Clinical Microbiology and Infection Placement

Intro to basic clinical microbiology, infection and antibiotics

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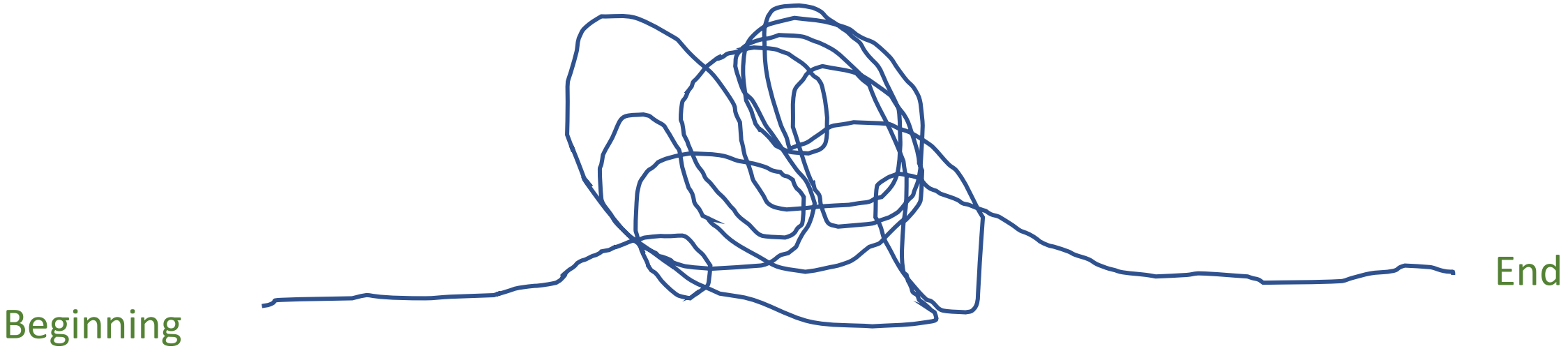
- Introduction
- Gram stain revision
- Which antibiotic?
- Short Break
- Clinical scenarios
- Case presentation

1/3 hospital in-patients receive antibiotics

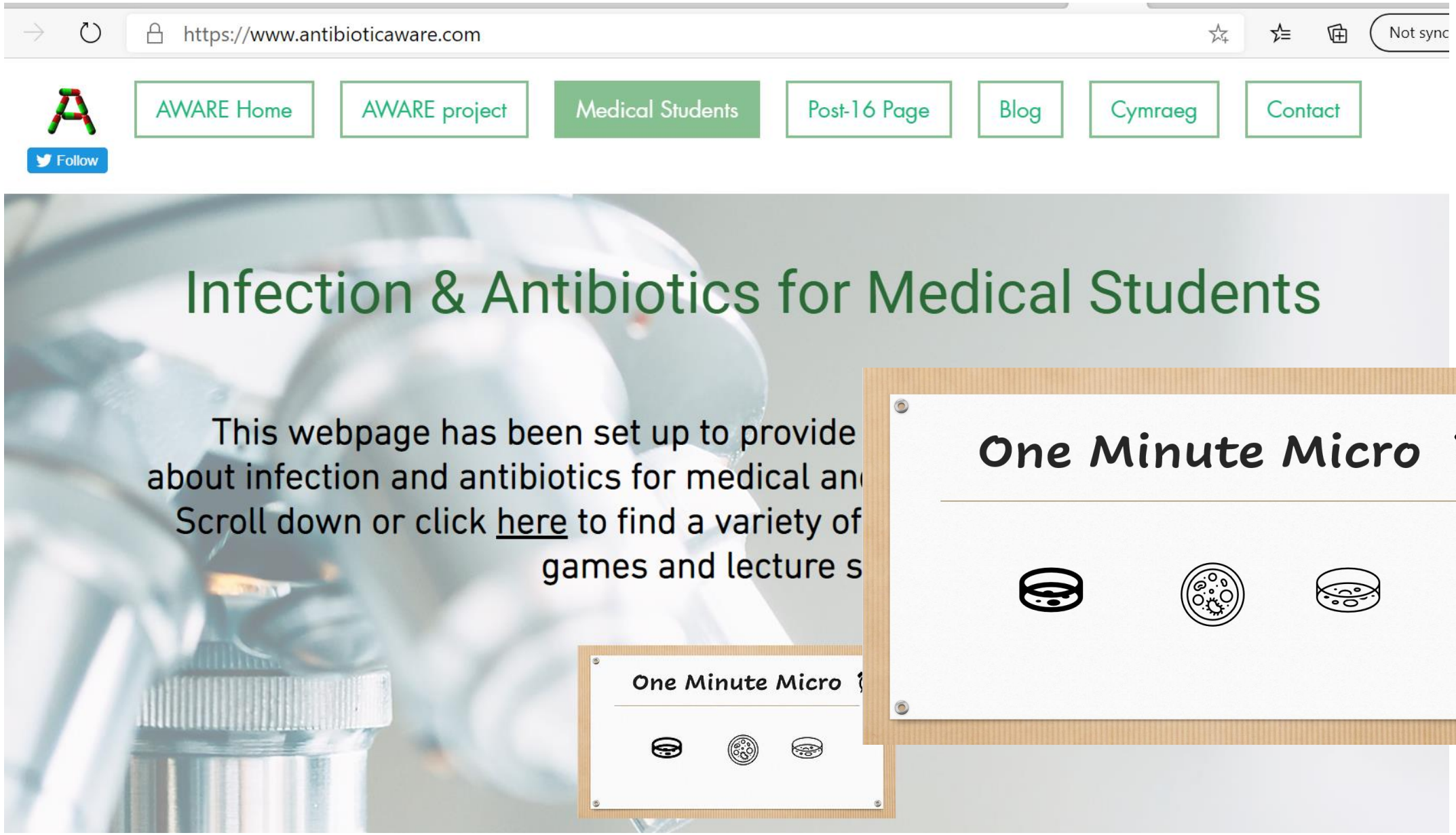
Every single medical and surgical specialty

Every day



Muddle

www.antibioticaware.com



BUGS: Clinical Microbiology made Simple (or, All you Need to Know on 3 sides of A4)

NB This crib-sheet only deals with bacteria and not other pathogens like viruses and fungi.

There are three sections:

1. **GRAM STAINING**
2. **CLINICALLY IMPORTANT BACTERIA**
3. **WHICH BACTERIA CAUSE WHICH INFECTIONS?**

1. GRAM STAINING

Bacteria can be seen under the microscope by performing a Gram stain.

The Gram stain appearance depends on the cell wall structure. Since this is also relevant to antibiotic sensitivity, Gram stain appearance is incredibly helpful in deciding on an antibiotic even before you know the full identity of the organism.

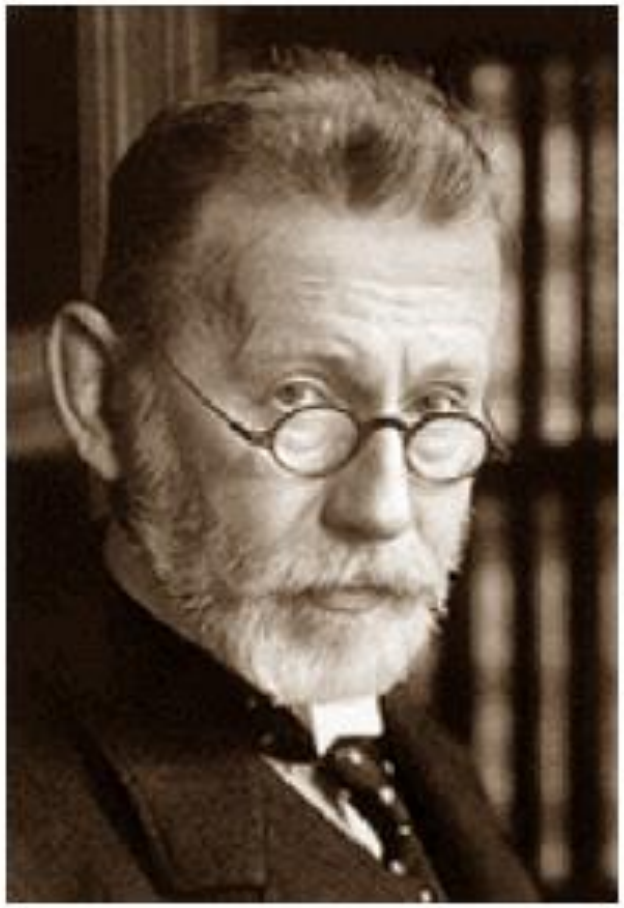
Gram **P**ositives look **Purple** under the microscope.

Gram n**E**gatives look r**E**d under the microscope

The *shape* of the organism is described as cocci (round) or bacilli/rods (rod-shaped)

Gram stains

Gram staining



- Hans Christian Gram, Denmark
- Investigating lung tissue from cadavers who died of pneumonia

‘I have published the method, although I am aware that it is as yet very defective and imperfect; but it is hoped that...it will turn out to be useful’

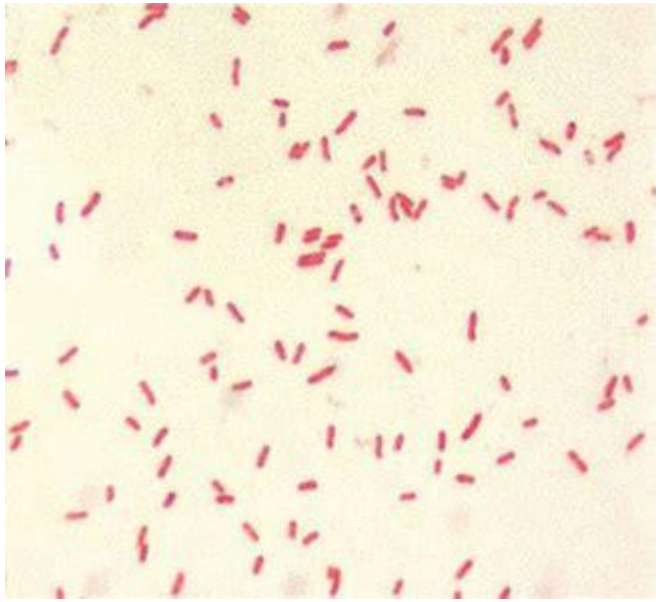
Mikroskopiske præparatglas
Microscope slides
Fremstillet af | Prepared by Hans Christian J. Gram
1880'erne | 1880s

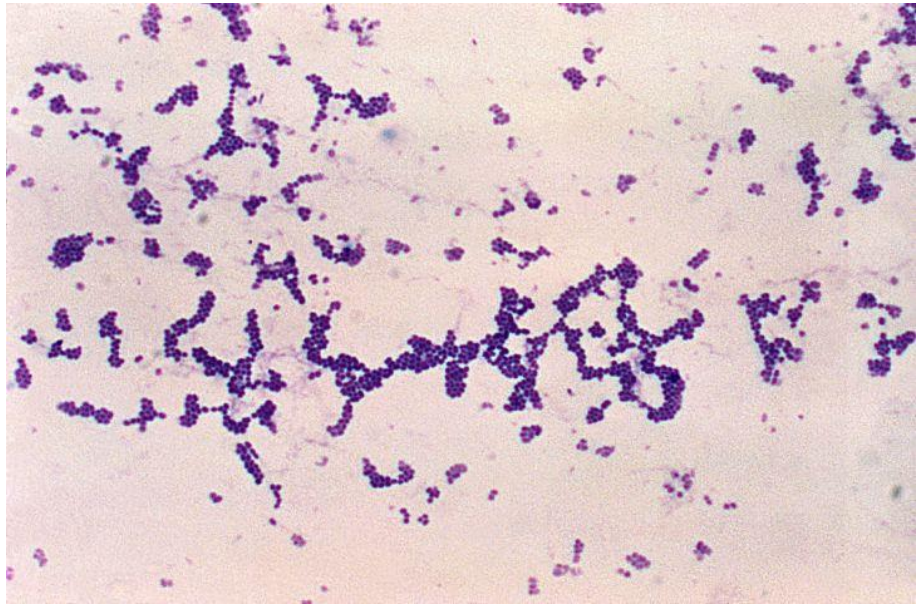
Gram staining

- ‘Gram-positive’ - blue/purple
- ‘Gram-negative’ – red

- Rods/bacilli
- Cocci

Gram stains





Whiteboard

- https://www.youtube.com/watch?v=OCJ6LxdOOvw&t=1s

Which antibiotic ?

Angharad Davies

DRUGS – a crib-sheet about commonly used antibiotics

The pathogens referred to will all be ones mentioned in the BUGS crib-sheet. It's advisable to be familiar with that first.

To see what to use for specific clinical conditions, check your Health Board policies on the Rx Guidelines app – these may vary but they are all based on the principles below

1. **Table of some antibiotic classes**
2. **Key facts about some important classes of antibiotics**
3. **Quick list of some important pathogens and what to use**

Rx Guidelines App

Choosing an antibiotic

1. What is the likely source of infection?
   (clinical assessment)

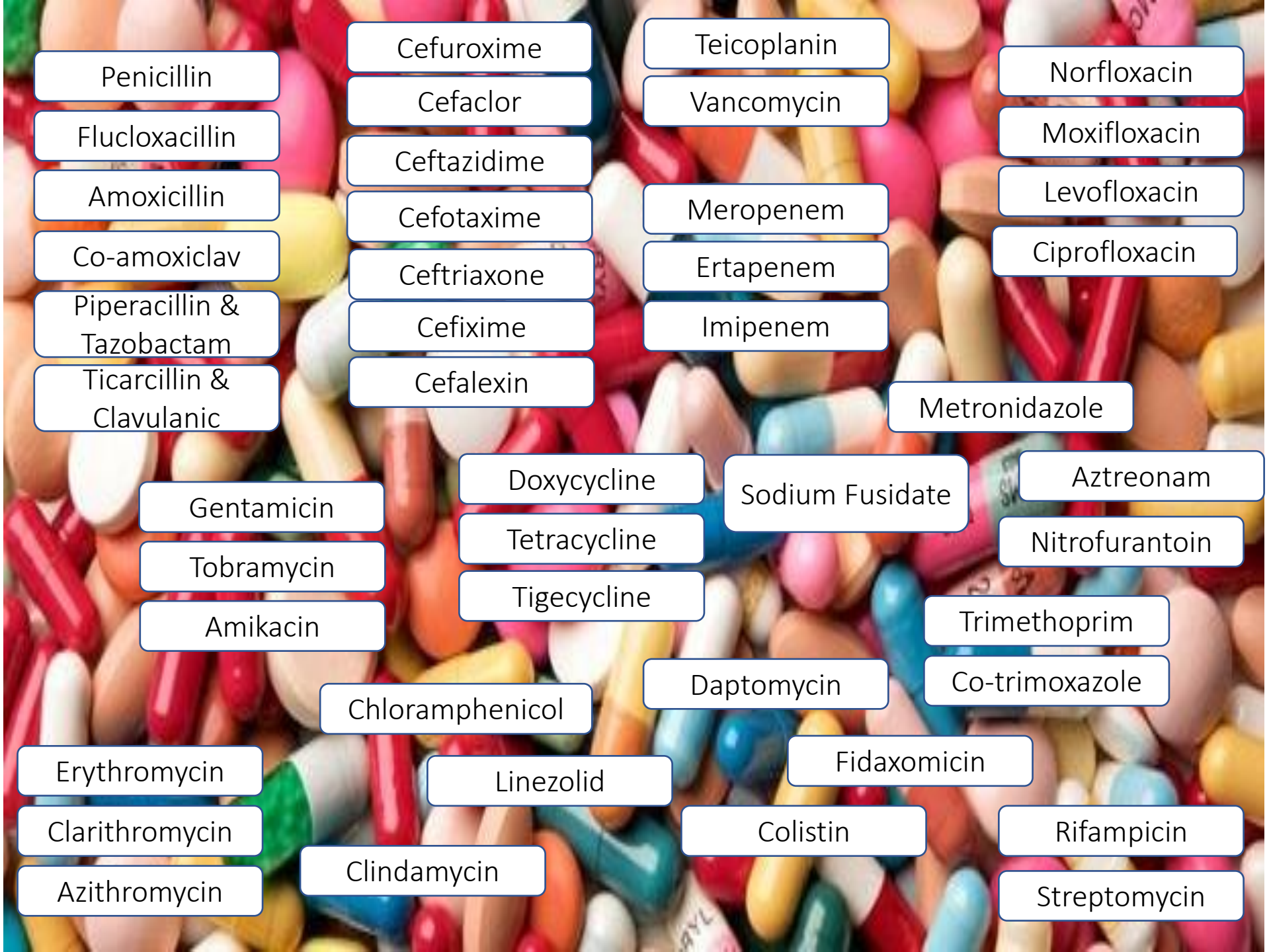
KNOW YOUR PATIENT

2. What organisms are likely to cause infection in that source?

KNOW YOUR ENEMY (basic knowledge of microbiology)

3. What antimicrobials are needed for those organisms? -in general choose narrow spectrum agent where possible.

KNOW YOUR ARMOURY (understand antibiotic spectra)


Penicillin
Flucloxacillin
Amoxicillin
Co-amoxiclav
Piperacillin & Tazobactam
Ticarcillin & Clavulanic
Cefuroxime
Cefaclor
Ceftazidime
Cefotaxime
Ceftriaxone
Cefixime
Cefalexin
Teicoplanin
Vancomycin
Meropenem
Ertapenem
Imipenem
Norfloxacin
Moxifloxacin
Levofloxacin
Ciprofloxacin
Metronidazole
Doxycycline
Tetracycline
Tigecycline
Sodium Fusidate
Aztreonam
Nitrofurantoin
Gentamicin
Tobramycin
Amikacin
Trimethoprim
Co-trimoxazole
Daptomycin
Chloramphenicol
Fidaxomicin
Erythromycin
Linezolid
Clarithromycin
Colistin
Rifampicin
Clindamycin
Azithromycin
Streptomycin

Antibiotic spectra

- Broad vs narrow

- Gram-positive organisms
- Gram-negative organisms
- ‘Atypical’ pneumonia organisms
- Anaerobes
- Resistant organisms, e.g:

  Meticillin Resistant *S. aureus* (MRSA)

  Vancomycin Resistant Enterococci (VRE)

  Extended Spectrum Beta Lactamase (ESBL) carriers

Some important antibiotic classes

Class	Examples	Target
Beta-lactams	Penicillin, flucloxacillin, cephalosporins, meropenem	Cell wall synthesis
Tetracyclines	Tetracycline, doxycycline	ribosome
Glycopeptides	Vancomycin, teicoplanin	Cell wall synthesis
Macrolides	Erythromycin, clarithromycin	ribosome
Quinolones	ciprofloxacin	DNA gyrase
aminoglycosides	gentamicin	ribosome

Beta-lactams

- **Penicillins**
  - eg penicillin, flucloxacillin, amoxycillin
- **Cephalosporins**
- Mono-bactams
- **Carbapenems**

Penicillins combined with beta-lactamase inhibitors

- **Amoxycillin +/- clavulanate***
  - **‘Co-amoxiclav’ (Augmentin®)**
  - Gives broader cover
- **Piperacillin +/- tazobactam***
  - **‘Piptazo-bactam’ (Tazocin®)**
  - gives broader cover including *Pseudomonas aeruginosa* (PSA)

*clavulanate and tazobactam are Beta-lactamase inhibitors

Flucloxacillin/penicillin

ceftriaxone

Metronidazole

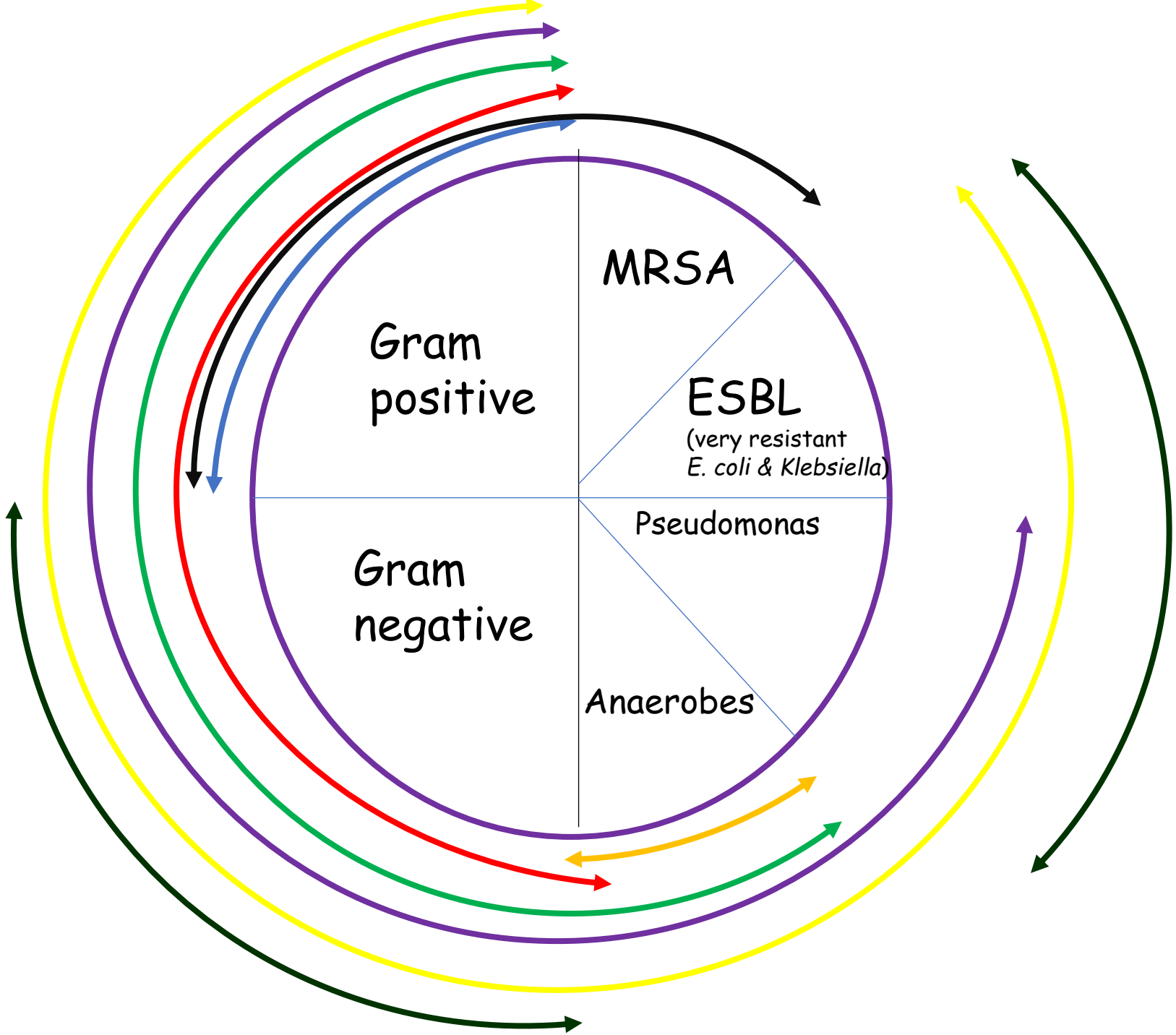
Co-amoxiclav

Tazocin

Meropenem

Vancomycin/Teicoplanin

(Gentamicin/amikacin)



Special consideration

- Anaerobes
- ‘Atypicals’
- *Pseudomonas*

Anaerobes

- **Metronidazole** covers them all

- Beta-lactams: co-amoxiclav, piperacillin-tazobactam and carbapenems cover most

‘Atypical’ pneumonia

Do not respond to beta-lactams

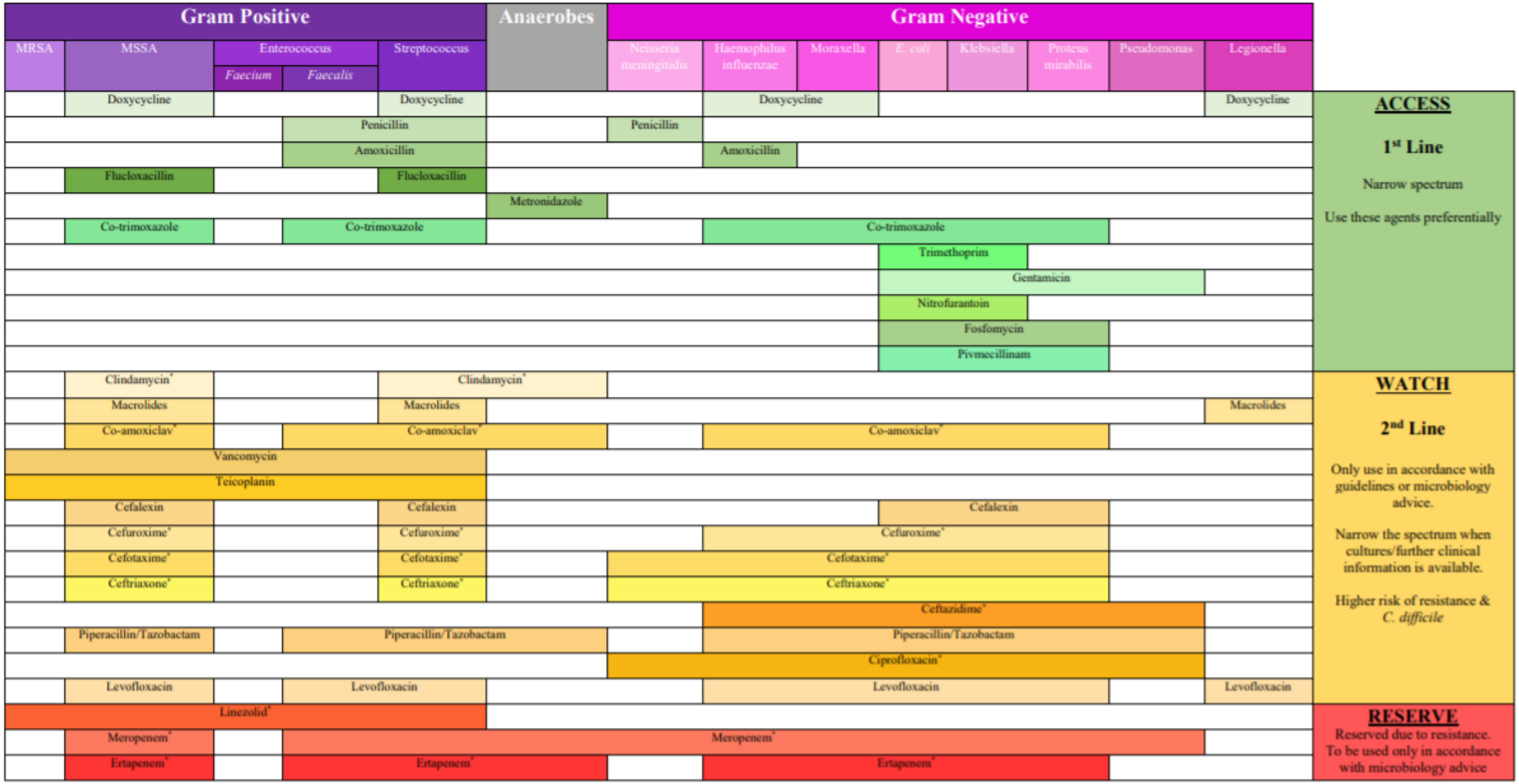
- Macrolides (eg clarithromycin)
- Quinolones (eg ciprofloxacin)
- Tetracyclines (eg doxycycline)
- Rifampicin (for severe legionellosis)

Pseudomonas aeruginosa

- Opportunist
- Intrinsic resistance to many agents
- Possible agents to use:
  - Quinolone (eg Ciprofloxacin)
  - Ceftazidime (3rd gen. cephalosporin)
  - Piperacillin-tazobactam
  - Carbapenem
  - Aminoglycoside (eg gentamicin)

- **Of these, quinolones are the only oral agents**

A Pragmatic Guide to Antibiotic Spectrum



Disclaimer: This chart is intended for use as a guide only, pending identification, sensitivities and microbiology advice. It **does not** replace expert advice. Local guidelines and preferences will vary.
For simplicity, atypical organisms (except Legionella) are not included above. For *C. difficile* treatment, please consult local guidelines.
(*): Requires microbiology approval, unless in line with antimicrobial guidelines.

Clinical scenarios

68 year old female CO swollen
painful right lower leg, red and warm

Recent insect bite to ankle

Cellulitis

- Likely organisms:
  - Group A streptococci
  - *Staphylococcus aureus*

Cellulitis

- Likely organisms:
  - Group A streptococci
  - *Staphylococcus aureus*
- Appropriate antibiotics:
  - iv penicillin and flucloxacillin
  - *MICs are such that actually can just use flucloxacillin, though both have been used together traditionally

50 yo smoker with shortness of breath & cough with rusty sputum

T=38.7

RR = 32

Tachycardic

O2 sats 86%

Pneumonia

- Likely organisms:
  - ***Streptococcus pneumoniae***
  - '**Atypicals**' (legionella, mycoplasma, chlamydophila)

  - also:
    - *Haemophilus influenzae* (COPD)
    - *Moraxella catharralis* (COPD)
    - *Klebsiella pneumoniae*
    - *Staphylococcus aureus* (post-flu)
- Appropriate antibiotics – see BTS 2015:
- eg amoxycillin + clarithromycin (CURB 2) or amoxycillin alone if low severity (CURB 0-1)

- 19 year old student, headache, neck stiffness, drowsy, vomiting
- On examination T= 35.2, Kernig’s sign positive

Meningitis

- Likely organisms (adults):
  - *Streptococcus pneumoniae*
  - *Neisseria meningitidis*
  - *Listeria monocytogenes* (elderly, immunosuppressed, pregnant)
- Appropriate antibiotics:
  - Ceftriaxone
  - +/- amoxycillin if *Listeria* a possibility

37 yo female, dysuria and frequency

UTI

- Most likely organisms:
  - *E.coli*, Proteus
  - enterococci
- Appropriate antibiotics:
    - Nitrofurantoin
    - Or
    - Trimethoprim (see All Wales primary care UTI guidance)

Returns to surgery after 3 days on trimethoprim, symptoms have continued, now has fever and rigors and right loin pain
Reveals she is also pregnant but ‘forgot’ to mention it before
T=39

23 yo male, 6 day history severe abdo pain and vomiting, now rigid abdomen & high fever

Bowel sepsis

- Likely organisms
  - *E. coli* and other Gram negative rods
  - enterococci
  - anaerobes

- Appropriate antibiotics:

  Amoxycillin, Gentamicin, Metronidazole

  piperacillin–tazobactam

  $2^{nd}/3^{rd}$ gen cephalosporin + metronidazole

- A 45 year old man who has been ventilated and sedated on ICU for the last 14 days following a road traffic accident.
- He develops fever, and low oxygen saturations during weaning from the ventilator
- CXR reveals left lung basal shadowing

Ventilator acquired pneumonia (VAP)

- Some possible organisms:
- *Pseudomonas*
- Enterobacteriaceae (may be resistant)
- *S. aureus*

- Suitable antibiotics will be broad spectrum, enter lung tissue and cover *Pseudomonas aeruginosa,* e.g.
  - Piperacillin-tazobactam
  - carbapenem