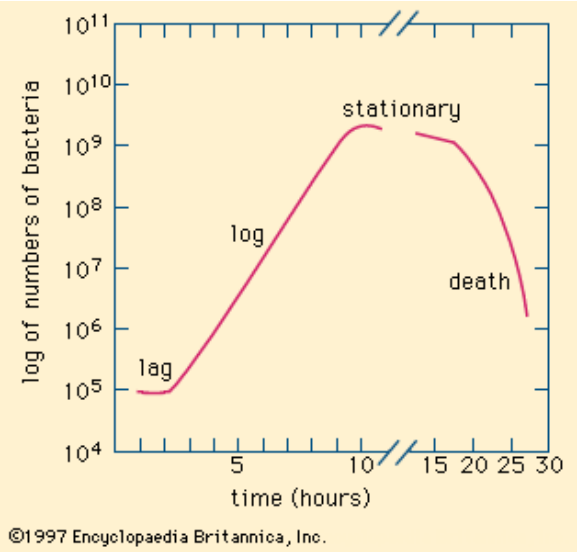
Microbial Growth Control

Antibiotics
Bacteriocins
Bdellovibrio – a bacteria eater
Bacterial cannibalism

Effect of Antimicrobial Agents on Growth

Growth Curve of Bacteria



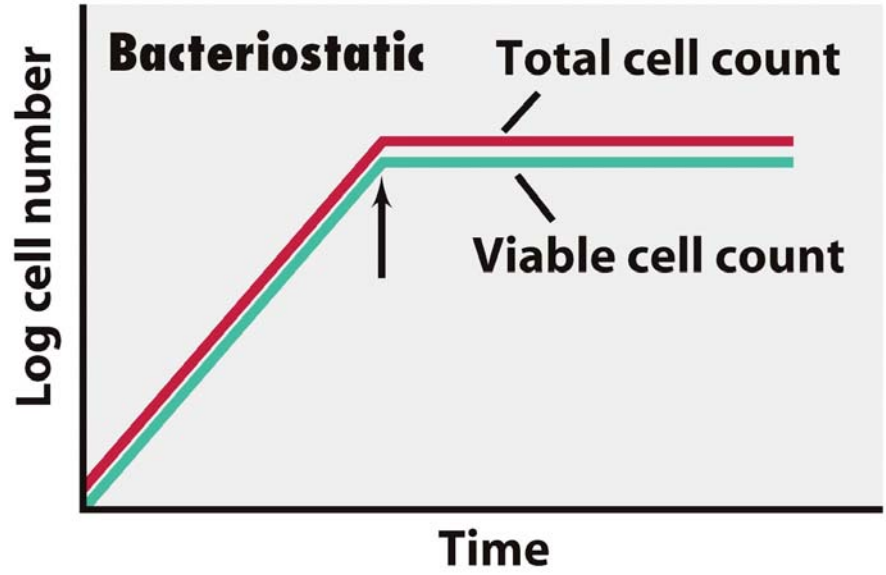


Figure 20-9a Brock Biology of Microorganisms 11/e

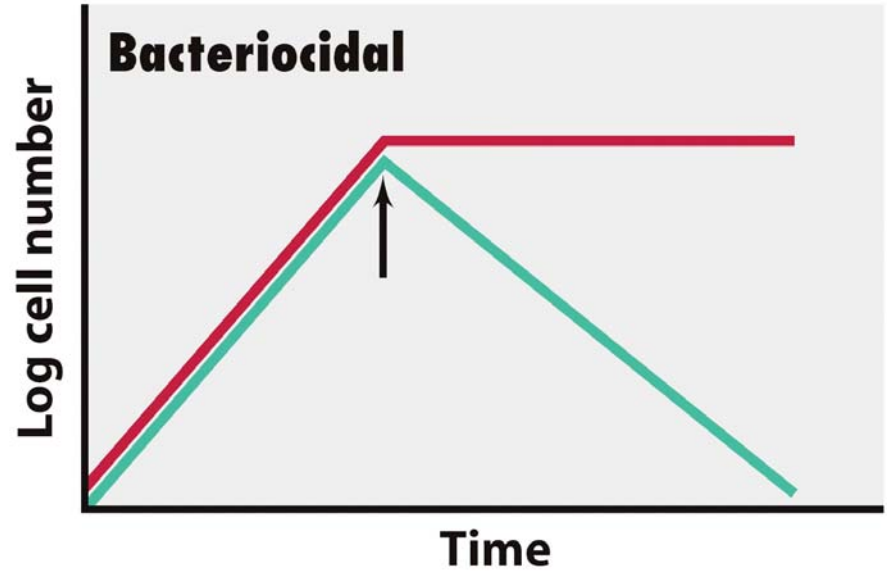


Figure 20-9b Brock Biology of Microorganisms 11/e

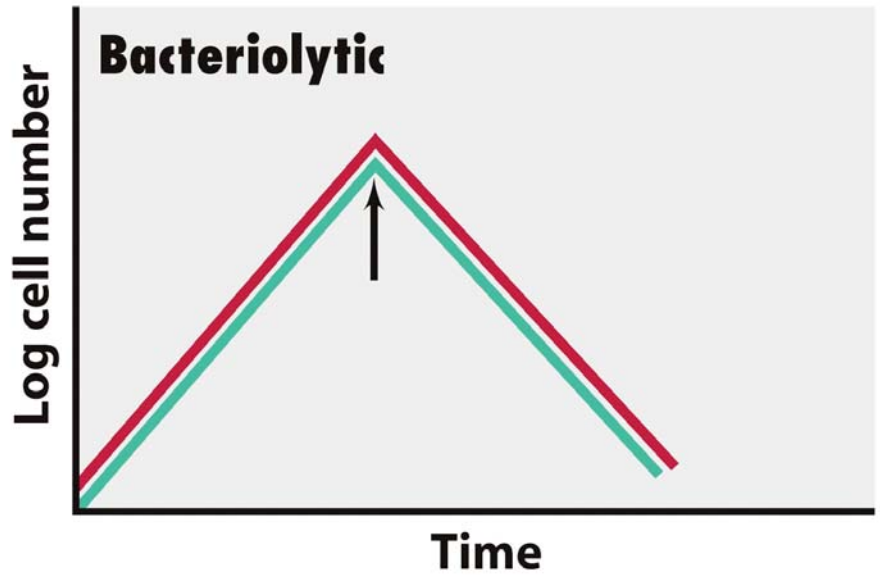


Figure 20-9c Brock Biology of Microorganisms 11/e

Measuring Antimicrobial Activity

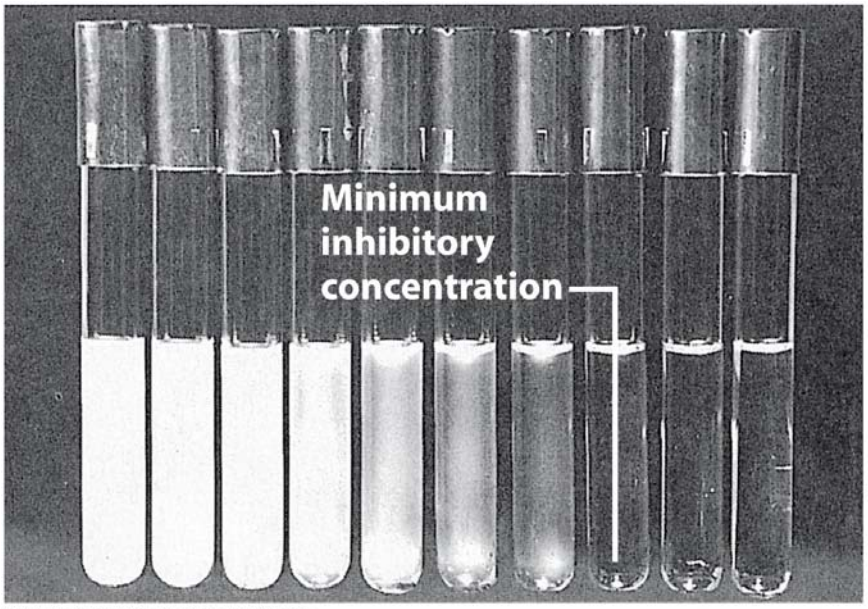


Figure 20-10 Brock Biology of Microorganisms 11/e

Test for antibiotics

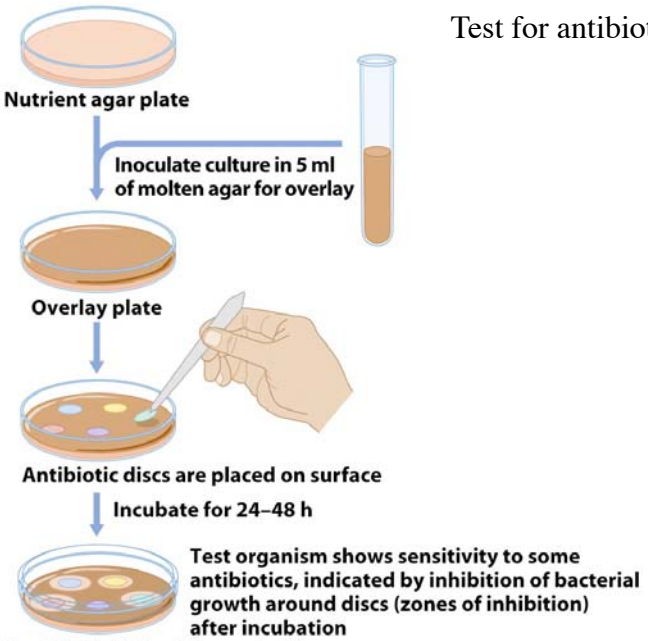


Figure 20-11 Brock Biology of Microorganisms 11/e

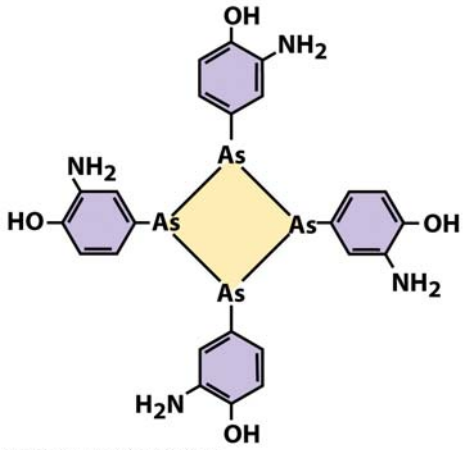


Figure 20-12 Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

Salvarsan:
Treatment of Syphilis
In the early 1910
"compound 606"

Targets of antibiotics

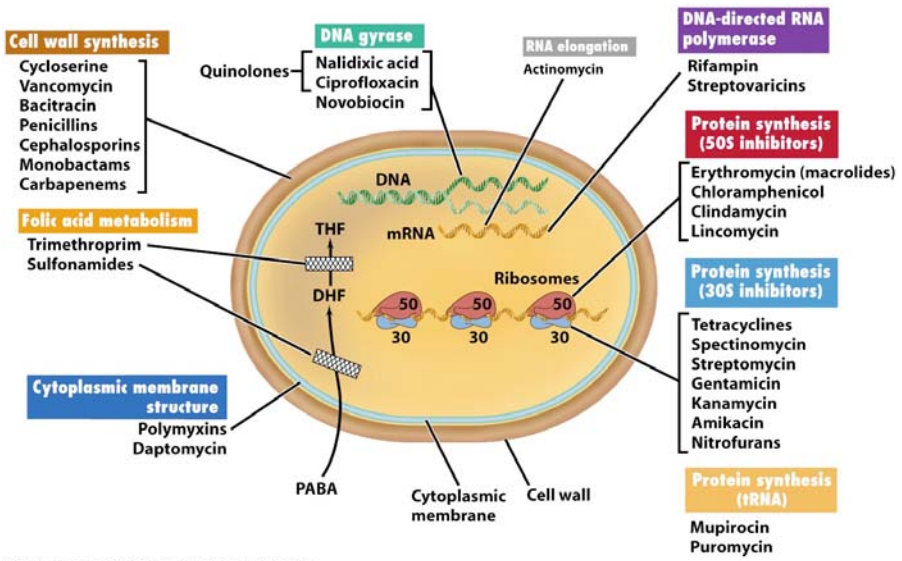


Figure 20-14 Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

Antibiotic classification		Subclassification	Example
I.	Carbohydrate-containing compounds	Pure sugars	Nojirimycin
		Aminoglycosides	Streptomycin
		Orthosomycins	Everninomicin
		N-Glycosides	Streptothricin
		C-Glycosides	Vancomycin
		Glycolipids	Moenomycin
II.	Macrocyclic lactones	Macrolide antibiotics	Erythromycin
		Polyene antibiotics	Candicidin
		Ansamycins	Rifampin
		Macrotetrolides	Tetranactin
III.	Quinones and related compounds	Tetracyclines	Tetracycline
		Anthracyclines	Adriamycin
		Naphthoquinones	Actinorhodin
		Benzoquinones	Mitomycin

Representative structure

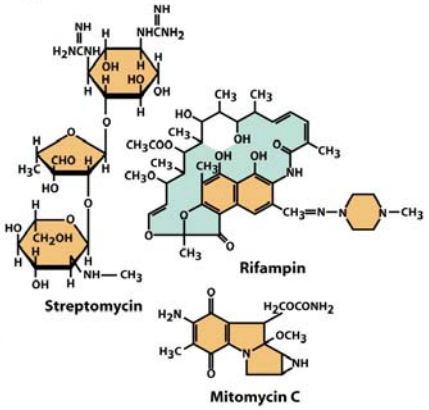


Figure 20-13 part 1 Brock Biology of Microorganisms 11/e

Antibiotic classification		Subclassification	Example
IV.	Amino acid and peptide analogs	Amino acid derivatives	Cycloserine
		β-Lactam antibiotics	Penicillin, ceftriaxone
		Peptide antibiotics	Bacitracin
		Chromopeptides	Actinomycin
		Depsipeptides	Valinomycin
		Chelate-forming peptides	Bleomycin
V.	Heterocyclic compounds containing nitrogen	Nucleoside antibiotics	Polyoxins
VI.	Heterocyclic compounds containing oxygen	Polyether antibiotics	Monensin

Representative structure

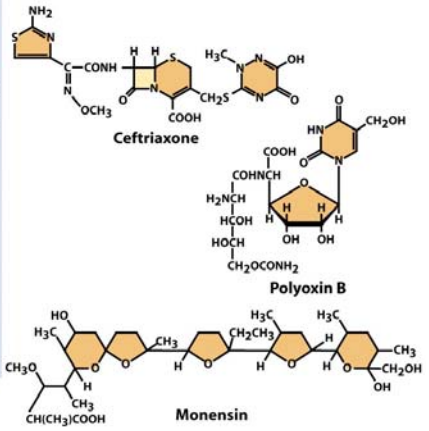


Figure 20-13 part 2 Brock Biology of Microorganisms 11/e

Antibiotic classification	Subclassification	Example
VII. Alicyclic derivatives	Cycloalkane derivatives Steroid antibiotics	Cycloheximide Fusidic acid
VIII. Aromatic compounds	Benzene derivatives Condensed aromatics Aromatic ether	Chloramphenicol Griseofulvin Novobiocin
IX. Aliphatic compounds	Compounds containing phosphorus	Fosfomycin

Representative structure

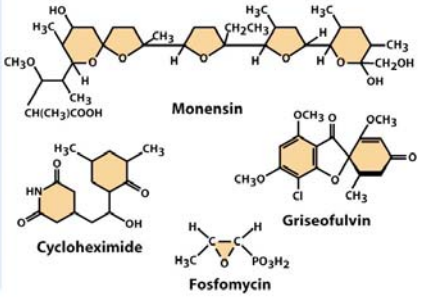


Figure 20-13 part 3 Brock Biology of Microorganisms 11/e

Antibiotic classification	Subclassification	Example
X. Quinolone compounds	4-Quinolone Fluoro-4-quinolones	Nalidixic acid Ciprofloxacin
XI. Oxazolidinone	Cyclic lactone	2-Oxazolidinone

Representative structure

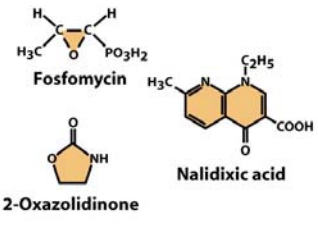


Figure 20-13 part 4 Brock Biology of Microorganisms 11/e

Wirkspektren

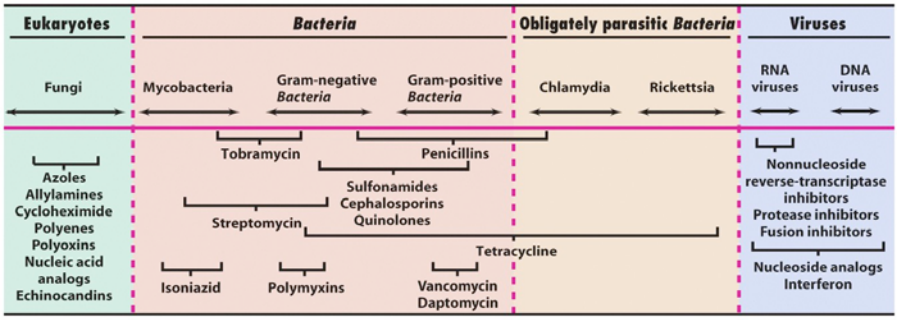


Figure 20-15 Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

Annual worldwide production and use of antibiotics

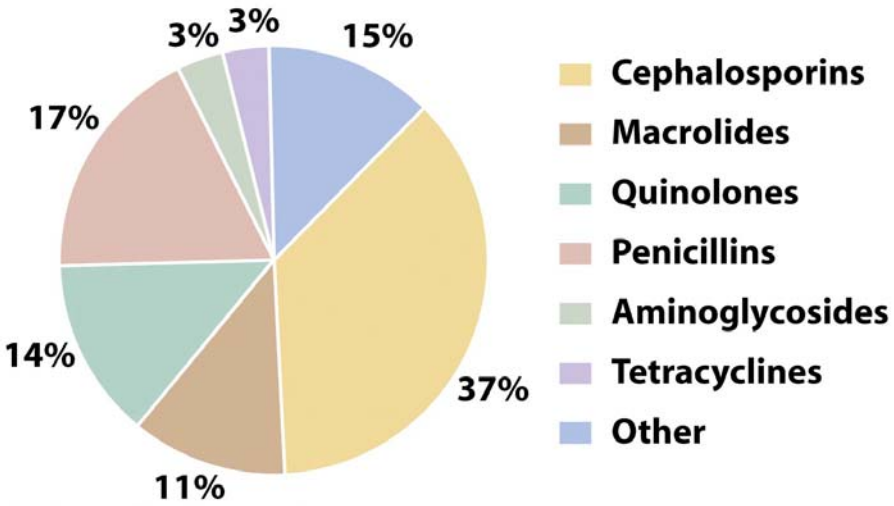


Figure 20-16 Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

Sulfa Drugs

Sulfanilamid is an analog of paba, a precursor of the growth factor folic acid

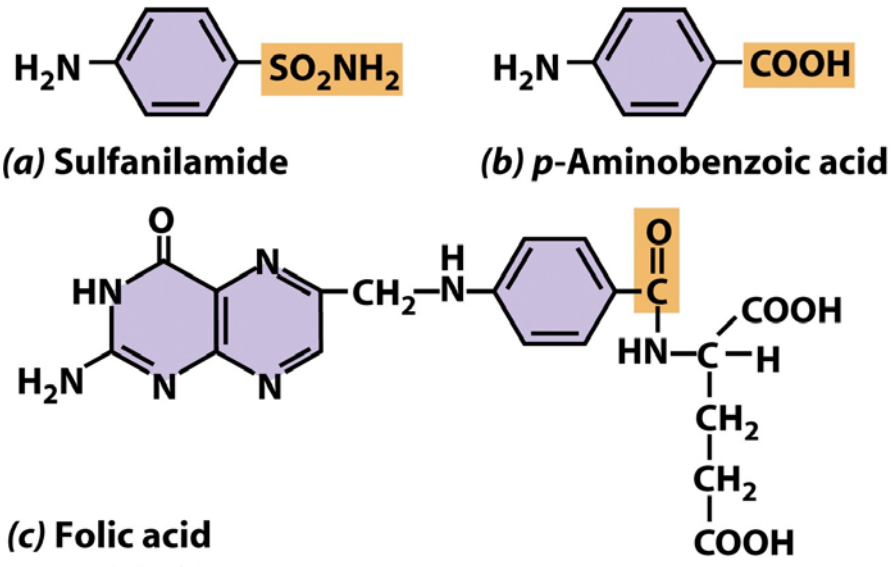


Figure 20-17 Brock Biology of Microorganisms 11/e

Nucleic Acid Analogs

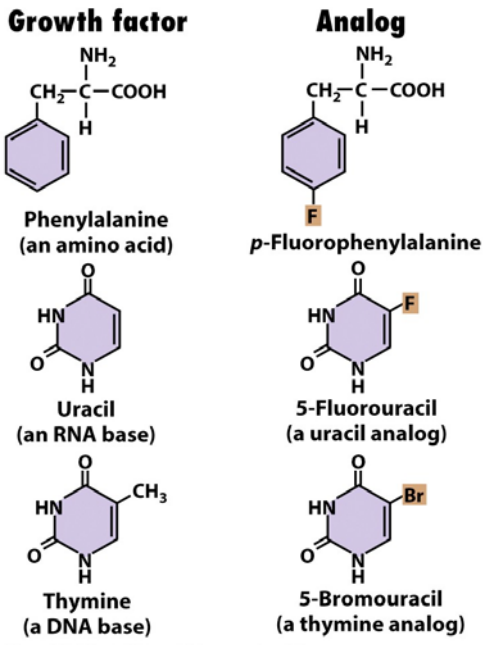


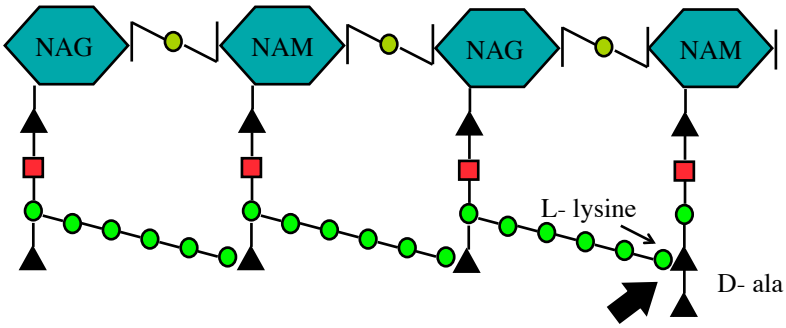
Figure 20-18 Brock Biology of Microorganisms 11/e

Naturally Occurring Antimicrobial Drugs: Antibiotics

β-Lactam Antibiotics: Penicillins and Cephalosporins

Inhibitors of bacterial cell wall synthesis

Cell wall Attachment of new wall unit to growing peptidoglycan



Beta-lactams
Bind to and inhibit enzymes which catalyse this link

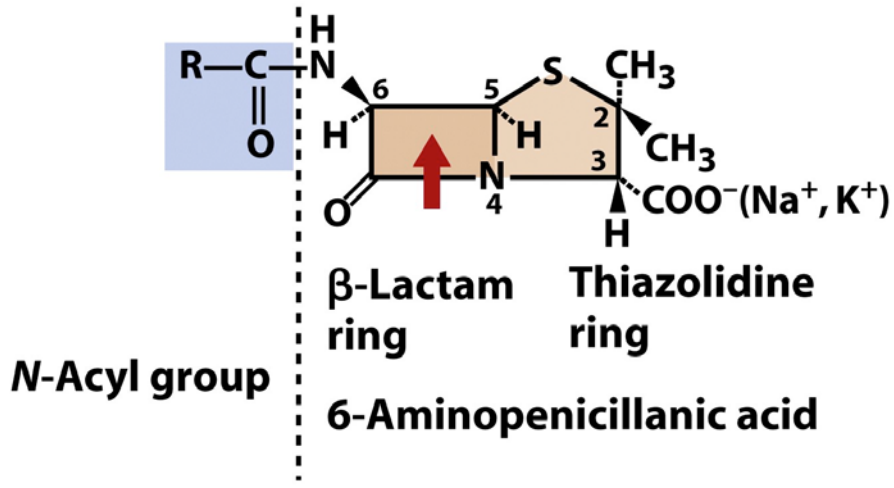


Figure 20-20 part 1 Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

Alexander Fleming in 1928

The β-lactam compounds, including the penicillins and the cephalosporins, are the most important clinical antibiotics. These antibiotics target cell wall synthesis in *Bacteria*. They have low host toxicity and a broad spectrum of activity.

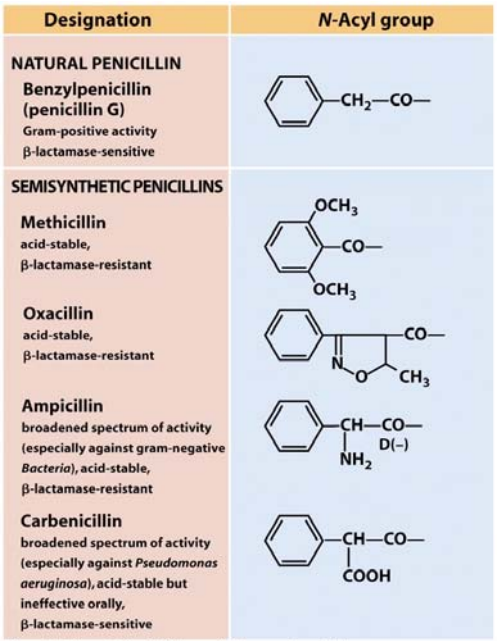


Figure 20-20 part 2 Brock Biology of Microorganisms 11/e

Antibiotics from Prokaryotes

Aminoglycoside Antibiotics

Amino sugars bonded by glycosidic linkages
Inhibit 30S subunit
Against gram-negative bacteria

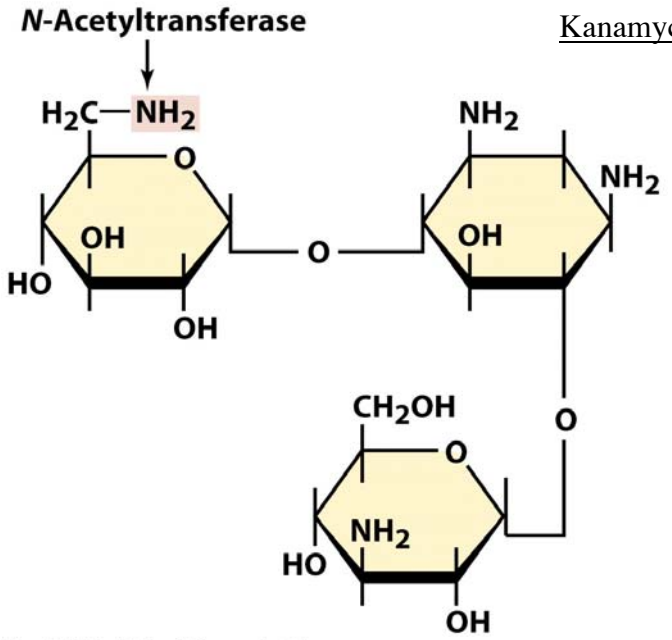


Figure 20-21 Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

Acetylation confers resistance

Macrolide Antibiotics

Erythromycin
Inhibits at 50 S subunit

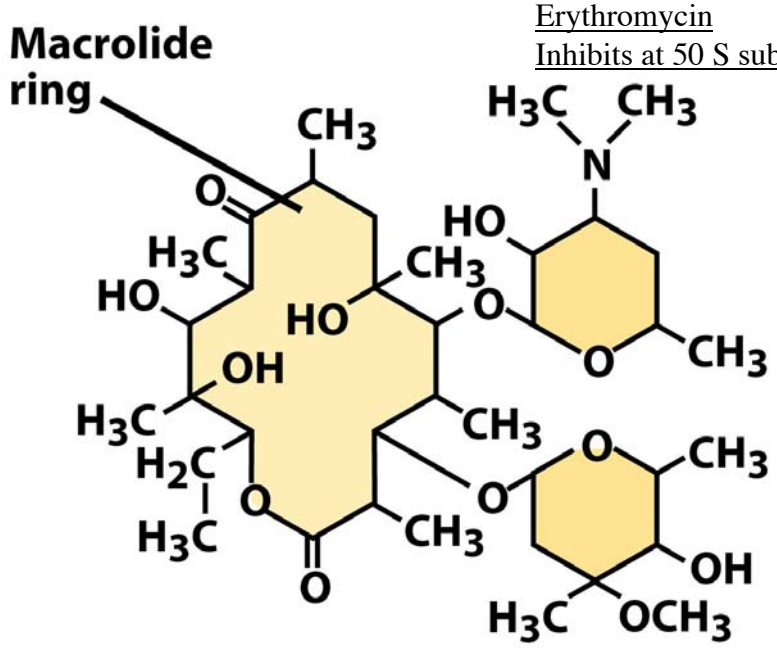
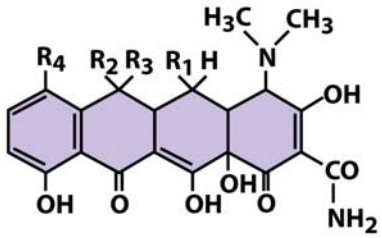


Figure 20-22 Brock Biology of Microorganisms 11/e

Tetracyclines

Tetracyclins interfer with 30S ribosomal subunit



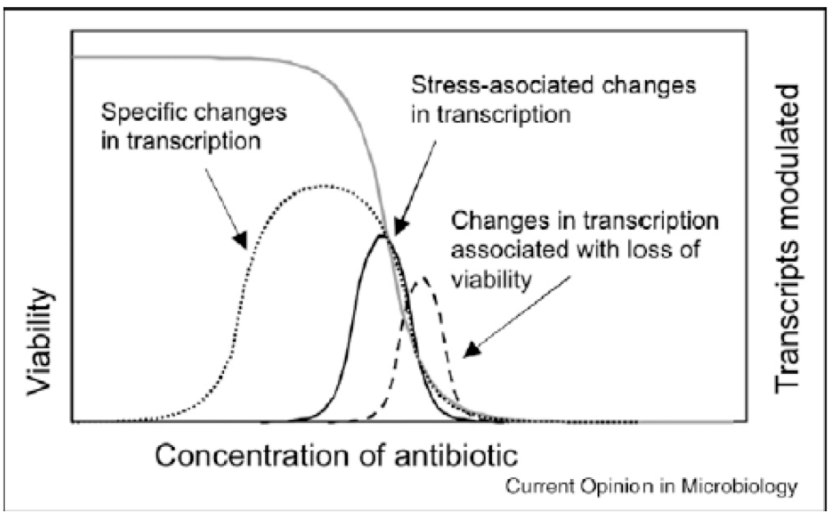
Tetracycline analog	R_1	R_2	R_3	R_4
Tetracycline	H	OH	CH_3	H
7-Chlortetracycline (aureomycin)	H	OH	CH_3	Cl
5-Oxytetracycline (terramycin)	OH	OH	CH_3	H

Figure 20-23 Brock Biology of Microorganisms 11/e

The aminoglycosides, macrolides, and tetracycline antibiotics are structurally complex molecules produced by *Bacteria* and are active against other *Bacteria*. All of these work by interfering with protein synthesis.

A different View on Antibiotics

Antibiotics in Nature: Signalling molecules at low concentration



Resistance Mechanisms

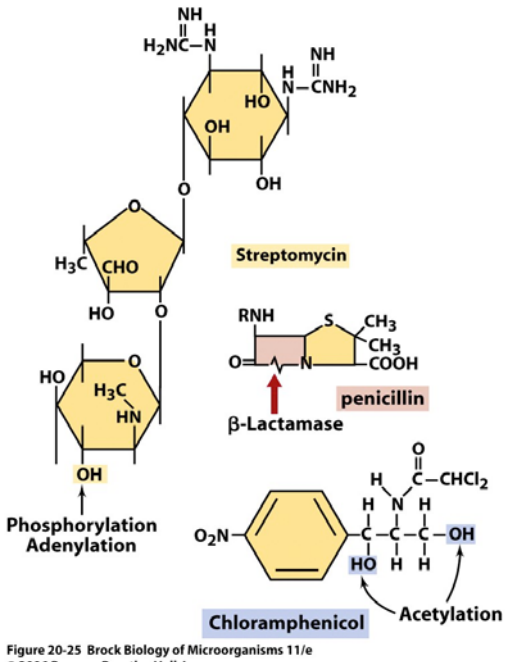


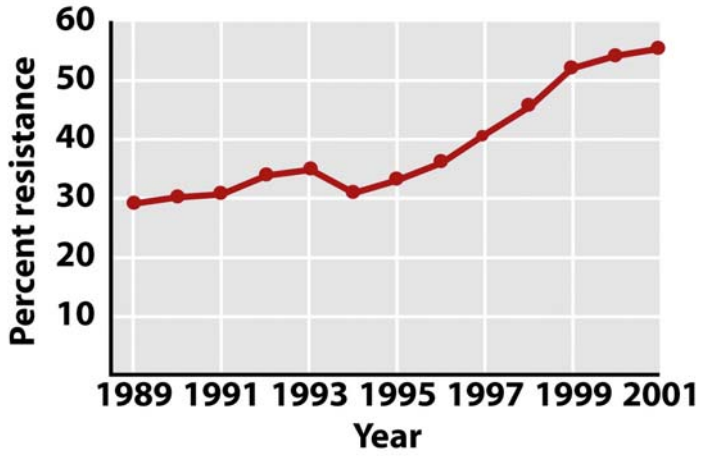
Figure 20-25 Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

Table 20.7 Mechanisms of bacterial resistance to antibiotics

Resistance mechanism	Antibiotic example	Genetic basis of resistance	Mechanism present in:
Reduced permeability	Penicillins	Chromosomal	*Pseudomonas aeruginosa*
			Enteric *Bacteria*
Inactivation of antibiotic (for example, penicillinase; modifying enzymes	Penicillins	Plasmid and chromosomal	*Staphylococcus aureus*
			Enteric *Bacteria*
			Neisseria gonorrhoeae
methylases, acetylases, and phosphorylases;	Chloramphenicol	Plasmid and chromosomal	*Staphylococcus aureus*
			Enteric *Bacteria*
and others)	Aminoglycosides	Plasmid	*Staphylococcus aureus*
Alteration of target (for example,	Erythromycin	Chromosomal	*Staphylococcus aureus*
RNA polymerase, rifamycin;	Rifamycin		Enteric *Bacteria*
ribosome, erythromycin, and	Streptomycin		Enteric *Bacteria*
streptomycin; DNA gyrase,	Norfloxacin		Enteric *Bacteria*
quinolones)			*Staphylococcus aureus*
Development of resistant	Sulfonamides	Chromosomal	Enteric *Bacteria*
biochemical pathway			*Staphylococcus aureus*
Efflux (pumping out of cell)	Tetracyclines	Plasmid	Enteric *Bacteria*
	Chloramphenicol	Chromosomal	*Staphylococcus aureus*
			Bacillus subtilis
	Erythromycin	Chromosomal	*Staphylococcus* spp.

Table 20-7 Brock Biology of Microorganisms 11/e

Methicillin-resistant Staphylococcus aureus nosocomial infections among intensive care unit patients from 1989-2001



Sidebar 20-1 Brock Biology of Microorganisms 11/e

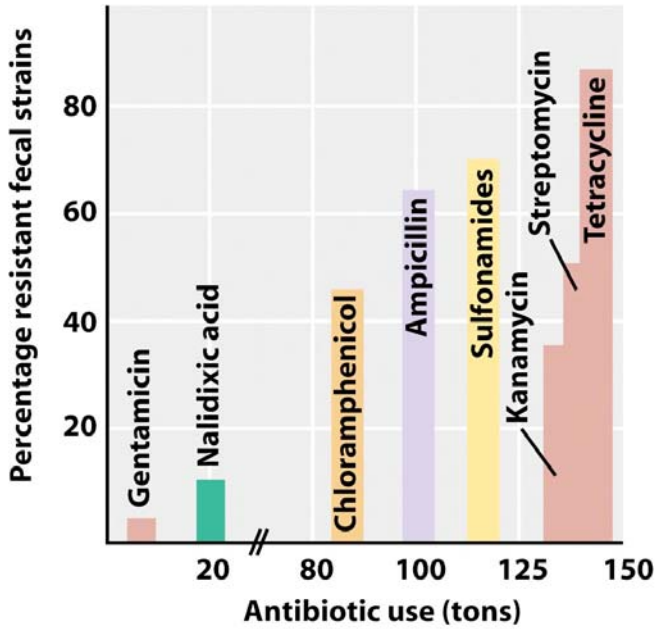


Figure 20-26a Brock Biology of Microorganisms 11/e

Antibiotic-Resistant Pathogens

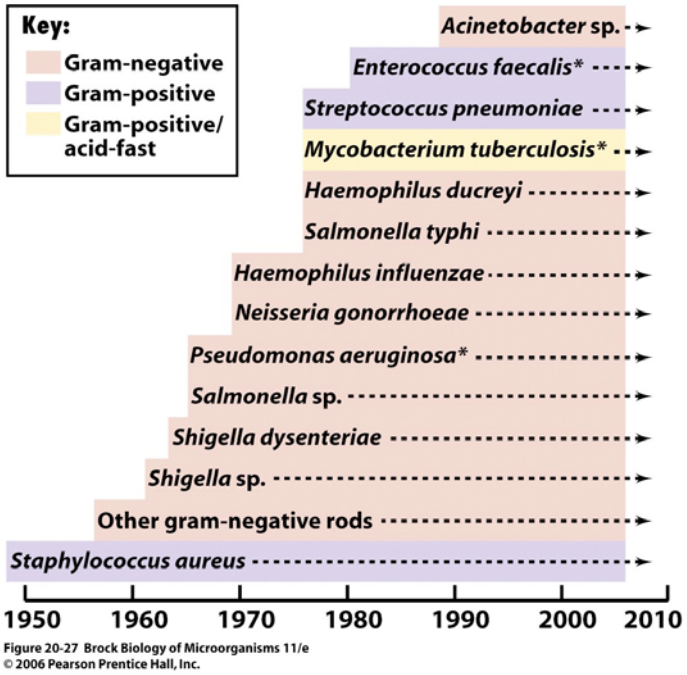


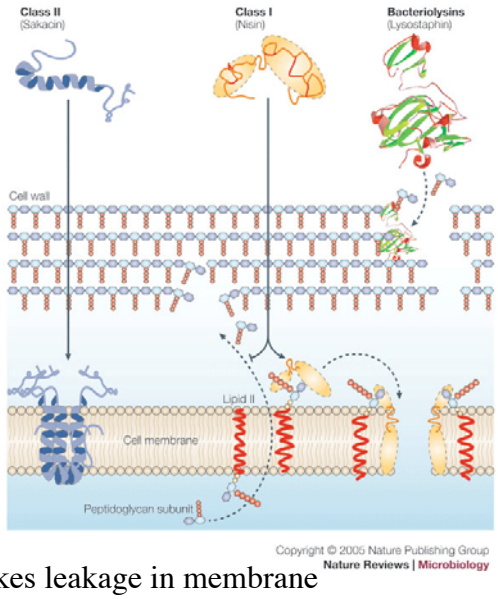
Figure 20-27 Brock Biology of Microorganisms 11/e

Bacteriocins

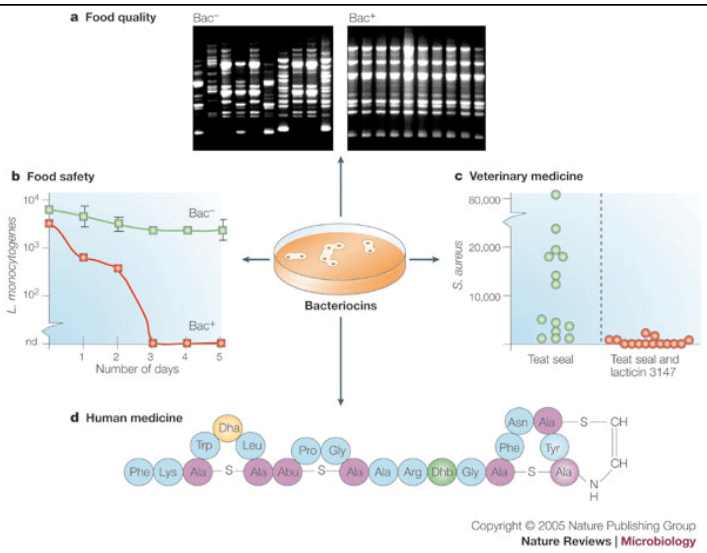
bacterially produced, small heat-stable peptides,
active against other bacteria
producer has specific immunity mechanism
narrow or broad target spectrum

many are produced by food-grade lactic acid bacteria
helps to direct or prevent the development of specific

bacterial species in food.



classII: makes leakage in membrane
classI: transport of units for peptidoglycan blocked and pore forming
Bacteriolysins: direct function on cell wall of gram positives

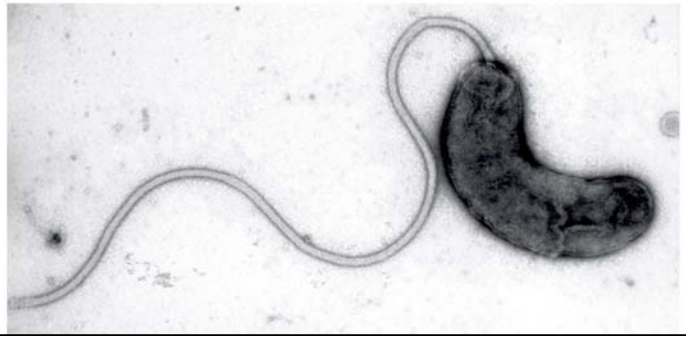


B: cheese made with commercial starter culture (Bac-) versus cheese inoculated with the Bacteriocin producing strain (BAC+), anti Listeria

Bdellovibrio: a bacterial killer

Bdellovibrio:

obligate aerobe,
highly motile,
energy from the oxidation of AA and Acetate and compounds of other bacteria
replicates in periplasmatic space
spherical structure called bdelloplast
attacks only gram- bacteria
widespread in soil and water, including marine environments
can be isolated like viruses (plaque assay with growing plaque)



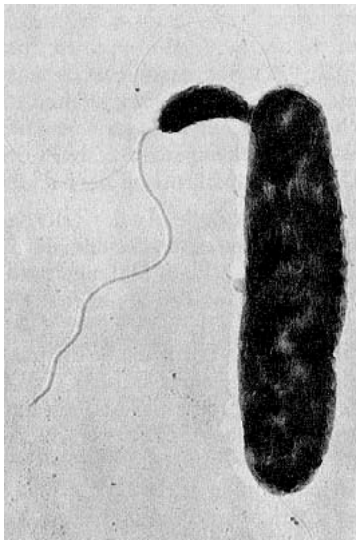


Figure 12-33a Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

Figure 12-33b Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.

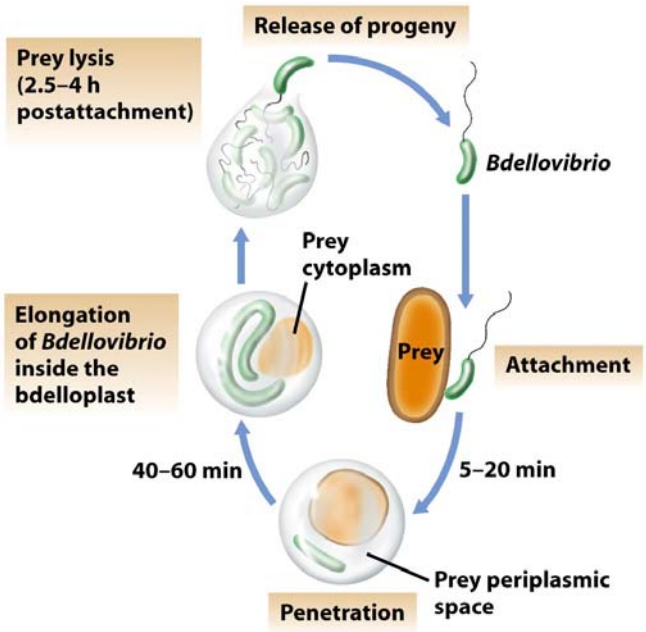
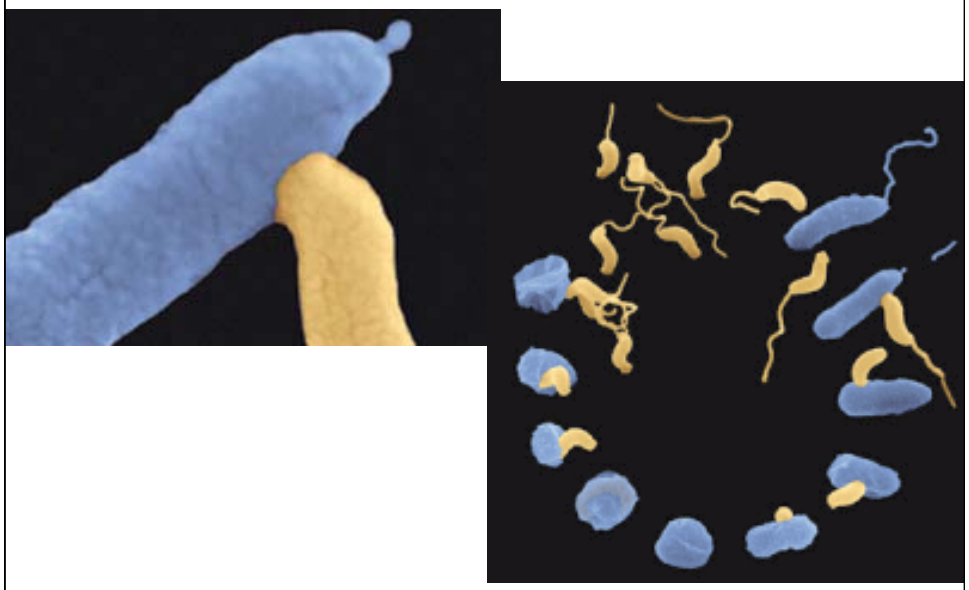
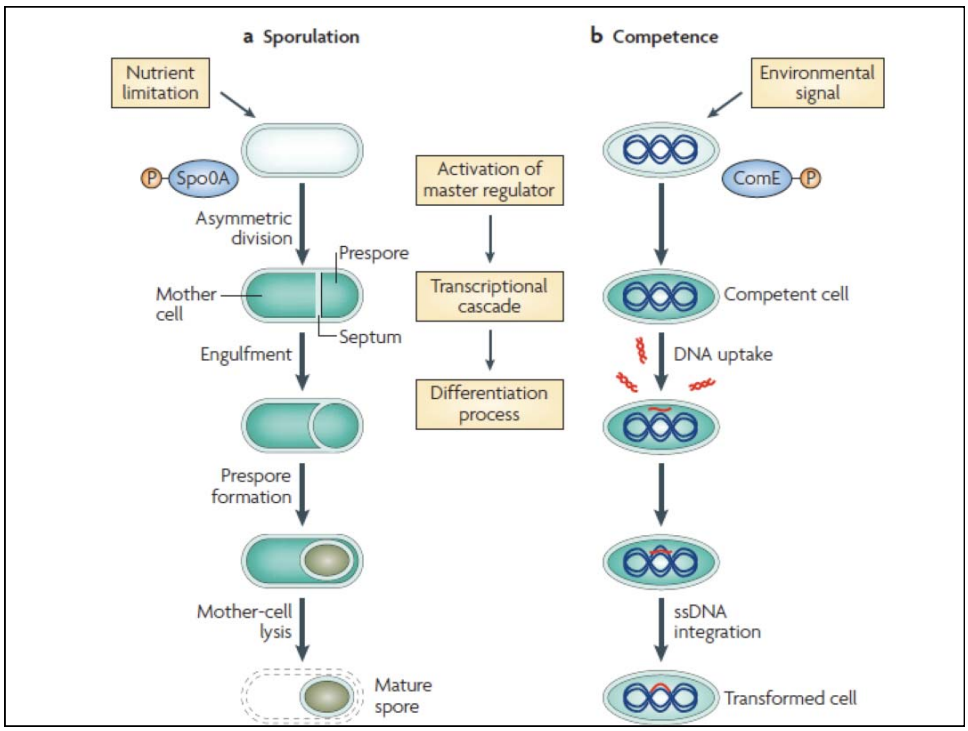
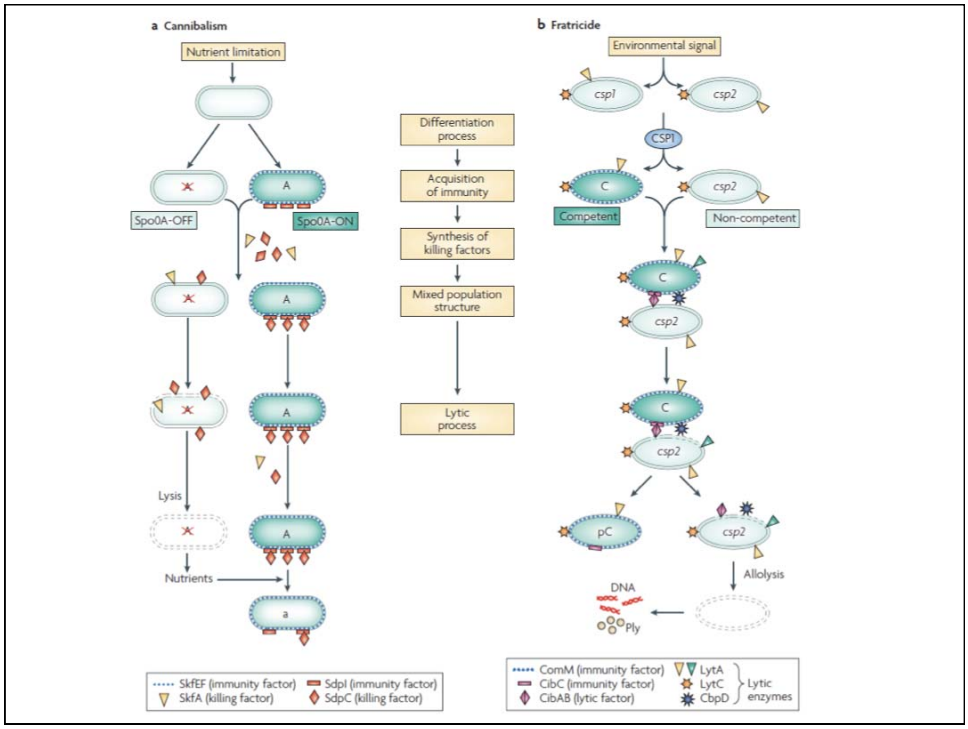


Figure 12-34b Brock Biology of Microorganisms 11/e
© 2006 Pearson Prentice Hall, Inc.



Bacterial cannibalism and fratricide




a Cannibalism
Nutrient limitation
Spo0A-OFF
Spo0A-ON
A
a
Lysis
Nutrients
Differentiation process
Acquisition of immunity
Synthesis of killing factors
Mixed population structure
Lytic process
b Fratricide
Environmental signal
csp1
csp2
CSP1
C
Competent
Non-competent
pC
Allolysis
DNA
Ply
SkfEF (immunity factor)
SkfA (killing factor)
SdpI (immunity factor)
SdpC (killing factor)
ComM (immunity factor)
CibC (immunity factor)
CibAB (lytic factor)
LytA
LytC
CbpD
Lytic enzymes