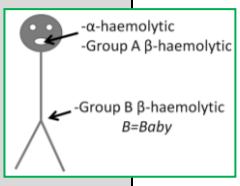
Microbiology

Bacteria

<table>
<tr><th></th><th>Gram positive</th><th colspan="2">Gram negative</th></tr>
<tr><td>Cocci</td><td>
• Staphylococcus (clusters and catalase +ve)
↘Coagulase +ve (aureus) – skin, pneumonia, endocarditis, abscess formation
↘Coagulase -ve (epidermidis; saprophyticus)
CONS = Contaminants (unless foreign bodies present)

• Streptococcus (strips and catalase -ve)
↘α-haemolytic i.e. partially lyse RBCs
-pneumoniae
– pneumonia, meningitis, URTIs, invasive
-viridans group (mitis, mutans, salivarius, sanguinis, anginosus) – endocarditis, dental
↘β-haemolytic i.e. completely lyse RBCs
-Group A strep (pyogenes) – skin, Rh fever, scarlet fever, strep throat, post-strep GN, erysipelas, necrotising fascitis, strep toxic shock
-Group B strep (agalactiae)
– vaginal colonisation, neonatal infection
↘Non-haemolytic
-Group D strep (bovis; equinus)
– bacteraemia
-Enterococcus (faecium; faecalis)
–UTIs, bacteraemia, endocarditis, diverticulitis


</td><td colspan="2"><u>Diplococci</u>
• Neisseria
↘meningitidis – meningitis
↘gonorrhoeae –gonorrhoea, conjunctivitis, pharyngitis, disseminated infection, arthritis

• Moraxella
↘catarrhalis –URTI s, chronic lung disease exacerbations, pneumonia</td></tr>
<tr><td>Rods (bacilli)</td><td>
<u>Big and spore forming</u>
• Clostridium (anaerobic)
↘difficile – C diff diarrhoea
↘tetani – tetanus
↘perfringens – gas gangrene
↘botulinum – botulism

• Bacillus
↘anthracis – anthrax (infected animal/product spores → cutaneous: black ulcer, lymphadenopathy, fever; lung: pneumonia; or GI: haematemsis/diarrhoea)
↘cereus – gastroenteritis (improperly refrigerated rice)

<u>Small and non-spore forming</u>
• Listeria
↘monocytogenes – gastroenteritis, septicaemia, meningitis, encephalitis, pneumonia, neonatal, endocarditis (risks = soft cheeses, unpasteurized milk, meats)

• Corynebacterium
↘diphtheriae – diphtheria, colonisation
</td><td>
Enteric
<u>Long</u>
ENTEROBACTERIACEAE
• E. Coli
– UTIs, gastroenteritis, neonatal meningitis
• Klebsiella
– pneumonia, UTIs
• Enterobacter
– LRTIs, UTIs, skin, intra-abdominal, endocarditis
• Citrobacter
– UTIs
Aerobic glucose + lactose fermenting (COLIFORMS – normal bowel flora)
• Salmonella
– gastroenteritis, typhoid
• Shigella
– gastroenteritis/dysentery
• Proteus
– UTIs, nosocomial
• Yersinia
– yersinosis (diarrhoeal illness), plague
• Serratia
– nosocomial
Aerobic glucose only fermenting
• Pseudomonas
– pneumonia, UTIs, sepsis, Gastrointestinal, wound
Aerobic non-fermenting
• Bacteroides
– intra-abdominal
Anaerobic
<u>Curved</u>
• Vibrio
↘cholerae – cholera (dysentery)
• Campylobacter (microaerophilic)
↘jejuni – gastroenteritis (raw meat)
• Helicobacter
↘pylori – gastritis
</td><td>
Non-enteric
<u>Coccobacilli</u>
• Haemophilus
↘influenzae
– pneumonia, meningitis, epiglottits
• Bordetella
↘pertussis
– Whooping cough
• Garnerella
↘vaginalis
– bacteria vaginosis
• Acinetobacter
– nosocomial infections
• Legionella
↘pneumophilia
– Legionnaires' disease (water tanks/air conditioners → atypical pneumonia)
• Coxiella
↘burnetii
–Q fever (livestock → flu-like illness, pneumonia, granulomatous hepatitis, endocarditis)
• Brucella
– brucellosis (unpasteurized milk → long flu-like illness)
• Pasteurella
– pasturellosis (cat bite → septic phlegmon)
• Francisella
– tularaemia (tick/deer fly bite → ulcer at site of entry, fever/sepsis, lymphadenopathy)
</td></tr>
<tr><td>Spirochetes</td><td></td><td colspan="2">
• Treponema
↘pallidum – syphilis
• Borrelia
↘burgdorferi – Lyme disease
• Leptospira – leptospirosis (spread by rodents)
</td></tr>
<tr><td>Branching filamentous growth</td><td>
• Actinomyces (anaerobic)
– dental, actinomycosis (abscesses)
• Nocardia (partially acid fast)
– pneumonia, endocarditis, encephalitis, brain abscess, skin
</td><td colspan="2"></td></tr>
<tr><td>Pleomorphic</td><td></td><td colspan="2">
• Chlamydia
↘trachomatis – cervicitis/urethritis
↘psittaci – psittacosis/pneumonia (spread by birds)
• Rickettsiae – typhus, rickettsialpox, Boutonneuse fever, African tick bite fever, Rocky Mountain spotted fever (all tick borne)
</td></tr>
<tr><td>Unique cell wall</td><td colspan="3">
• Mycobacterium (acid fast)
↘tuberculosis – TB
</td></tr>
<tr><td>No cell wall</td><td colspan="3">
• Mycoplasma
↘pneumoniae – pneumonia
</td></tr>
</table>

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Antibiotics

Gram Positive ← → **Gram Negative**

			Cocci					Rods (bacilli)					
Class	**Subclass**	**Antibiotic**	**Enterococcus**	**MRSA**	**Staphylococcus aureus (MSSA)**	**Streptococcus**	**Neisseria meningitidis**	**Haemophilus**	**E. Coli and coliforms**	**B-lactamase resistance***	**Pseudomonas**	**Anaerobes (except C. Diff)**	**Atypical pneumonias**
Target cell wall													
β-lactams *β-lactam ring lodges in bacterial cell wall*	**Penicillins**	**Flucloxacillin** *Large so not affected by β-lactamase*		*MRSA is resistant to β-lactams due to modification of penicillin binding protein*	++++	+							
		Benzylpenicillin	++ *Not all*		*Staph secretes penicillinase (β-lactamase that destroys β-lactam ring of penicillin)*	++++	++			-***Penicillinase*** -*ESBL* -*Amp C* - *Carbapenemase*		+	
		Amoxicillin/ Ampicillin				+++		+	+ *Many resistant*				
		Co-Amoxiclav (Amoxicillin + β-lactamase inhibitor)			+++			++		-***Amp C*** *(resistant to inhibitor)* -*Carbapenemase*		++	
		Tazocin (Piperacillin + β-lactamase inhibitor)						+++		*ESBLs sensitive in vitro but have variable activity in vivo*	+++		
	Carbapenems	**Meropenem**								-***Carbapenemase*** *Antibiotic of choice for ESBL/Amp C*	+++		
	2nd gen Cephalosporins	**Cefuroxime**			++		*Cefuroxime doesn't penetrate BBB*			-***ESBL*** *(but sensitive to cephamycins)* -*Amp C* -*Carbapenemase*			
	3rd gen Cephalosporins	**Ceftriaxone/ Cefotaxime**					++++				*Ceftazidime is used for pseudomonas only (best agent)*		
	4th gen Cephalosporins	**Cefepime**			+++					*-ESBL (variable)* *-Carbapenemase (variable)*	+++		
Glycopeptides *Inhibit peptidoglycan links in cell wall*		**Vancomycin/ Teicoplanin**	+++ *Some strains resistant (VRE)*	+++		++						+	
Target protein synthesis													
Aminoglycosides *Inhibit 30S ribosomal subunit*		**Gentamicin**	+	+	++				+++	*Some cross resistance with ESBL and carbapenemase*	+++	*Aminoglycosides use oxygen dependent active transport*	
Tetracyclines *Inhibit 30S ribosomal subunit*		**Doxycycline**		++		++		++	+/-				++
Lincosamides *Inhibit 50S ribosomal subunit*		**Clindamycin**		++								++	
Macrolides *Inhibit 50S ribosomal subunit*		**Erythromycin/ Clarithromycin/ Azithromycin** (gram -ve)							++				+++
Misc *Inhibit 50S ribosomal subunit*		**Chloramphenicol**	++	+	+	+	+	+	+/-			++	
Target DNA													
Fluroquinolones *Inhibit DNA gyrase*		**Ciprofloxacin**		+ *Not alone*				+++	+++	*Some cross resistance with ESBL and carbapenemase*	++		+++
Misc *Inhibit DNA*		**Metronidazole**										+++	
		Trimethoprim		+				+	++				
		Co-trimoxazole (sulfamethoxazole + trimethoprim)						++	++	*Some cross resistance with ESBL and carbapenemase*			
		Nitrofurantion	++						++				

Atypical pneumonias: *legionella (gram –ve), mycoplasma*

Coliforms (lactose-fermenting enterobacteriaceae): *E. Coli, enterbacter, klebsiella*

Anaerobes: *clostridium (gram +ve rod), bacteroides (gram -ve rod)*

Other important bacteria to know antibiotics for: *mycobacterium (gram +ve rod); clostridium difficile (gram +ve rod); chlamydia (gram –ve)*

β-lactamase resistance: *β-lactamases are enzymes produced some bacteria which break down the β-lactam ring of certain β-lactam antibiotics and cause resistance.*

Penicillinase is produced by several bacteria, most notably staphylococcus; the other β-lactamases (ESBL, Amp C, carbapenemase) are mainly produced by some enterobacteriaceae.

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Coverage Needed

Community acquired pneumonia
- Streptococcus pneumoniae
- Haemophilus influenza (if not vaccinated)
- Atypicals

If immunocompromised (i.e. malnourished, alcoholic, diabetic, on long term steroids), also: staphylococcus aureus, coliforms, TB
If severely immunosuppressed (i.e. HIV with CD4<200, transplant recipient): pneumocystis carinii, cryptococcus, CMV, varicella zoster virus, influenza, fungal infections

Hospital acquired pneumonia
- Staphylococcus aureus (including MRSA)
- Anaerobes
- Coliforms
- Pseudomonas

Colonising bacteria in chronic respiratory ill health (may or may not cause infection e.g. exacerbation)
- Streptococcus pneumoniae
- Haemophilus influenzae
- Moraxella catarrhalis
- Staphylococcus aureus
- Pseudomonas

In cystic fibrosis, also: burkholderia cepacia

Upper respiratory tract infections
- Streptococcus pneumoniae
- Streptococcus pyogenes
- Haemophilus influenzae
- Moraxella catarrhalis

Cavitating pneumonia
- Streptococcus pneumoniae
- Staphylococcus aureus
- Klebsiella
- TB
- Anaerobes

Intra-abdominal (including biliary)
Normal bowel flora:
- Anaerobes e.g. bacteroides
- Coliforms
- Enterococcus

Gastroenteritis/diarrhoea → ceftriaxone/ciprofloxacin/azithromycin
- Salmonella enteritidis
- Shigella
- Campylobacter
- E. coli (enterotoxic)

Less common: yersinia enterocolitica, bacillus cereus, staphylococcus aureus
If been at risk, also: clostridium difficile, vibrio cholerae, salmonella typhi
If dysentery: shigella, vibrio cholera, amoeba
Don't forget viral, parasitic and non-infectious causes!

Skin/joints/bone
- Staphylococcus aureus
- Streptococcus pyogenes

For wound/ulcer infections or severe/necrotising cellulitis, also: anaerobes
For burns, also: anaerobes, pseudomonas
For post-surgical wounds, also: gram negative bacilli (e.g. E. coli, kelbsiella, pseudomonas), enterococci, MRSA, CONS
NB. wound colonising bacteria (colonise exudate without necessarily causing infection) include: coliforms, enterococcus, anaerobes

Meningitis
- Nisseria meningitidis (meningococcal)
- Streptococcus pneumonia (pneumococcal)
- Haemophilus influenza (if not vaccinated)
- Listeria (if >65y or immunocompromised)

If neonatal: group B streptococcus, E. coli/coliforms, listeria (rare)

Urine
1. E. coli
2. Staphylococcus saprophyticus
3. Non-E. Coli enterobacteriaceae (klebsiella, enterobacter, proteus), pseudomonas, enterococci, staphylococci (CONS/aureus)

Less common organisms (3) are associated with: catheters, hospital, structural abnormalities and instrumentation

Infective endocarditis
- Viridans group streptococci and other streptococci (e.g. bovis)
- Enterococci
- Staphylococcus aureus and coagulase negative staphylococci (e.g. epidermidis)
- Coxiella burnetii
- HACEK organisms

Surgical prophylaxis
- Need to cover skin ± intra-abdominal

Sepsis of unknown origin
- Need to cover skin, chest, urine, meningitis, intra-abdominal

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