antibiotic resistance – an ecological problem

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this part of the session

› an ecological perspective
  • the global bacterial ecosystem
  • the global mobile gene pool
› selection pressure and evolution
  • optimising microbial husbandry
  • picking resistance early
› natural checks and balances
  • predator-prey balance: bacteriophages
  • gene pool distortion and manipulation
this part of the session

› an ecological perspective
  - the global bacterial ecosystem that keeps us healthy
  - the global mobile gene pool
› selection pressure and evolution
  - microbial husbandry
  - the consequences of late recognition
› natural checks and balances
  - predator-prey balance: bacteriophages
  - gene pool distortion and manipulation

shared bacteria connect us all

› drinking and bathing waters

› animals

› travel

the global bacterial gene pool:
bacteria share genes between each other

rules of the gene pool:
Only one gene carrier of each type per bacteria (plasmid incompatibility)
Once carriers are in, they stay in (plasmid addiction)

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(gut) bacterial community

- dynamic and responsive,
- complex relationship to the immune system,
- stable average state resistant to outside influences, including diet.

Bacteria we hit

Bacteria we aim at

antimicrobial stewardship: good microbial husbandry

- antibiotics with small ecological footprints
- minimising antibiotic exposure
- repairing ecological damage: probiotics

Doing the same experiment with humans in ICU:
Comparing good drug and bad drug that are equally effective against the bugs we aim at
Paradox: bad drug leads to more of the bugs we aim at (opportunist)

Probiotics
Probiotics should work - some probably do
They might keep some bugs out of ICU
Not enough research so we have to make do
Seems Nan was right – there’s nothing like a healthy…
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- survival
  - immediate
  - delayed

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The best adapted gene packages win!
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bacteriophage: viruses that prey on bacteria

natural predators
eg for:
Golden staph (MRSA etc)
Pseudomonas (eg in Cystic Fibrosis)

shared gene pools
R gene/s/R plasmids
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the global bacterial ecosystem
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Both daughter cells are full of long-lived stable toxin

The plasmid continues to provide the short-lived antidote. Cells without the plasmid (antidote) die.

Addictive R (bad) plasmid with toxin and antitoxin.

Curative plasmid challenges both addiction and compatibility.

Getting rid of the antibiotic resistance: making bacteria susceptible, stopping transmission spread, rescuing biodiversity.

Research Activity Domains (RADs)

- Major human diseases
- Major animal diseases
- Microbiome disturbance
- Antimicrobial resistance
- Pandemic infections
- Zoonoses
- Environment & Sustainability
- Biosecurity
2009 Maldives cabinet meeting

thanks

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Key affiliations:
- Marie Bashir Institute
- Westmead Millennium Institute
- Sydney Medical School

More information?
- type 'critical infection' into your browser
- sydney.edu.au/medicine/criticalinfection/
the golden staph

- (S. aureus)
  - common infections
  - infected cuts (surgery)
  - boils and impetigo
  - bone and joint
  - survival strategies
  - drying
  - physical stress

the paradox of gut bacteria

- (E. coli):
  - normal gut ecology
  - commonest cause of lethal blood infection
  - less hardy
  - all about sharing
  - messages
  - rapid and efficient gene exchange

Gram staining indicates basic differences

1880s: Streptococcus or Klebsiella pneumoniae?

Hans Christian Joachim Gram
(1853-1938)
Gram pos

Tend to be more hardy and resistant to drying
not ideally adapted to the aqueous environment – typically can’t swim

Single outer wall

Darwinian evolution:
successful mutations are passed on

Gram neg

Information exchange
- chemical messages
- genetic material

Recombinant evolution:
rapid and promiscuous gene exchange

sensing and responding

Sampling the outside world

Information exchange
- chemical messages
- genetic material