CONTENTS

PF	REFACE	XV
	Why should you read this book?	XV
	Why did I write this book?	xviii
AC	KNOWLEDGMENTS	XXI
1.	ORIGIN AND FUNCTION	1
	What is an antibiotic?	1
	What is the difference between an antibiotic and an antimicrobial?	1
	How do antibiotics work?	7
	What is the difference between broad- and narrow-spectrum antibiotics?	8
	Why do we have so many different antibiotics?	10
	Do antibiotics work against viruses?	13
	Why do people confuse bacteria and viruses?	14
	How were antibiotics discovered?	15
	Where do antibiotics come from?	26
	How are antibiotics made?	30
	Are new antibiotics created in the laboratory or discovered in nature?	32
	What happens after a compound with antibacterial activity is discovered? How does it come to be used to treat infections?	32
	Are the same antibiotics used all over the world?	37

	How common are substandard and falsified antibiotics?	39
	What is the WHO model list of essential medicines?	41
2.	USE IN HUMANS	43
	How are antibiotics administered? What are the routes of administration besides by mouth and by injection? What determines how they should be given?	43
	Are pills as effective as injections?	46
	Where does the antibiotic go in the body? Does it reach all organs and tissues? What is its fate? Does any part of the antibiotic leave the body in urine or feces?	49
	What happens with antibiotics after they leave the body?	51
	Why are antibiotics that are not absorbed used?	52
	How does one decide which antibiotic to use?	53
	What information about each antibiotic is available to the pharmacist, the health provider, and the patient?	57
	How long does it take for an antibiotic to work? Why are some antibiotics given as a single dose and others prescribed for weeks or longer?	60
	What determines the right dose of an antibiotic?	61
	Can one overdose on an antibiotic?	63
	Does an antibiotic have any effect other than against the bacteria being treated?	63
	How long does the effect of an antibiotic last?	65
	Why are some infections, such as tuberculosis, always treated with multiple different antibiotics taken simultaneously?	66
	Does one always have to take the entire course of prescribed antibiotics?	68
	Can one take leftover antibiotics for a new infection? Or give it to a family member or friend?	70
	What should one do with leftover antibiotics?	71
	Is it dangerous to take expired antibiotics?	72
	When are antibiotics used to prevent infections (in contrast to treating an established infection)?	75
	How are antibiotics used to prevent infections in surgery?	76

In what other settings are antibiotics used to prevent infections (antibiotic prophylaxis)?	78
When are antibiotics used to treat entire populations in mass treatment campaigns?	82
What are the consequences of mass treatment with antibiotics?	87
How are antibiotics used in the human population? Who receives them?	90
What are the main reasons that antibiotics are prescribed?	91
Why is antibiotic use so common for respiratory infections?	92
Does antibiotic use vary by region or by country?	94
Is antibiotic use increasing or decreasing?	96
How much is spent on antibiotics?	98

3. CONSEQUENCES OF USE: ADVERSE EVENTS ASSOCIATED WITH USE OF ANTIBIOTICS IN HUMANS

4

101

101
107
109
109
111
111
112
115
118
119
122
122
126

x Contents

	Why do yeast infections occur during and after treatment with antibiotics?	128
	What is the microbiome and why is it so important?	129
	What is the Human Microbiome Project?	134
	What are the functions of the human microbiome?	136
	How do antibiotics affect the human microbiome?	140
	Does human use of antibiotics and other agents affect animal microbiota?	143
	Do other drugs besides antibiotics affect the microbiome?	145
	Can the gut microbiota be protected from the effect of antibiotics?	146
4.	OTHER USES OF ANTIBIOTICS (NONHUMAN USE)	149
	What are the uses of antibiotics other than to treat infections in humans?	149
	What proportion of antibiotics produced in recent years had a nonhuman use?	149
	Why are antibiotics given to healthy animals?	150
	Which animals receive antibiotics?	155
	Which antibiotics are used? Are the same antibiotics used in people also used in animals?	156
	And antibiotics used in faced enimals in other countries?	450
	Are antibiotics used in food animals in other countries?	158
	Are antibiotics used in tood animals in other countries? How are antibiotics used in aquaculture?	158 159

What are the consequences of using antibiotics in animals?162Is any antibiotic still present in the meat, fish, eggs, or milk when
they are sold for human consumption?164Why are antibiotics used in bees?166Do plants develop infections? Why and how often are antibiotics
used in plants?167Can humans pick up infections from plants?168

How can plant infections affect human health?169Is food from plants contaminated with antibiotics?172

Does feeding animals antibiotics in large production facilities (such as industrial production of food animals like chickens, pigs, and	
cattle) have an impact on the local environment?	176
What are other sources of antibiotics in the environment?	178

5. ANTIBIOTIC RESISTANCE

•

181

What is antibiotic resistance?	181
Where did antibiotic resistance come from?	185
What are the mechanisms bacteria use to evade antibiotics?	189
How do bacteria destroy or disable the antibiotic?	190
How can bacteria change an antibiotic to resist it?	193
How can bacteria prevent antibiotics from getting through the cell wall of the bacteria?	194
How do bacteria manage to pump antibiotics out of the bacterial cell?	194
How can bacteria alter the target of antibiotic action in the bacteria?	195
How can bacteria bypass key functions to survive despite the presence of antibiotics?	196
What else can bacteria do to avoid being killed?	197
How does one test bacteria for resistance to antibiotics?	199
How does antibiotic resistance spread among bacteria?	202
Where does this transfer of resistance genes among bacteria take place?	205
How do resistant bacteria and resistance genes spread globally? What is the role of travel in the movement of resistant bacteria and resistance genes globally?	206
How do travelers pick up multiply resistant bacteria? Where are the resistant bacteria found?	210
How often do travelers pick up resistant bacteria? Do they spread \checkmark them to others?	215
What is medical tourism? Are travelers who receive medical care abroad at risk for infections with resistant bacteria?	218
Are mass gatherings an important source of infections and spread of infections or resistance?	220
What is wastewater epidemiology?	221

	How does resistance spread in health care facilities?	223
	Are there ways resistant bacteria spread that do not involve movement of humans?	225
	Do pets carry antibiotic-resistant bacteria?	227
	What are other routes of spread of bacteria from animals to humans?	228
	Does antibiotic resistance ever disappear?	229
	Which bacteria have developed resistance?	229
	Why does tuberculosis remain such a serious global problem?	230
	Why is gonorrhea so hard to treat?	239
	Are antibiotic-resistant bacteria found in all countries?	244
	Are levels of resistance influenced by the amount of antibiotic used in a region or country?	245
	What can be done to slow or stop antibiotic resistance?	245
6.	CONSEQUENCES OF ANTIBIOTIC RESISTANCE	247
	What are the most important consequences of having infections caused by antibiotic-resistant bacteria?	247
	Are infections caused by antibiotic-resistant bacteria less severe, more severe, or the same?	249
	Are outcomes worse for antibiotic-resistant infections?	250
	What would be the consequences if antibiotics stopped working? What do people mean by the "postantibiotic era"?	253
	What medical procedures today rely on the availability of highly effective preventive antibiotics?	253
	Do we have antibiotics to use when bacteria become resistant to first-line drugs?	255
	Are these other antibiotics as safe and effective as first-line drugs? Are they available and affordable?	256
	Can antibiotics still be used for prevention when bacteria become resistant?	257
•	Are people dying today because of antibiotic-resistant infections?	257
	Why are antibiotics considered community drugs? How does my taking an antibiotic affect my neighbors and the community?	260

Contents xiii

263

7. INTERVENTIONS TO REDUCE NEED FOR ANTIBIOTICS AND ALTERNATIVES TO ANTIBIOTICS

Are there ways to reduce the risks of infections so that we do not need antibiotics?	263
How do clean water and improved sanitation reduce use of antibiotics?	264
How can processing and handling of food affect antibiotic use?	267
How can using vaccines reduce the need for antibiotics?	270
How can vaccines against viral infections reduce the need for antibiotics? Why does influenza, a virus, get so much attention?	272
Are vaccines used to prevent infections in animals? Can they prevent infections that could affect humans?	278
How can controlling vectors like mosquitoes and ticks reduce antibiotic use?	279
Are health care—associated infections a common reason for antibiotic treatment?	280
Do antiseptics and alcohol-based hand sanitizers work against all microbes?	286
How can copper be used to reduce infections?	288
Are there approaches to treating infections that do not involve antibiotics—treatment approaches that do not drive the development of resistance the way that use of antibiotics does?	293
What other approaches to treating infections are being tried that do not involve antibiotics?	294
What is bacteriophage therapy? How does it work? Is it being used today?	297
Looking to the future	302
How are phages and bacteriocins used today?	303

8. PRESERVING ANTIBIOTICS AND DEVELOPING NEW ANTIBACTERIAL TREATMENTS

307

How common is inappropriate prescribing of antibiotics?	307
What approaches have been effective in increasing the appropriate use of antibiotics and decreasing inappropriate prescribing	
by clinicians?	311

/

What can individuals do to reduce the inappropriate use of antibiotics?	316
What are antibiotic stewardship programs?	318
Do antibiotic stewardship programs work?	319
Why do stewardship programs include focus on reported allergies to antibiotics?	321
What is the role of better diagnostic testing in reducing use of antibiotics?	324
What is procalcitonin and can it help guide antibiotic treatment?	325
Are procalcitonin levels useful in diagnosing infections in infants?	328
Why did use of rapid diagnostic tests lead to increased use of antibiotics in some settings?	329
Are there other approaches that use urine, saliva, breath, or other specimens to diagnose infection?	331
What is the role of national and international agencies in reducing inappropriate use of antibiotics?	335
Why aren't pharmaceutical companies developing more new antibiotics? Why don't we have more antibiotics in the pipeline?	337
Which bacteria are the highest priority for development of new antibiotics?	338
What antibiotics or antibacterial products are currently in the pipeline?	339
Whose responsibility is it to develop new antibiotics? Who pays for their development? What incentives or other approaches might increase the development of new antibiotics?	340
What are priority areas in looking for other ways to treat bacterial infections?	342
GLOSSARY	347
BIBLIOGRAPHY	
INDEX	