RCSI Royal College of Surgeons in Ireland *Coláiste Ríoga na Máinleá in Éirinn*

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FANTASTIC BUGS…
…AND WHERE TO FIND THEM

Safe Patient Care Course
Roisin Connolly
Antimicrobial Stewardship Fellow, Beaumont Hospital
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OUTLINE

1. **Back to basics: "Fantastic bugs"**
2. Host- pathogen wars
3. Colonisation or infection?
4. **Resistant bacteria & where to find them**

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BACK TO BASICS: "MICRO-ORGANISMS"

- Parasites
- Fungi
- Viruses
- Bacteria

- AKA
  - "Bugs"
  - "Germs"

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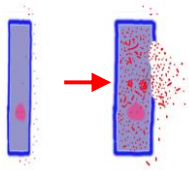
VIRUSES

- Can only multiply within a living cell
- Turn host cell into 'virus factory'
- Host cell is then killed
- **Some viral infections are <u>controlled</u> rather than eliminated**
  - **E.g. Cold sores, chicken pox**



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COMMON VIRAL INFECTIONS

- Norovirus - Gastroenteritis
- Hepatitis A virus
- Influenza – 'flu' virus
- Rhinovirus – common cold virus
- Herpes simplex – cold sore virus
- Varicella zoster – chicken pox and shingles virus
- Blood-borne viruses: Hepatitis B, C, HIV

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FUNGI: CAN BE USEFUL

COMMON FUNGAL INFECTIONS

Candida albicans

Aspergillus fumigatus

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BACTERIA

- **10 times more bacteria in/ on us than cells belonging to us**

- **Normal flora ("colonisers")**
- **1g faeces = 100 billion bacteria!**

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GOOD AND BAD BACTERIA?

Not always that simple…

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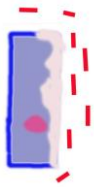
HOW DO BACTERIA CAUSE INFECTION?

- Stick to or enter human cells
- Destroy tissue
- Produce toxins:
  - E.g. *C. difficile* toxin



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HOW DO MICROORGANISMS GET AROUND?

1. **Contact/ Touch e.g. MRSA, VRE**
2. **Droplet inhalation e.g. influenza**
3. **Aerosol inhalation e.g. TB**
3. Ingestion (food or water or contaminated droplets or aerosols) e.g. salmonella
4. Blood-borne e.g. HIV, hepatitis B&C
5. Vertical (mother-to-child *via* placenta) e.g. HIV
6. Sexual transmission e.g. chlamydia
7. Arthropods (mosquitoes, ticks etc.) e.g. malaria
8. Animals e.g. brucellosis

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HOW DO MICRO-ORGANISMS GET AROUND IN HOSPITALS?

1. Contact: MRSA, VRE etc.

2. Droplet: influenza, RSV

3. Aerosols: TB

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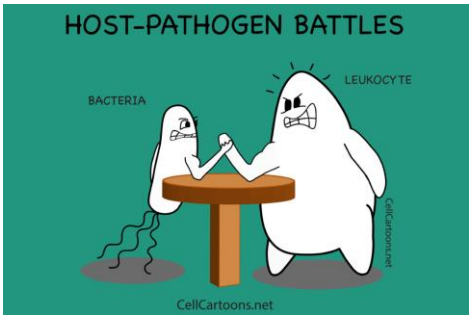
IMMUNE SYSTEM VS. BACTERIA



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IMMUNE SYSTEM VS. BACTERIA

- We are protected from bacterial invasion by our immune system:
  - Normal skin barrier
  - Normal bowel lining
  - Properly functioning immune cells: white blood cells
- Defective immune system predisposes a person to developing infection

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IMMUNE SYSTEM VS. BACTERIA

- How can harmful bacteria be destroyed?
  - Normally functioning white blood cells “munch” on harmful bacteria: phagocytosis
  - Antibiotics

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WHAT CAUSES A WEAKENED IMMUNE SYSTEM?

- Damage to the skin barrier: burns, wounds, devices
- Major illness: trauma, sepsis, surgery
- Cancer: leukaemia
- Chemotherapy: attacks cancer cells and good cells
- Medications that suppress over-active immune systems
- Malnutrition
- Diabetes
- Drugs/ alcohol
- HIV

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FIGHTING BACTERIAL INFECTION

- Bacteria will take any opportunity to invade the body and cause infection
- Outcome depends on:
  - Immune system's ability to fight infection
  - Virulence of the bacteria
  - Early recognition of infection
  - Timely and appropriate antibiotics
  - Supportive treatments

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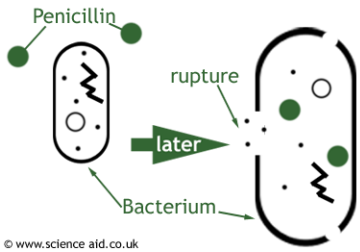
HOW DO ANTIBIOTICS WORK?



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PATIENTS CAN BE COLONISED OR INFECTED WITH BACTERIA

- **Colonisation:**
  Bug is living on the patient but not causing them any harm
- **Infection:**
  Bug is living on the patient and making them sick

e.g. *Staph. aureus*

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HOW DO BACTERIAL INFECTIONS DECLARE THEMSELVES?

Non-specific symptoms

- High temperature or low temperature
- Generally unwell
- Confusion
- High WCC

Symptoms localised to site of infection

- Dysuria – pain on urination
- Diarrhoea
- Cough
- Redness or pus at a wound site

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MULTI-DRUG-RESISTANT BACTERIA

- Bacteria that antibiotics don't work against
- May also be referred to as "antibiotic-resistant bacteria"

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MULTI-DRUG-RESISTANT BACTERIA

- **MRSA**: Meticillin-resistant *Staphylococcus aureus*
- **VRE**: Vancomycin-resistant Enterococci
- **ESBL**: Extended-spectrum β-lactamase- producing *Enterobacterales*
- **CPE**: **Carbapenemase-producing *Enterobacterales***

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WHY DO RESISTANT BACTERIA MATTER?

- If a patient gets an **infection** with one of these bacteria, it can be very difficult to treat

MRSA

ESBL

VRE

CRE

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WHAT PUTS PATIENTS AT RISK OF RESISTANT BACTERIA?

- Previous antibiotic therapy
- Nursing home residents
- Multiple/ prolonged hospital admissions
- Extremes of age
- Chronic disease
- Immunosuppression
- Invasive devices

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DIFFERENCES BETWEEN THE IMPORTANT RESISTANT BACTERIA

1. Where they live (where to find them..)

MRSA	vs.	VRE/ ESBL/ CRE
Lives on skin/ inside nose		Live in bowel
Can decolonise		No decolonisation

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DIFFERENCES BETWEEN RESISTANT BACTERIA

2. The kind of infections they cause

- **MRSA** causes cellulitis, wound infections, septic arthritis
- **VRE** may cause central line infections/ UTIs/ intra-abdominal infections
- **ESBL**- producing organisms and **CPE** cause mainly UTIs and intra-abdominal infections
  - In some cases these can be very severe ("Gram negative sepsis")

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MRSA: METICILLIN-RESISTANT *S. AUREUS*

- Lives on skin and inside nose
- Many people may be **colonised**
  - e.g. Healthcare workers, people who have been in hospital
- Possible to decolonise
- Only problematic when causes **infection**
  - Cellulitis, wound/ ulcer infections, line infections
  - Bone/ joint infections

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MRSA: COLONISATION VS. INFECTION

Colonisation

Infection

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MRSA: WHERE TO FIND THEM…

- MRSA screening swabs of nose and groin
- Also swab ulcers, PEG sites etc.
- Usually charcoal swabs (for culture)

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VRE: VANCOMYCIN-RESISTANT ENTEROCOCCI

- Live in the bowel
- Many hospitalised patients may be colonised
- Can't decolonise (bowel cannot be sterilised)
- Can survive for long periods on surfaces so cleaning of bed spaces and toilet facilities very important

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VRE IN THE PATIENT ENVIRONMENT

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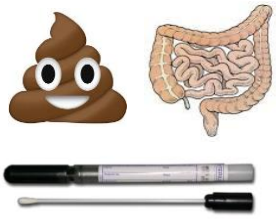
VRE: WHERE TO FIND THEM…



- VRE screening swab (rectal or stoma)
- Usually charcoal swab (for culture)
- "Round and round until it's brown…"

ESBL: EXTENDED-SPECTRUM BETA-LACTAMASE

- Enzymes carried by Gram-negative bowel organisms (e.g. *E.coli, Klebsiella* spp.) which make them resistant to:
  - Cephalosporin antibiotics (e.g. "Rocephin")
  - Sometimes co-amoxiclav ("Augmentin")
  - Sometimes piperacillin-tazobactam ("Tazocin")
- Live in the bowel
- Can't decolonise (bowel cannot be sterilised)
- Cause UTIs, intra-abdominal infections

ESBLS: WHERE TO FIND THEM…

- ESBL screening swab (rectal or stoma)
- Usually charcoal swab for culture
- "Round and round until it's brown…"
- Many hospitals don't screen for ESBLs

ESBLS AND CPE

ESBLS CPE

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CPE: CARBAPENEMASE-PRODUCING ENTEROBACTERALES

- Gram-negative bowel organisms (e.g. *E.coli, Klebsiella* spp.) that produce enzymes that make them **resistant to meropenem** (our "last-resort" antibiotic)
- Live in the bowel

- Can't decolonise (bowel cannot be sterilised)
- Only problematic when they cause **infection**
  - E.g. UTIs, intra-abdominal infection

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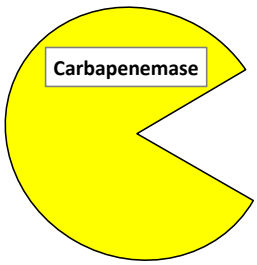

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CPE CAN LOOK SOMETHING LIKE THIS….

AGENT	RESULT
Amoxicillin	RESISTANT
Co-amoxiclav	RESISTANT
Cefuroxime	RESISTANT
Cefotaxime	RESISTANT
Ceftazidime	RESISTANT
Piperacillin/Tazobactam	RESISTANT
Aztreonam	RESISTANT
Meropenem	RESISTANT
Ciprofloxacin	RESISTANT
Gentamicin	RESISTANT
Tobramycin	RESISTANT
Amikacin	RESISTANT
Tigecycline	RESISTANT
Colistin	SUSCEPTIBLE

CPE: CARBAPENEMASE-PRODUCING *ENTEROBACTERALES*

- Becoming more widespread
- **A big problem**
- If a patient gets a CPE infection
  - May be **no suitable antibiotic** to treat them with
  - High mortality

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CPE: WHERE TO FIND THEM

- CPE screening swab (rectal or stoma)
- Usually charcoal swab for culture
- Some labs now using molecular methods
- "Round and round until it's brown…"

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RESISTANT BACTERIA IN CLINICAL SPECIMENS

- Sometimes we find resistant organisms when we weren't looking for them
- Can be picked up in any specimen (urine, ulcer swab etc.)
- E.g. CPE in a catheter urine
- Doesn't always indicate **infection**; depends on the clinical picture- how is the patient?

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SUMMARY

- Bacteria are all over us and are important for our health
- Resistant bacteria (e.g. MRSA, VRE, ESBLs, CPE) can be carried harmlessly (colonisation) or cause infection
- Different resistant bacteria are carried at different sites and cause different types of infection

UP NEXT:

What happens when the specimen gets to the lab?

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Thank you!

Any Questions?

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