelerating factor (DAF) 52, 58
- dendritic cells (DCs) 5, 14, 24, 26, 33, 72–73, 79, 82, 84–85, 92, 136, 143–145, 150–151, 153–154, 161–162
  - activated 5
  - engineered 154
  - follicular 79

- inhibition of 161
- mature 154
- diabetes mellitus 95–96, 125, 223
- diabodies 182–183, 195
- DiGeorge syndrome 107, 118, 126
- diphtheria, tetanus, pertussis (DTP) 221–222
- diseases
  - autoimmune 9, 15, 96, 120, 126, 162, 229, 232
  - celiac 95–96
  - HLA-associated 94–95
  - infectious 1, 7, 20, 74, 179, 213–216, 218–219, 222–223, 229, 232
  - neurodegenerative 102
  - neurological 99
  - non-infectious 223
- DNAPLOT program 232
- DTP, *see* diphtheria, tetanus, pertussis
- effector cells 4–5, 14, 136
  - activated 146
  - immune 82, 184
  - primary 114
- ELISA 176, 194, 203–206, 211–212
- encephalitis 221–222
- endocytic vesicles 26, 79
- endocytosis 12, 14, 37
- endoplasmic reticulum (ER) 14, 25–26, 82, 86, 88–89, 144, 186
- endosomes 26, 37, 79, 82, 86
- endothelial cells 73, 84, 104
  - vascular 24, 73
- endotoxin 38, 40
- epithelial cells 34, 42, 84, 175
  - mucosal 175
  - thymic 24, 73
  - thymic cortical 136
  - thyroid 24
- epitopes
  - antigenic 147
  - immune 228
  - peptide 228, 232
  - protein 14
- ER, *see* endoplasmic reticulum
- FACS, *see* fluorescence-activated cell sorting
- feline leukemia virus (FLV) 156
- flow cytometry 206–208, 210–212
- fluorescence-activated cell sorting (FACS) 208, 211
- fluorochromes 206–208
- FLV, *see* feline leukemia virus
- GALT, *see* gut-associated lymphoid tissue
- gene therapy 114, 122–123, 126
- genes
  - antibody 172
  - complement factor 93
  - disease-associated 230
  - heat shock protein 77
  - immunoglobulin 4
  - tumor suppressor 134, 138, 161
- genetic defects 114, 116, 118–119
- genetic mutations 134
- GITR, *see* glucocorticoid-induced tumor necrosis factor receptor
- glial cells 84, 100, 103
- globulins 3–4, 8
  - anti-tetanus 219
- glucocorticoid-induced tumor necrosis factor receptor (GITR) 148
- glycoproteins 13, 28, 42, 141
- GMCSF, *see* granulocyte macrophage colony stimulating factor

- Gram-negative bacteria 37, 40, 105
- Gram-positive bacterial peptidoglycan 38
- granulocyte macrophage colony stimulating factor (GMCSF) 155
- granulocytes 118, 150, 162
- gut-associated lymphoid tissue (GALT) 124
  
- haptens 3, 232
- HBV, *see* hepatitis B vaccine
- HCV, *see* hepatitis C virus
- hematopoietic stem cell transplantation (HSCT) 122
- hemolytic anemia, autoimmune 9
- hepatitis B vaccine (HBV) 140, 152, 156, 212, 217
- hepatitis C virus (HCV) 211–212
- Hermansky-Pudlak syndrome (HPS) 121
- HIV 35, 113–114, 123–124, 126, 204, 206, 212, 218
- HIV-infected cells 124
- HLA, *see* human leukocyte antigen
- HLA antigen expression analysis 208
- HPS, *see* Hermansky-Pudlak syndrome
- HPV, *see* human papilloma virus
- HSCT, *see* hematopoietic stem cell transplantation
- human immune deficiency virus 228
- human leukocyte antigen (HLA) 4, 67–70, 73, 228
- human papilloma virus (HPV) 140, 152, 156, 160, 222
- hybridoma 154, 177–179
  
- IDDM, *see* insulin dependent diabetes mellitus
- immune dysregulation 115, 121, 147
- immune functions, defective 125
- immune response
  - local 85
  - T-cell-mediated 27
- immune responses
  - cell-mediated 23, 103, 145
  - cellular 11
- immunization 7, 79, 92, 156, 218, 224
  - active 218, 220
  - mass 219
  - passive 7, 192, 218–220, 223
- Immuno Polymorphism Database (IPD) 230
- immunocytokines 185
- immunodeficiency 114, 123, 125
  - combined 115
  - human severe combined 115, 127
- immunodeficiency disorders, overview of 113–114, 116, 118, 120, 122, 124, 126
- immunogenetics 10, 229, 231
- immunoglobulins 5, 10, 22, 69, 78, 119, 146, 170–172, 174–176, 183, 196, 202, 210, 219, 229
  - human 219
- immunoinformatics 225–230, 232–234
- immunology, computational 225
- immunopathogenesis 124
- immunopathology 3
- immunosuppression 161, 192
  - tumor-related 147
- immunosuppressive medications 142
- immunosurveillance 137, 141–142, 147–148, 150, 158
- immunosurveillance hypothesis 142–143

- immunosurveillance theory 141
- immunotherapy 151–156, 229
  - active 152
  - passive 152
- infectious pancreatic necrosis
  - virus (IPNV) 208, 211
- insulin 211, 228
- insulin dependent diabetes
  - mellitus (IDDM) 228
- IPD, *see* Immuno Polymorphism Database
- IPNV, *see* infectious pancreatic necrosis virus
  
- Langerhans cells 72, 82, 85, 97
- leucine-rich repeats (LRRs) 37
- leukemia, chronic lymphocytic
  - 155, 181
- LRRs, *see* leucine-rich repeats
- lymph nodes 2, 85, 119, 124, 146, 151, 157, 176, 179, 227
- lymphatic vessels 84–85
- lymphocytes, tumor-infiltrating
  - 143
- lymphocytic choriomeningitis 93
- lymphomas, spontaneous 143
- lymphopenia 116–117, 123–124
- lymphotoxin 73
- lysosomal degradation 185
  
- MAC, *see* membrane attack complex
- macrophage activation 5, 122
- major histocompatibility complex (MHC) 4, 6, 13–14, 23–27, 67–68, 70–84, 86, 88–90, 92–97, 100, 102, 105, 229–231
- MCP, *see* membrane cofactor protein
- MDSCs, *see* myeloid-derived suppressor cells
- measles 6, 21, 214, 218, 221–222
- membrane attack complex (MAC)
  - 46, 55
- membrane cofactor protein (MCP)
  - 52, 57–58
- memory cells 11, 28–30
  - primed 81
- metastasis 134, 150, 159, 231
- MHC, *see* major histocompatibility complex
- MHC antigens 67–68, 94
  - human 67–68
- MHC binding sites 91–92
- MHC-expressing cells 72
- MHC gene products 68, 72, 76
- MHC molecules 4, 13–14, 23, 25, 68–77, 79, 82–84, 90, 94, 228, 231
- microglia 99–106
- microglial activation 101–103, 106–107
- microglial cells 101–104
- microglobulin 25, 68, 75–77, 88–89
- mixed lymphocyte reaction (MLR)
  - 81, 91–92, 97
- MLR, *see* mixed lymphocyte reaction
- monoclonal antibodies 152, 154, 169, 176–180, 191–192, 194–196, 202
  - human chimeric 195
  - rat-derived anti-CD3 184
- mutagens 161
- mutations 5, 36, 94, 116–121, 124, 134, 160–161, 173, 188–190, 216
- myeloid cells 100, 150–151, 162
- myeloid-derived suppressor cells (MDSCs) 146, 148, 150–151, 158, 162
- naive B-cell activation 28–29

- natural killer (NK) 75, 116, 143, 157
- neoantigens 138, 160
- neoplasia 134
- neurodegeneration 100, 106
- neuronal death 102, 106–107
- nitric oxide 102–103
- NK, *see* natural killer
- NK cells 42, 116, 118, 121–122, 144–145, 148–149, 161
- NKT cell activation 161
- nucleotides 42
  
- Obinutuzumab 187
- opsonins 8, 34, 45–46, 49, 53
- opsonization 28, 46, 58–59, 173
- optical filters 206
- OPV, *see* oral polio vaccine
- oral polio vaccine (OPV) 216
- organisms, multicellular 19, 58
  
- PAMPs, *see* pathogen-associated molecular patterns
- pancreas 34, 141
- pancreatic islet cell autoantigen 96
- PAP, *see* prostatic acid phosphatase
- parasites, intracellular 149–150
- pathogen-associated molecular patterns (PAMPs) 35, 105
- pathogenesis, molecular 114
- pathways
  - biological 230
  - cytosolic 24, 26–27
  - endocytic 14, 24, 26, 86
  - immunological 229
- pattern recognition receptors (PRRs) 35, 102, 104
- PEG, *see* poly ethylene glycol
- PEGylation 191
- peptide-binding sites 96
- peptide complexes 74, 83
- peptide linkers 183–184
- peptides
  - antigenic 86–87, 90
  - antimicrobial 28, 33–34, 38, 59
  - cationic 34, 59
  - MHC 25, 27, 87, 231
- peptidoglycan 37, 105
- phagocytes 2, 5, 22–23, 30, 35, 46
- phagocytosis 26, 41, 46, 55, 58, 86, 101, 104
- PIDs, *see* primary immunodeficiency diseases
- platelets 72, 80, 118, 175
- poliovirus 216
- poly ethylene glycol (PEG) 123, 177
- polymerization 46, 55, 57
- polymorphisms 72, 74, 76–78, 93
- polypeptide chains 25, 75, 78, 170
- primary immunodeficiency diseases (PIDs) 113, 115, 122, 126
- prostatic acid phosphatase (PAP) 156
- proteases
  - active 48–49
  - multifunctional 24–25
- proteasomes 24–25, 78
- protein engineering 188
- proteins
  - acute phase 33, 40–41, 49, 59–60
  - antigenic 228
  - B-cell antigenic 228
  - complement 28–29, 33–34, 46, 54, 57–59, 93, 171
  - complement-regulatory 52
  - cytosolic 58, 88
  - disease-causing 215
  - effector-complement 45
  - endogenous 82, 92
  - exogenous 82



- extracellular 26, 86
- heat shock 25–27, 73
- immune responsive 170
- molecular chaperon 25
- natural disease-fighting 194
- NOD 39–40, 58
- phagocytosed microbial 88
- plasma 40, 44–45, 52, 54, 170
- pulmonary surfactant 41
- therapeutic 194
- transmembrane 5, 79
- tumor suppressor 160
- vaccine 217
- proteolytic enzymes 26, 86–87, 150
- proteosomes 74, 79, 88
- protooncogenes 119, 134, 161
- pseudogenes 77, 80
- radiolabeled antigen 208–209
- reactive oxygen species (ROS) 102–103, 149
- receptors
  - antigen 69, 96
  - antigen binding 13
  - chemokine 102–103
  - cytokine 116, 122
  - lymphocyte 173
  - macrophage 38
  - membrane-bound 33, 59
  - phagocytic 35, 102
  - scavenger 35
  - T-cell antigen 4, 69
- rheumatoid arthritis 95–96, 126, 181, 228
- ROS, *see* reactive oxygen species
- Rous sarcoma virus (RSV) 140
- RSV, *see* Rous sarcoma virus
- SAP, *see* SLAM-associated protein
- SCN, *see* severe congenital neutropenia
- self-antigens 76, 89, 136, 148
- self-peptides 74, 92
  - immunogenic 95
- self-proteins 160
- serum, anti-tetanus 218–219
- serum immunoglobulin 119
- severe congenital neutropenia (SCN) 121
- signaling lymphocytic activation molecule (SLAM) 118
- SLAM, *see* signaling lymphocytic activation molecule
- SLAM-associated protein (SAP) 118
- T-cell activation 27, 105
- T-cell clones 90–91
- T-cell functions, impaired 126
- T-cell interaction molecules 69
- T-cell-mediated autoimmune response 95
- T-cell receptor (TCR) 13, 23, 27, 39, 73–77, 83–84, 90–93, 143–146, 153, 226
- T-cells 4–5, 13–14, 23, 25, 27–28, 69–70, 73–76, 79, 82–87, 89–92, 95, 118, 152, 227–228
  - activated 5, 27, 79
  - adherent 93
  - antigen binding 14
  - clonotypic 74
  - cytotoxic 76, 92
  - effector 13–14, 85
  - helper 6, 28–29, 92
  - memory 13
  - naïve 85
  - suppressor 6, 11
- T cytotoxic (TC) 13–14, 23, 25, 136, 143–145, 155, 184–185
- T-lymphocytes 10, 20, 22–23
- T-reg cells 146, 151, 157

- TAAs, *see* tumor-associated antigens
- TAMs, *see* tumor-associated macrophages
- tapasin 25, 89
- target cells release 144
- TC, *see* T cytotoxic
- TC cells 14, 23
- TCR, *see* T-cell receptor
  - endogenous 153
- TLRs, *see* toll like receptors
- TNF, *see* tumor necrosis factor
- toll like receptors (TLRs) 12, 37–39, 58, 102–103, 105
- toxicity 219–220
- TSAs, *see* tumor-specific antigen
- tuberculosis 2, 22, 215
- tumor angiogenesis 181
- tumor-associated antigens (TAAs) 140, 156
- tumor-associated macrophages (TAMs) 146, 148–152, 157–158
- tumor cells 23, 84, 133–137, 139–140, 143–148, 150–152, 156–158, 160–162
- tumor immunology 137
- tumor immunosuppression 148–149
- tumor immunosurveillance 136, 141, 143, 146, 158–159, 162
- tumor immunotherapy 155, 158
- tumor necrosis factor (TNF) 25, 40, 54, 73, 77, 144, 148, 181
- tumor-specific antigen (TSAs) 139–140, 147, 151
- tumor vaccination 157
- tumorogenesis 138–139
- tumors
  - antigenic 147
  - solid 184, 195
  - virus-induced 140, 156
- ubiquitin 24, 88
- vaccine ontology (VO) 232
- vaccines
  - cancer 215, 223
  - inactivated 215–217
  - recombinant protein 218
- vascular-endothelial growth factor receptor (VEGFRs) 155
- vascular endothelial growth factors (VEGFs) 149
- VEGFRs, *see* vascular-endothelial growth factor receptor
- VEGFs, *see* vascular endothelial growth factors
- viruses, pathogenic 133, 139
- VO, *see* vaccine ontology
- Wiskott–Aldrich syndrome 117
- X-linked agammaglobulinemia (XLA) 119
- X-linked hyper-IgM immunodeficiency 5
- X-linked recessive severe combined immunodeficiency (X-SCID) 116
- X-SCID, *see* X-linked recessive severe combined immunodeficiency
- XLA, *see* X-linked agammaglobulinemia

*“This book addresses the need for a comprehensive understanding of the immunological processes associated with the various ways in which the human body counters pathogens and other antigenic challenges. It fills the gaps in the field of immunology with its up-to-date content, simplified language, well-edited chapters, and ample number of illustrations. It will serve as a useful resource for medical students as well as interdisciplinary researchers. The book is a very welcome addition to the field of immunology.”*

**Prof. Vasu Punj**

**University of Southern California, Los Angeles, USA**

Immunology has emerged as a key component of the curricula of graduate and postgraduate courses in biotechnology, microbiology, biochemistry, bioinformatics, and other interdisciplinary fields of biology, including zoology, veterinary science, and medicine. As a basic introductory textbook on one of the fastest-moving and most challenging areas of immunological science, this book contains the most recent information about immunologic mechanisms and their importance, along with various molecular techniques employed in immunology. The short and concise text helps make the structures, processes, and interactions of the immune system easily comprehensible. The book includes chapters on immunoinformatics as well as the immune system of the brain, rarely found in any of the immunology books published so far. Many diverse and interesting aspects of the advances in immunology have also been covered, including tumor immunology and immunodeficiency disorders. The easy-to-understand concepts presented in the textbook make it an ideal companion for learners preparing for competitive and other examinations. Undergraduate, postgraduate, and PhD students, people from the industry and academia, and research scholars will immensely benefit from it.



**Anil K. Sharma** is full professor and head of the Department of Biotechnology at Maharishi Markandeshwar (Deemed to be University), India, since 2010. From 2003 to 2010, he was a senior research scientist and a postdoctoral research fellow (molecular biology) at the Department of Microbiology and Immunology of the University of Illinois College of Medicine, Chicago, USA. He gained exposure to industrial R&D when

he worked for Ranbaxy Research Laboratories, a multinational pharma major, as a research scientist from 2001 to 2003. Prof. Sharma has published 6 books and more than 100 articles in peer-reviewed journals with h-Index of 16 ( $i_{10}$  score of 23), and the cumulative impact factor of his publications is more than 130.0, with more than 1000 citations. He has been felicitated with many prestigious awards and accolades, including the Eminent Scientist Award (2017), Achiever Award of the Society for the Advancement of Human and Nature (2016), and Bharat Excellence Award (2013). He has been the editor or an editorial board member for several journals of international repute. His research interests range from the etiology of breast cancer, immunoregulation in prokaryotes and eukaryotes, drug resistance, and nanomedicines to the development of microbial strains for the remediation of heavy metals and pesticides.



**PAN STANFORD PUBLISHING**

[www.panstanford.com](http://www.panstanford.com)

