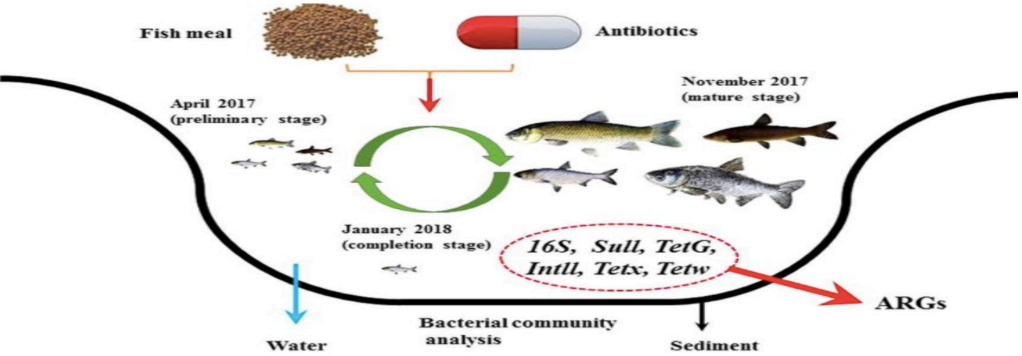

Antimicrobial resistance in aquaculture in the context of one health

Indrani Karunasagar
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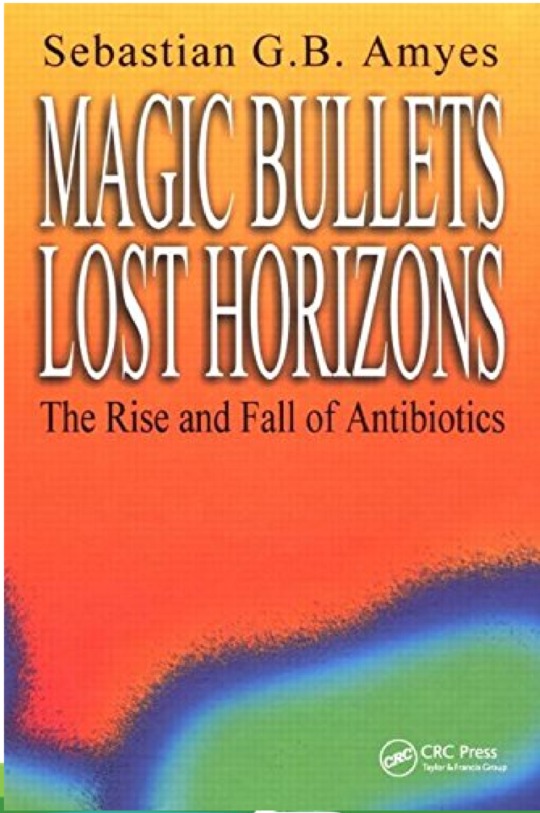
Human
health
One
Health
Animal
health
Environmental
health

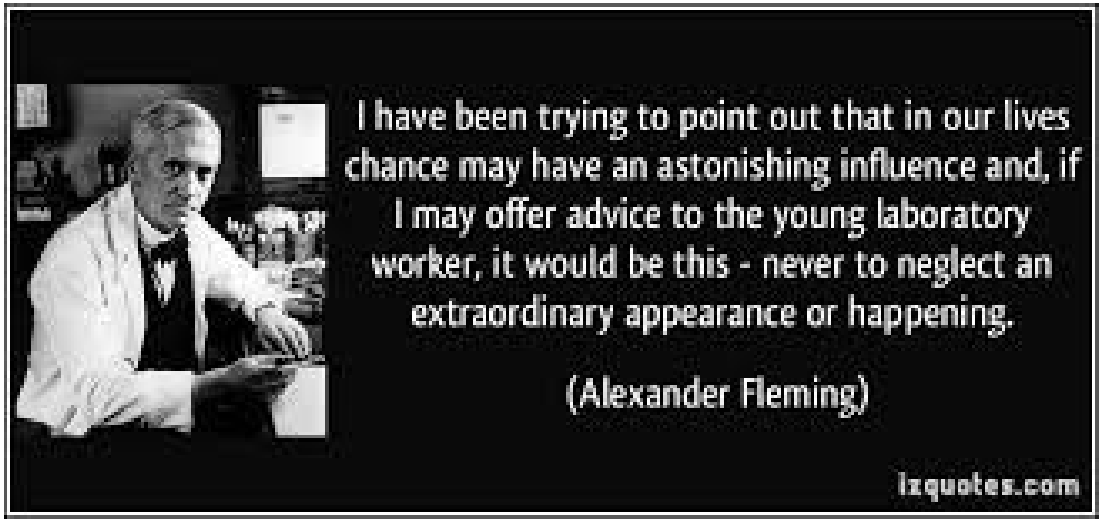

ANTIBIOTIC RESISTANCE
THE MAGIC BULLET'S TOLL
What if a saviour turns into a killer? After 80 years of use, overuse and abuse of antibiotics—termed magic bullets—microbes have become resistant to them. Antibiotic resistant diseases are undoing the great strides in modern treatment.
BY 2030
126 BILLION
defined daily dosages of antibiotics*
200% more than in 2015*
BY 2050
10 MILLION
deaths/year**
More than those killed in the Rwandan genocide
BY 2050
$100 TRILLION
economic loss**
Which is over 15 times of Africa's GDP
Source: *Global increase and geographic convergence in antibiotic consumption between 2000 and 2015, PNAS, April 10, 2018, **Tackling drug-resistant infections globally: final report and recommendations, 2016, Wellcome Trust, HM Government, the UK

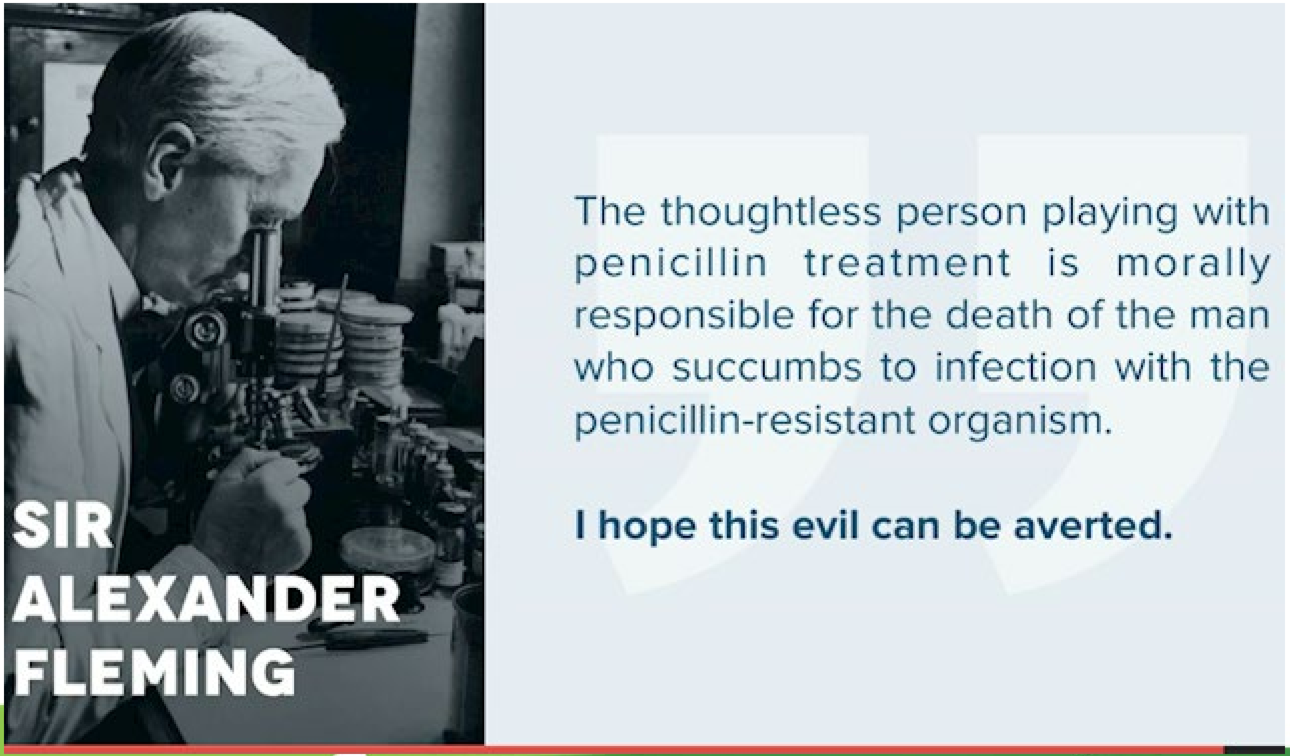

Sebastian G.B. Amyes
MAGIC BULLETS LOST HORIZONS
The Rise and Fall of Antibiotics
CRC Press

Understanding resistance is Important…

WORLD
ANTIMICROBIAL
AWARENESS WEEK

18-24 NOVEMBER


I have been trying to point out that in our lives chance may have an astonishing influence and, if I may offer advice to the young laboratory worker, it would be this - never to neglect an extraordinary appearance or happening.
(Alexander Fleming)
izquotes.com


SIR
ALEXANDER
FLEMING
The thoughtless person playing with penicillin treatment is morally responsible for the death of the man who succumbs to infection with the penicillin-resistant organism.
I hope this evil can be averted.

Why should we talk about resistance

"Resistance training is just as important as cardio. Train yourself to resist chocolate, pastries, fried foods, beer, pizza...."

Definitions

Multidrug Resistant (MDR)

- Acquired non-susceptibility to at least one agent in three or more antimicrobial categories

Extensively drug resistant (XDR)

- Non-susceptibility to at least one agent in all, but two or fewer antimicrobial categories

Pan drug resistant (PDR)

- Non-susceptibility to all agents in all available antimicrobial categories

Exner et al. GMS Hyg Infect Control. 2017; 12: Doc05.

Antimicrobial resistance global threat

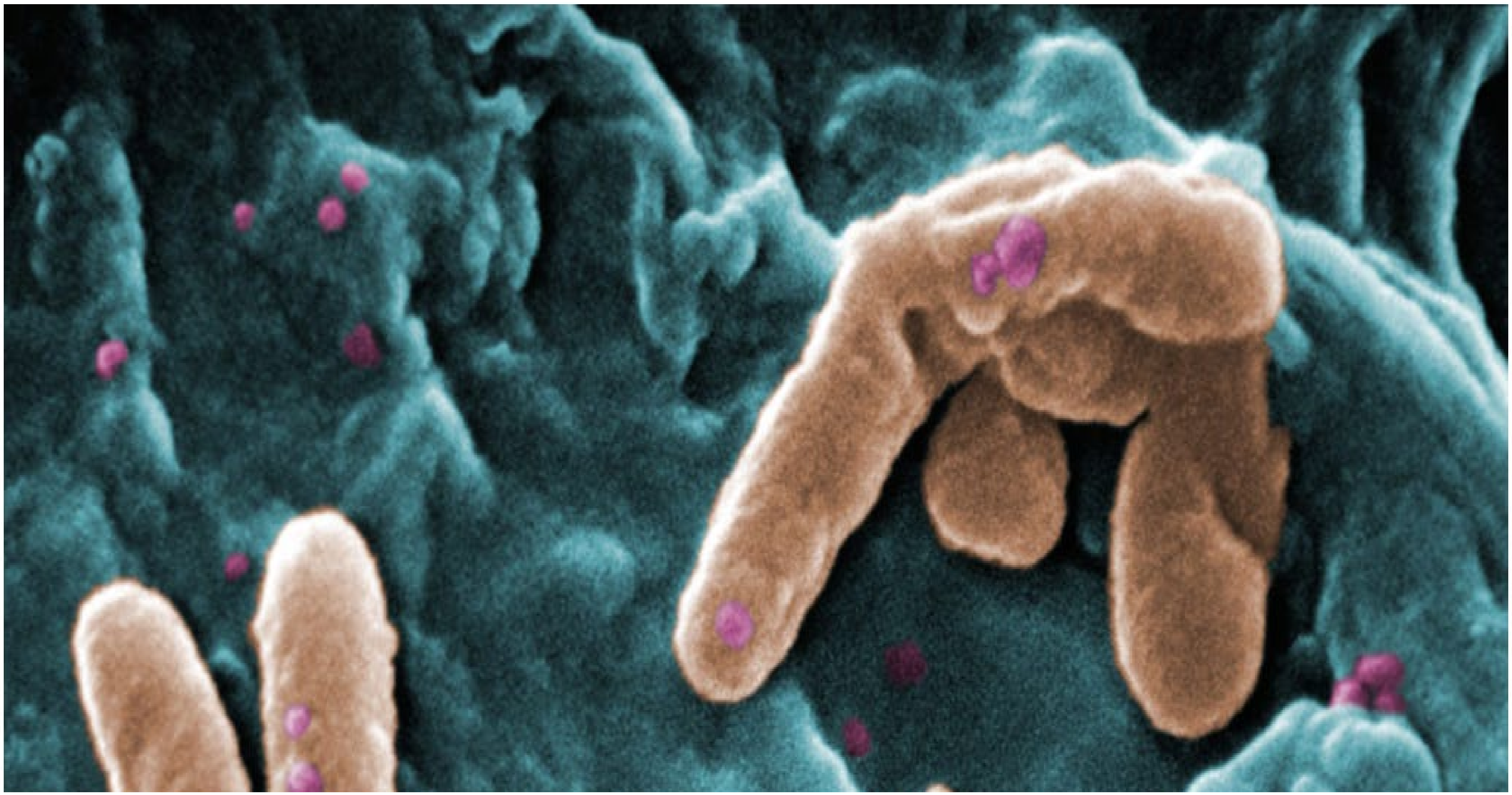
- WHO has identified AMR as one among top 10 global public health threats.
- US CDC estimates- two million people affected by AMR infections and 23,000 die every year.
- Europe estimates- ~ half million affected by AMR infections and deaths 33,116 per year.
- In 2011, UN General assembly adopted "Political declaration on antimicrobial resistance".
- WHO, FAO and OIE have developed action plan against AMR

WHO – most important organisms for which new therapeutics are needed

- ESKAPE group
  - *Enterococcus faecium*
  - *Staphylococcus aureus*
  - *Klebsiella pneumoniae*
  - *Acinetobacter baumanii*
  - *Pseudomonas aeruginosa*
  - *Enterobacter* spp
- Cause of most important healthcare associated infections
- Impact:
  - Infections not responding to antibiotics - mortality
  - Longer hospital stays

HEALTH

WHO releases list of world's most dangerous superbugs



- **Priority 1: Critical**

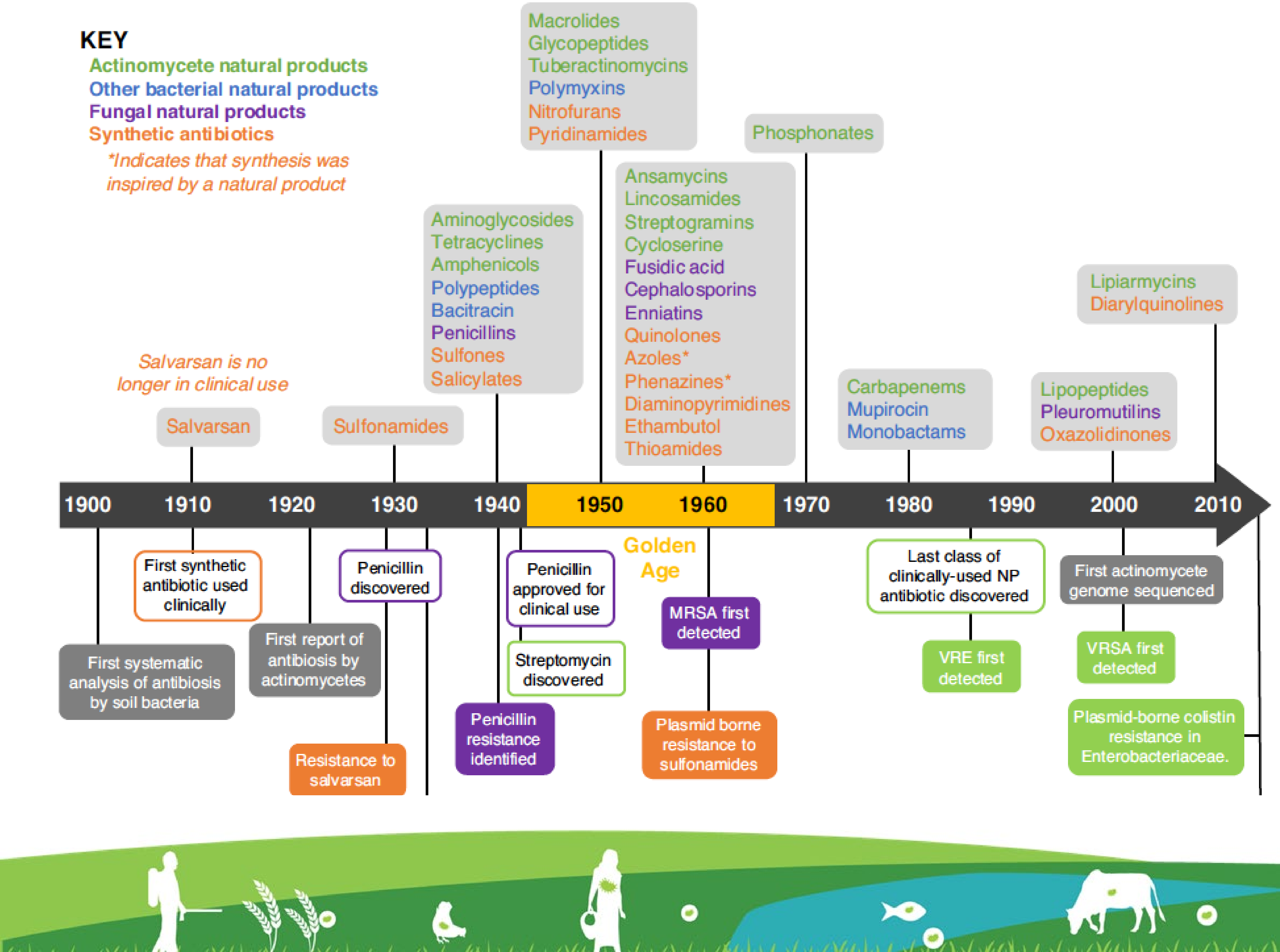
1. *Acinetobacter baumannii*, carbapenem-resistant
2. *Pseudomonas aeruginosa*, carbapenem-resistant
3. *Enterobacteriaceae*, carbapenem-resistant, ESBL-producing

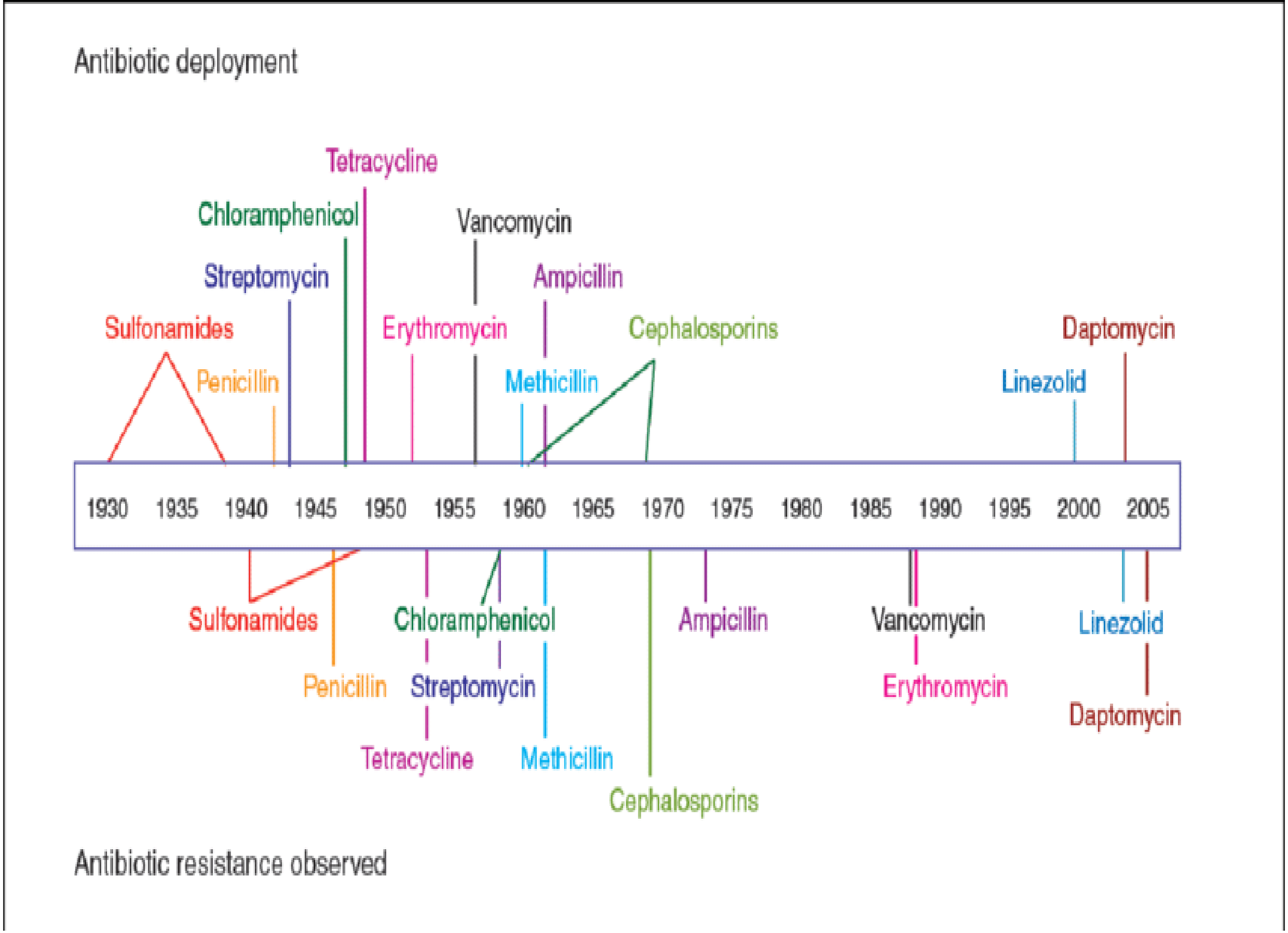
- **Priority 2: High**

4. *Enterococcus faecium*, vancomycin-resistant
5. *Staphylococcus aureus*, methicillin-resistant, vancomycin-intermediate and resistant
6. *Helicobacter pylori*, clarithromycin-resistant
7. *Campylobacter spp*., fluoroquinolone-resistant
8. *Salmonellae*, fluoroquinolone-resistant
9. *Neisseria gonorrhoeae*, cephalosporin-resistant, fluoroquinolone-resistant

- **Priority 3: Medium**

10. *Streptococcus pneumoniae*, penicillin-non-susceptible
11. *Haemophilus influenzae*, ampicillin-resistant
12. *Shigella* spp., fluoroquinolone-resistant


KEY
Actinomycete natural products
Other bacterial natural products
Fungal natural products
Synthetic antibiotics
*Indicates that synthesis was inspired by a natural product
Macrolides
Glycopeptides
Tuberactinomycins
Polymyxins
Nitrofurans
Pyridinamides
Phosphonates
Ansamycins
Lincosamides
Streptogramins
Cycloserine
Fusidic acid
Cephalosporins
Enniatins
Quinolones
Azoles*
Phenazines*
Diaminopyrimidines
Ethambutol
Thioamides
Aminoglycosides
Tetracyclines
Amphenicols
Polypeptides
Bacitracin
Penicillins
Sulfones
Salicylates
Lipiarmycins
Diarylquinolines
Salvarsan is no longer in clinical use
Salvarsan
Sulfonamides
Carbapenems
Mupirocin
Monobactams
Lipopeptides
Pleuromutilins
Oxazolidinones
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Golden Age
First synthetic antibiotic used clinically
Penicillin discovered
Penicillin approved for clinical use
Last class of clinically-used NP antibiotic discovered
First actinomycete genome sequenced
MRSA first detected
First systematic analysis of antibiosis by soil bacteria
First report of antibiosis by actinomycetes
Streptomycin discovered
VRE first detected
VRSA first detected
Penicillin resistance identified
Plasmid borne resistance to sulfonamides
Plasmid-borne colistin resistance in Enterobacteriaceae.
Resistance to salvarsan



Antibiotic deployment
Tetracycline
Chloramphenicol
Vancomycin
Streptomycin
Ampicillin
Sulfonamides
Erythromycin
Cephalosporins
Daptomycin
Penicillin
Methicillin
Linezolid
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Sulfonamides
Chloramphenicol
Ampicillin
Vancomycin
Linezolid
Penicillin
Streptomycin
Erythromycin
Daptomycin
Tetracycline
Methicillin
Cephalosporins
Antibiotic resistance observed

CONSULTATIONS AND WORKSHOPS

Antimicrobial Use in Aquaculture and Antimicrobial Resistance

Report of a Joint FAO/OIE/WHO
Expert Consultation on Antimicrobial Use in
Aquaculture and Antimicrobial Resistance

Seoul, Republic of Korea, 13–16 June 2006

World Health Organization

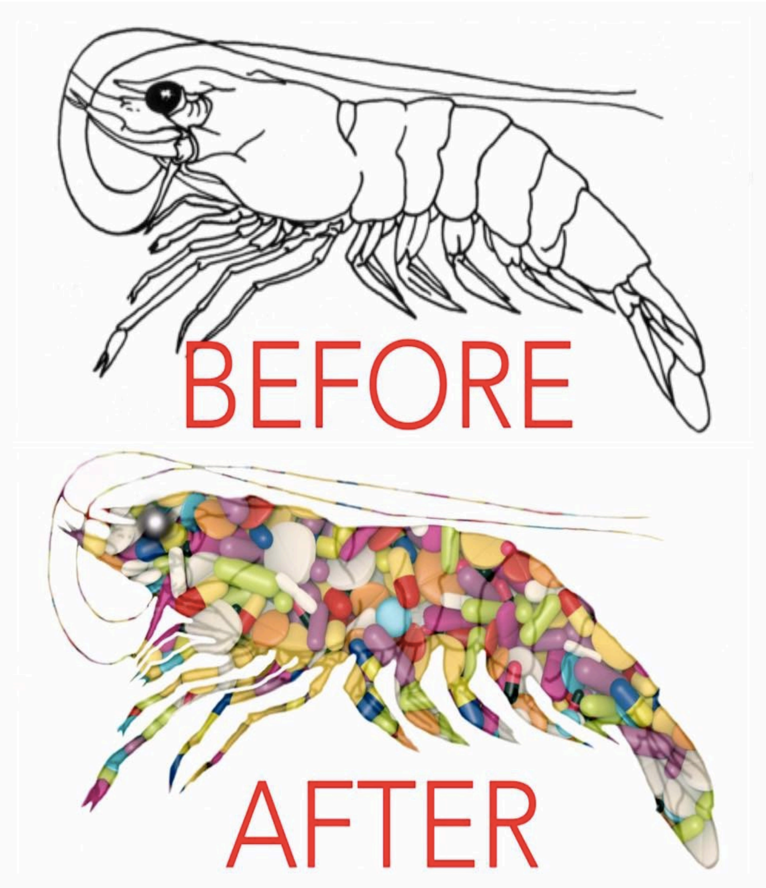
Issued by the World Health Organization in collaboration
with the Food and Agriculture Organization of the United Nations
and the World Organisation for Animal Health

DEPARTMENT OF FOOD SAFETY, ZOONOSES AND FOODBORNE DISEASES
WORLD HEALTH ORGANIZATION
GENEVA, SWITZERLAND

Major risks associated with antimicrobial use in aquaculture

- Antimicrobial residues in fish
- Selection and spread of antimicrobial resistance
  - Pathogens of aquatic animals
  - Fish associated bacteria with zoonotic potential
  - Resistance transfer can happen across bacterial species and genera
  - Aquatic bacteria that may transfer resistance to human pathogens


抗生素


BEFORE
AFTER

Publications that raised serious concern

Environmental Microbiology (2006) **8**(7), 1137–1144

doi:10.1111/j.1462-2920.2006.01054.x

Minireview

Heavy use of prophylactic antibiotics in aquaculture: a growing problem for human and animal health and for the environment

Felipe C. Cabello
Department of Microbiology and Immunology, New York Medical College, Valhalla, NY 10595, USA.

many developed and developing countries. It is expected that this growth will increase at an even faster rate in the future, stimulated by the depletion of fisheries and the market forces that globalize the sources of food supply

Aquaculture as yet another environmental gateway to the development and globalisation of antimicrobial resistance

Felipe C Cabello, Henry P Godfrey, Alejandro H Buschmann, Humberto J Dölz

Aquaculture uses hundreds of tonnes of antimicrobials annually to prevent and treat bacterial infection. The passage of these antimicrobials into the aquatic environment selects for resistant bacteria and resistance genes and stimulates bacterial mutation, recombination, and horizontal gene transfer. The potential bridging of aquatic and human pathogen resistomes leads to emergence of new antimicrobial-resistant bacteria and global dissemination of them and their antimicrobial resistance genes into animal and human populations. Efforts to prevent antimicrobial overuse in aquaculture must include education of all stakeholders about its detrimental effects on the health of fish, human beings, and the aquatic ecosystem (the notion of One Health), and encouragement of environmentally friendly measures of disease prevention, including vaccines, probiotics, and bacteriophages. Adoption of these measures is a crucial supplement to efforts dealing with antimicrobial resistance by developing new therapeutic agents, if headway is to be made against the increasing problem of antimicrobial resistance in human and veterinary medicine.

Lancet Infect Dis 2016;
16: e127–33

Published Online
April 12, 2016
http://dx.doi.org/10.1016/
S1473-3099(16)00100-6

Department of Microbiology and Immunology and Department of Pathology, New York Medical College, Valhalla, New York, NY, USA (Prof F C Cabello MD,

Antimicrobial use in Aquaculture

- Fish contributes to about 7% of global protein intake (FAO, 2020).
- 2017 global antimicrobial consumption in aquaculture- 10,259 tonnes - expected to increase to 13,600 tonnes (33% increase) by 2030 (Schar et al., 2020).
- Consumption intensity : *157 mg* kg^{-1} *for catfish, 103 mg* kg^{-1} *for trout, 59 mg* kg^{-1} *for tilapia, 46 mg* kg^{-1} *for shrimp, 27 mg* kg^{-1} *for salmon, 208 mg* kg^{-1} *for pooled species.*
- Global antimicrobial consumption in 2030 - expected to be 236,757 tonnes – Application sector wise:
  humans accounting for 20.5%
  terrestrial animal production accounting for 73.7%
  aquaculture accounting for 5.7%

Global antimicrobial consumption

Source: Schar et al., 2020

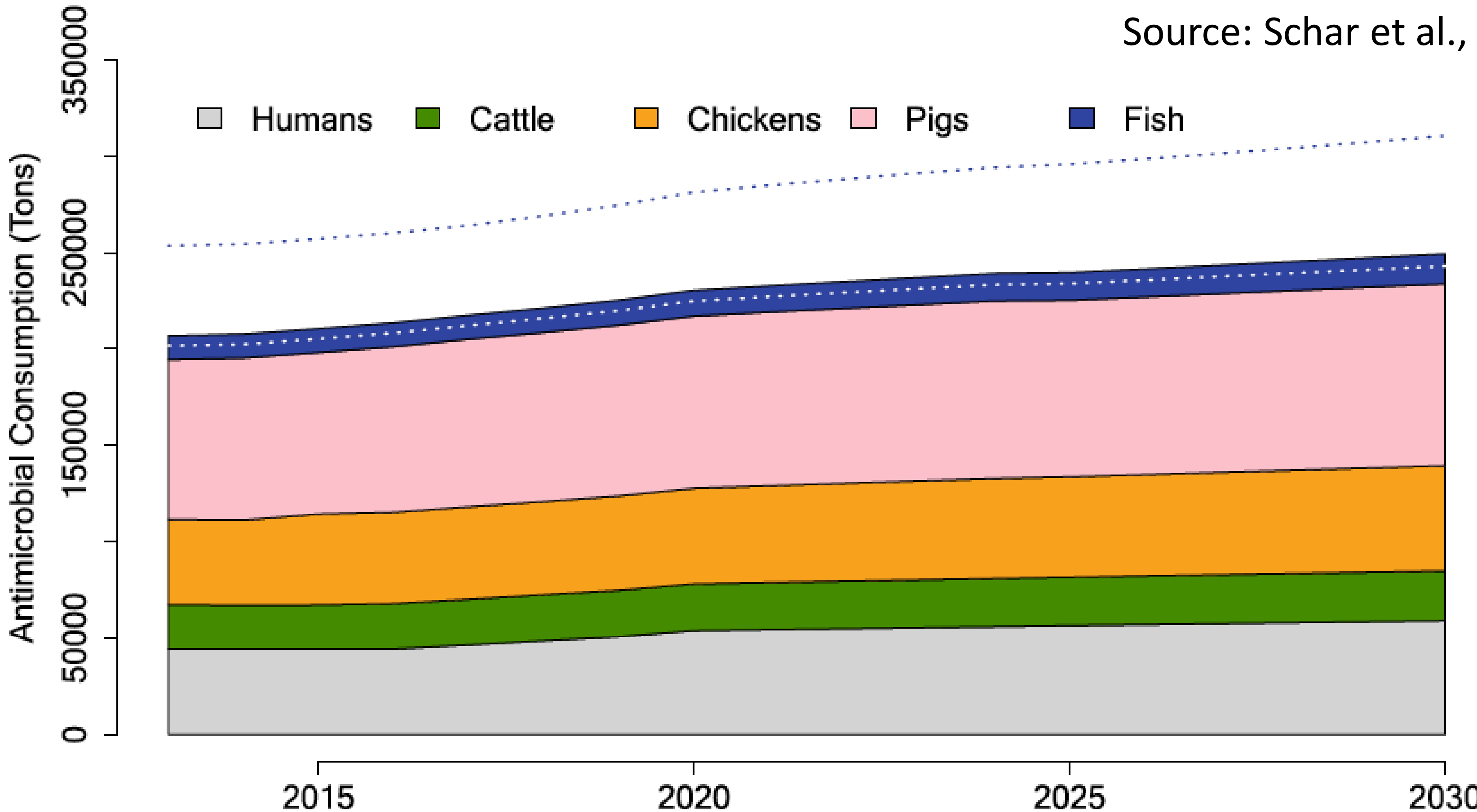


Figure 3. Global antimicrobial consumption, 2013–2030. Dotted lines represent the 95% uncertainty interval for fish.

Antibiotic consumption in aquaculture (Schar et al., 2020)

- In 2017 , 93.8% global antibiotic consumption in aquaculture sector was in Asia-Pacific Region, 2.3% in Africa, 1.8% in Europe.

  In 2030, increases would be 50.9% in Africa and 50.6% in Latin America

- In Asia-Pacific region,antibiotic consumers – Global aquaculture production

  China 57.9% ---51.2%

  India 11.3%--9.9%

  Indonesia 8.6% --9.8%

  Vietnam 5% ---5.7%

- The countries with largest projected increase during 2017-2030 would be Brazil (94%), Saudi Arabia (77%), Australia (61%), Russia (59%) and Indonesia (55%).

Development of Antibiotic Resistance

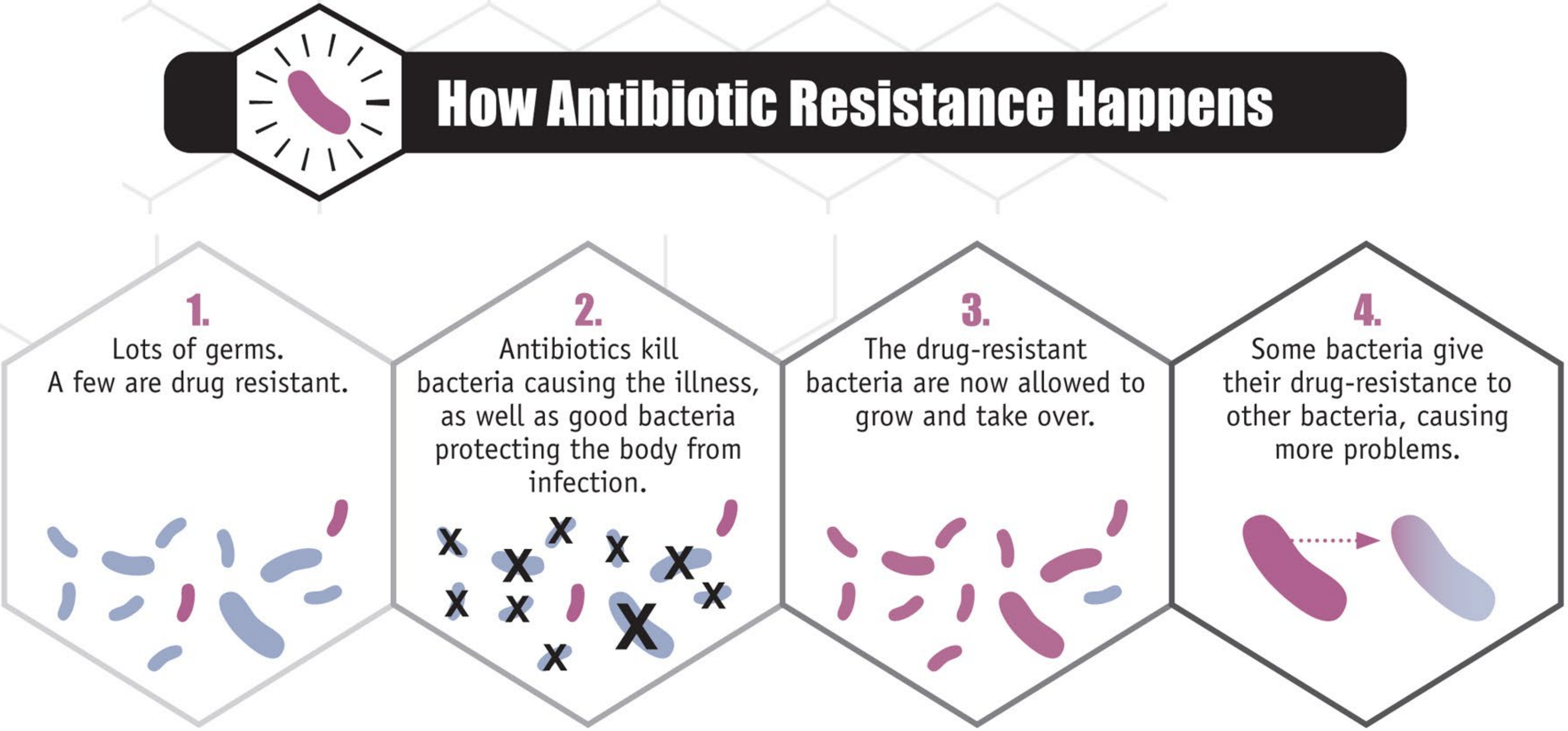
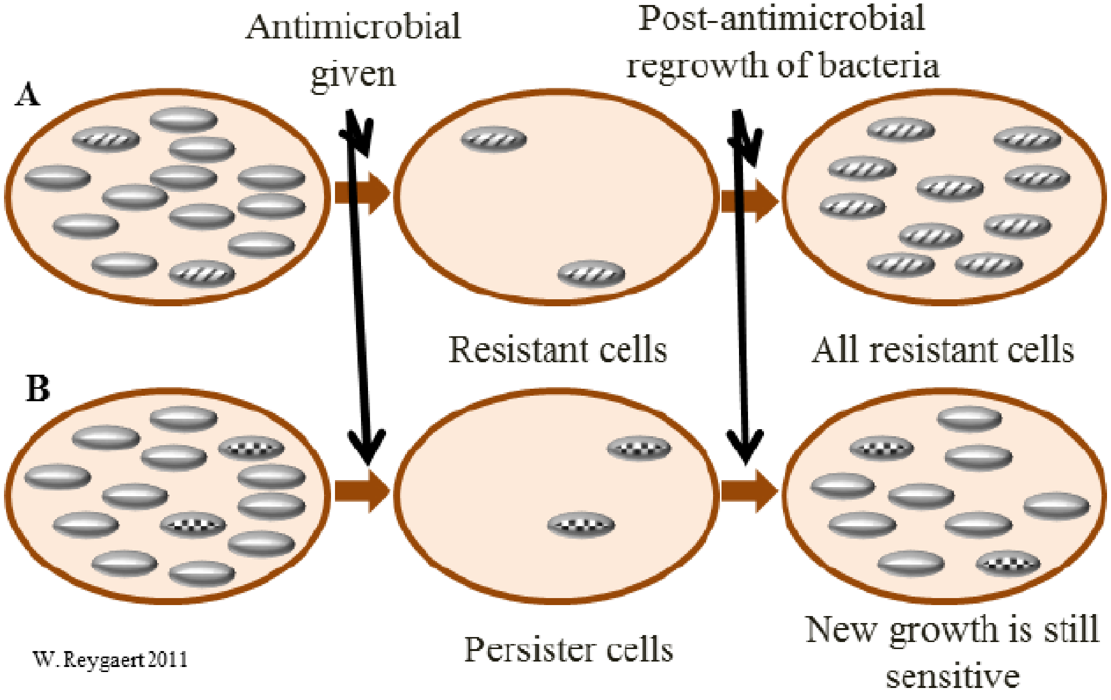


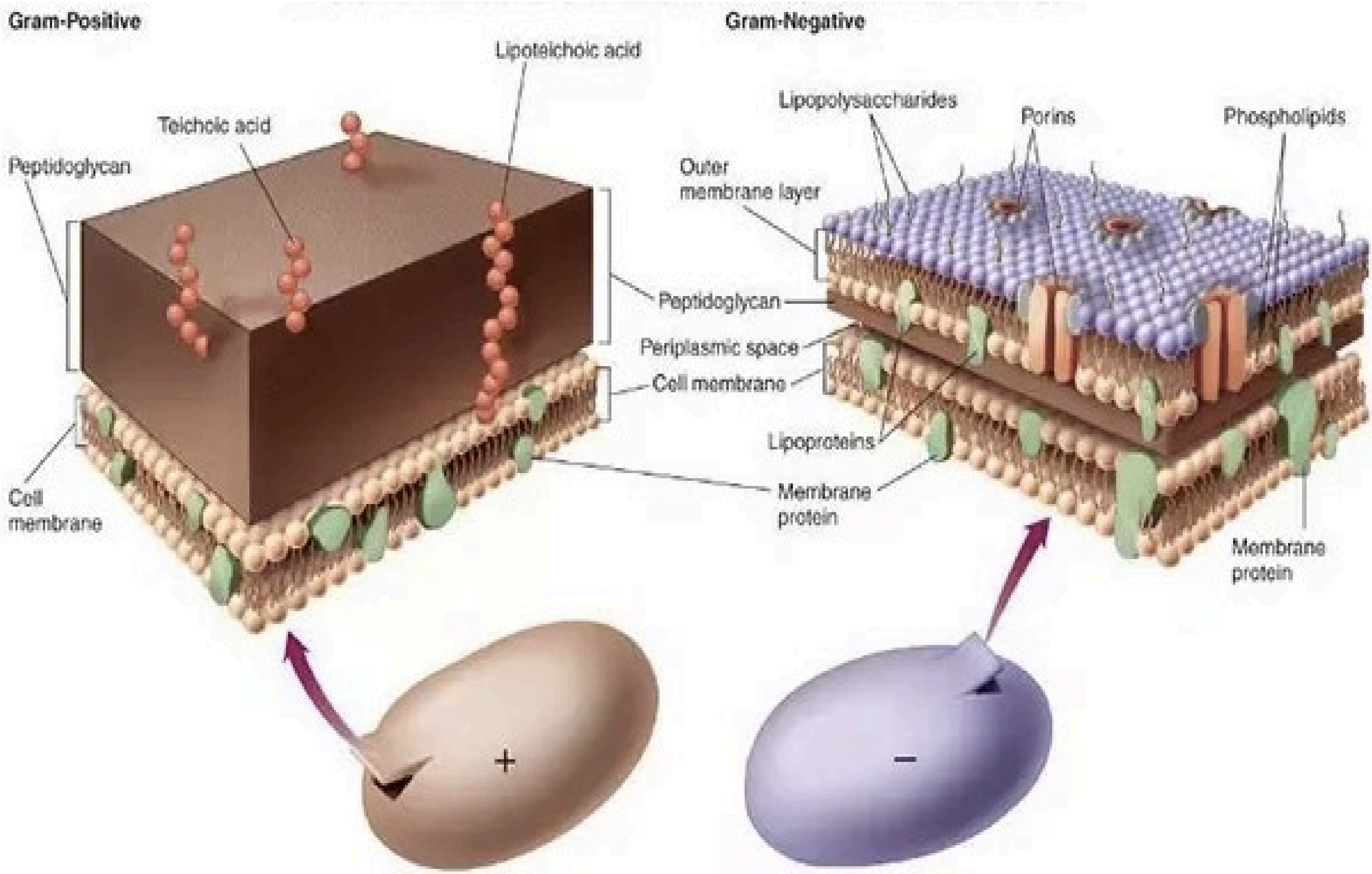
Image courtesy of CDC / Melissa Brower
Centers for Disease Control and Prevention Public Health Image Library
http://phil.cdc.gov/phil/home.asp

Persistance *vs* resistance ?



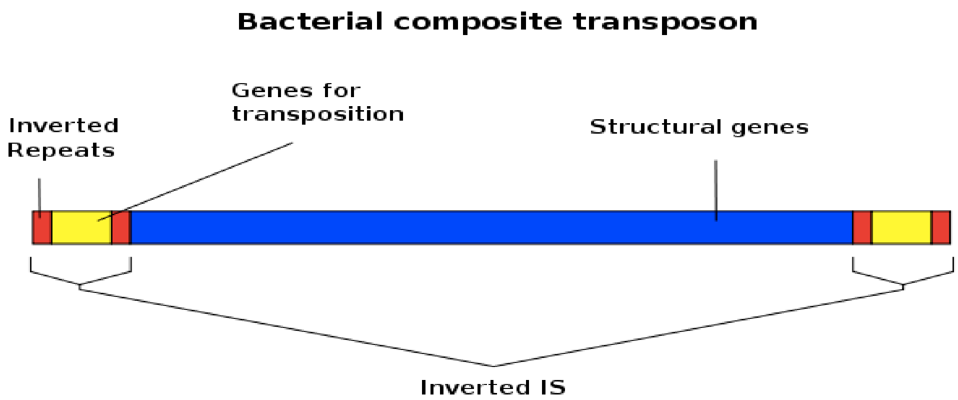
Some bacteria have intrinsic resistance

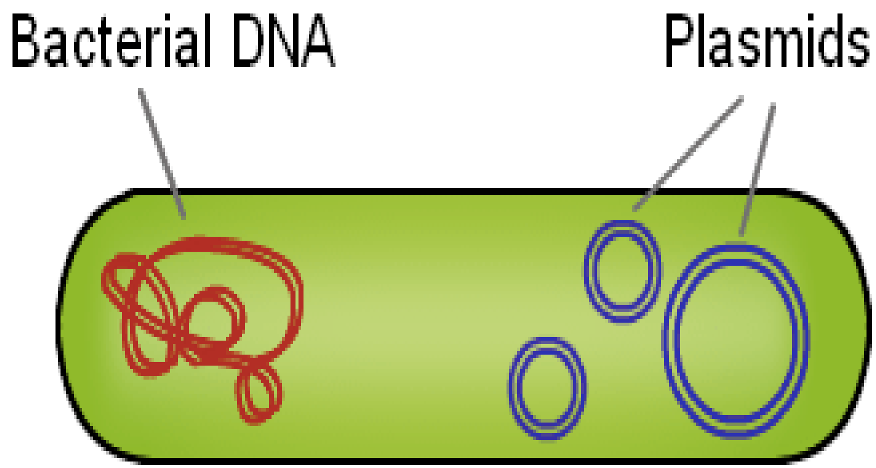
- The intrinsic resistance of a bacterial species to a particular antibiotic : ability to resist the action of that antibiotic as a result of inherent structural or functional characteristics.
- For example: glycopeptide antibiotic vancomycin inhibits peptidoglycan crosslinking by binding to target d-Ala- d-Ala peptides, but in Gram-negative organisms, it cannot cross the outer membrane and access these peptides in the periplasm
- *Aeromonas* has intrinsic beta-lactamases which makes them resistant to ampicillin.

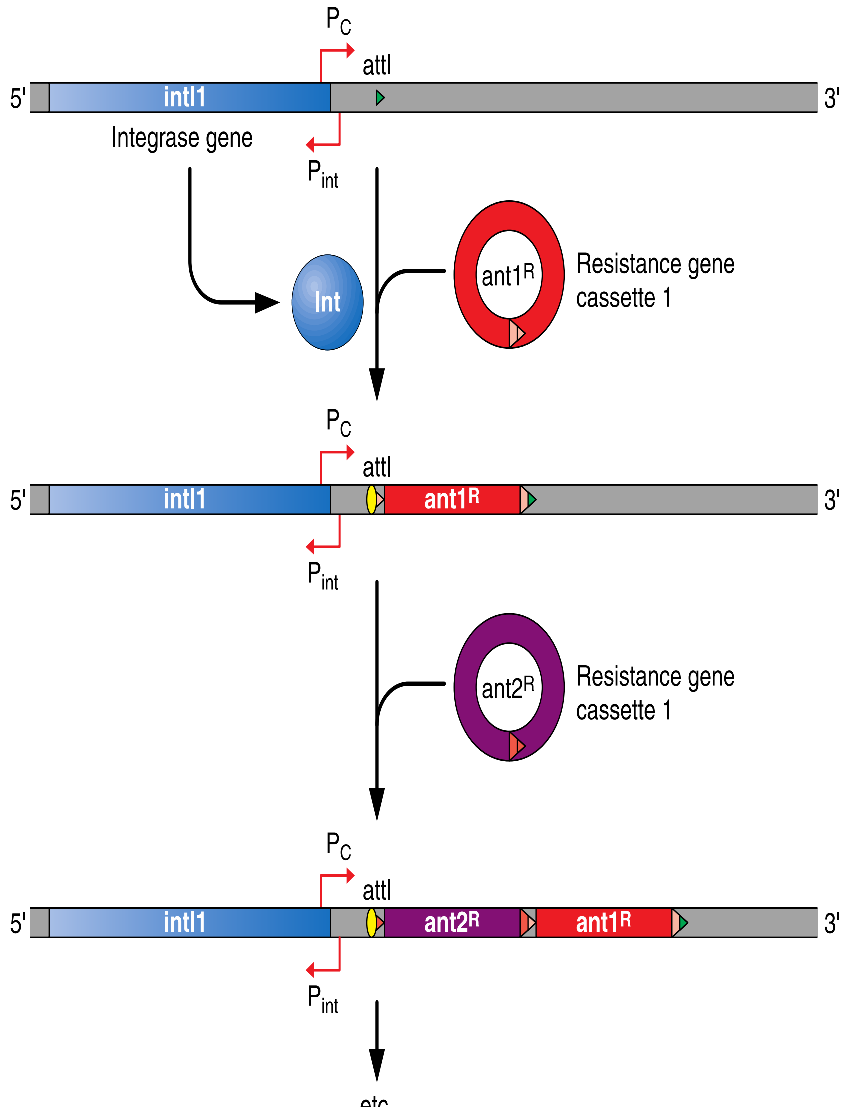

Gram-Positive
Gram-Negative
Lipoteichoic acid
Teichoic acid
Peptidoglycan
Lipopolysaccharides
Porins
Phospholipids
Outer membrane layer
Peptidoglycan
Periplasmic space
Cell membrane
Cell membrane
Lipoproteins
Membrane protein
Membrane protein
+
–

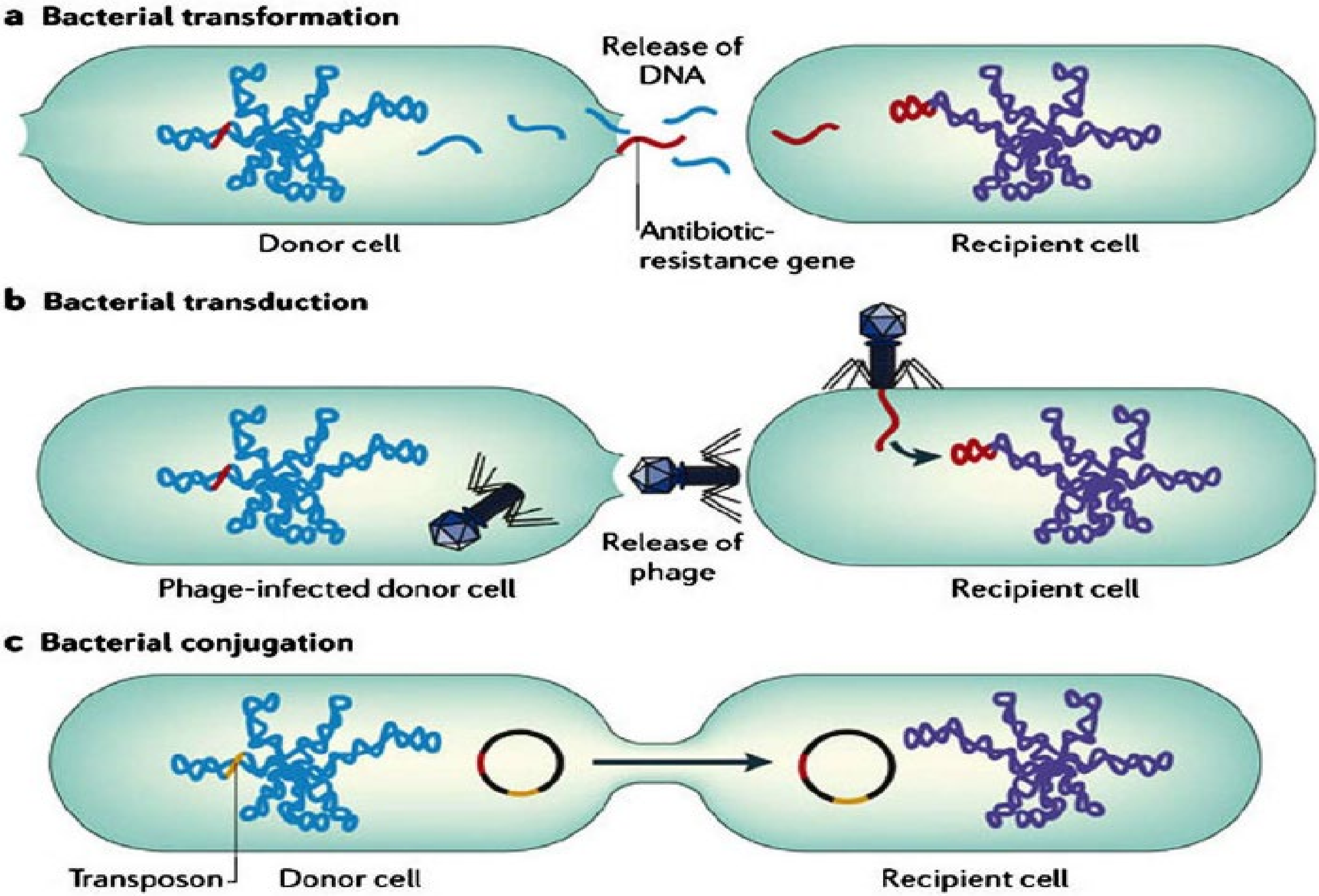
Acquired antimicrobial resistance

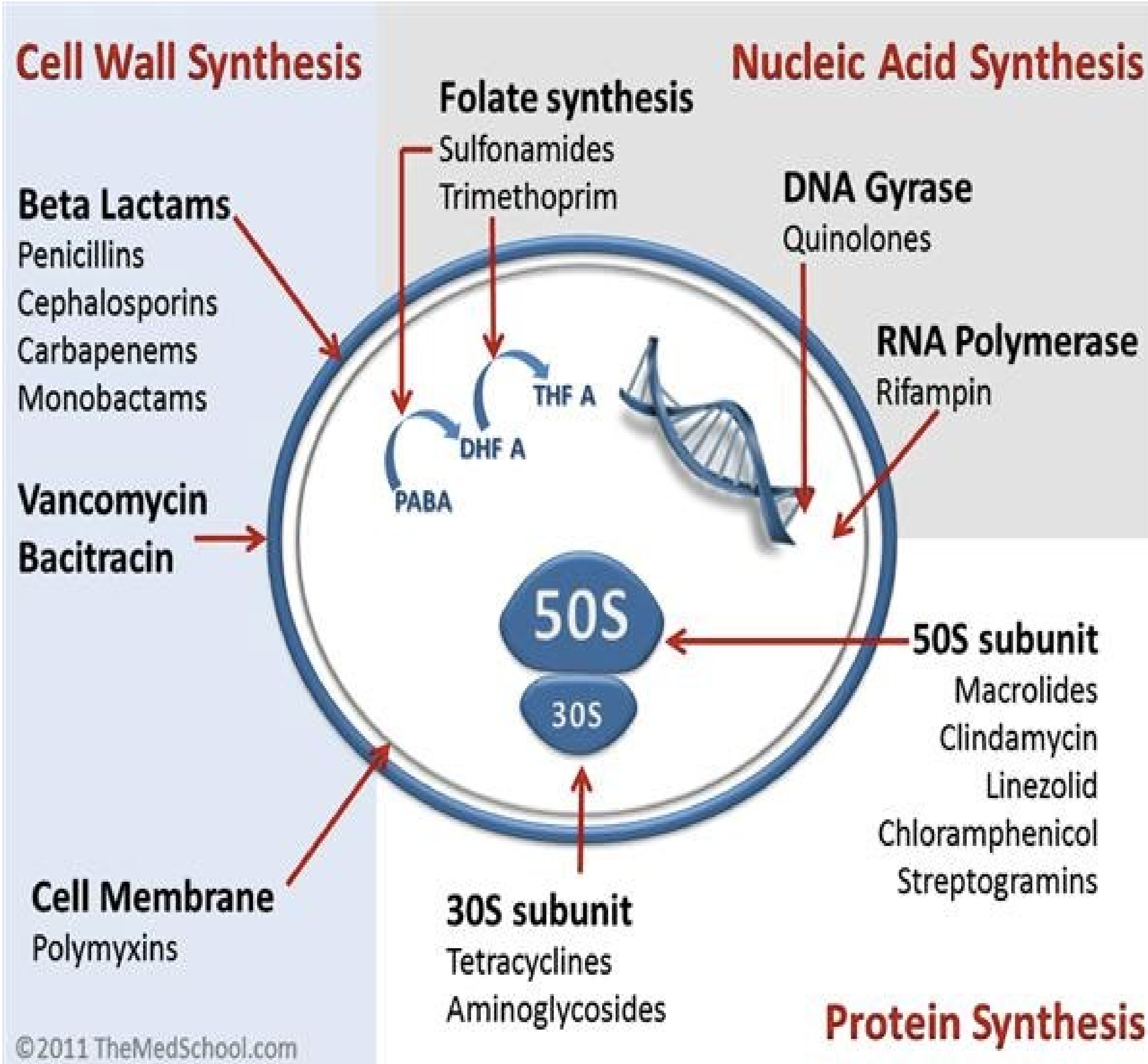
- When microorganisms once sensitive to an antimicrobial agent become resistant to that particular antibiotic, the resistance is acquired
- The acquired resistance could be due to genetic changes such as mutations or acquisition of genes contributing to resistance through horizontal gene transfer
- Mobile genetic elements like plasmids, transposons, bacteriophages contribute to horizontal gene transfer
- Horizontal gene transfer can occur across bacterial genera and species eg from environmental bacteria to human pathogens

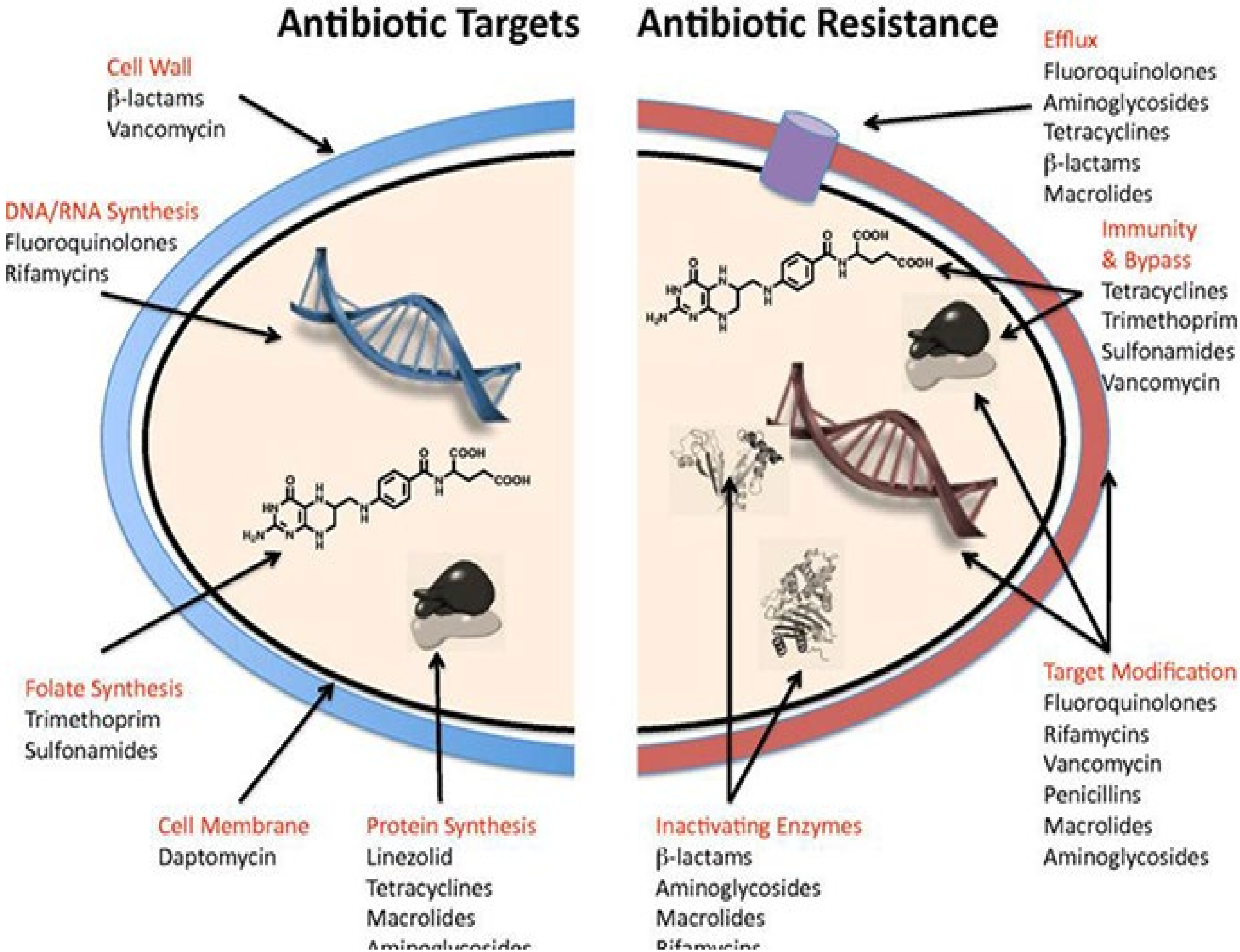

Bacterial composite transposon
Inverted Repeats
Genes for transposition
Structural genes
Inverted IS


Bacterial DNA
Plasmids


P C
attI
5'
intI1
3'
Integrase gene
P int
Int
ant1R
Resistance gene cassette 1
ant2R
Resistance gene cassette 1
ant2R
ant1R
etc


a Bacterial transformation
Release of DNA
Donor cell
Antibiotic-resistance gene
Recipient cell
b Bacterial transduction
Phage-infected donor cell
Release of phage
Recipient cell
c Bacterial conjugation
Transposon
Donor cell
Recipient cell


Cell Wall Synthesis
Nucleic Acid Synthesis
Folate synthesis
Sulfonamides
Trimethoprim
DNA Gyrase
Quinolones
Beta Lactams
Penicillins
Cephalosporins
Carbapenems
Monobactams
RNA Polymerase
Rifampin
THF A
DHF A
PABA
Vancomycin
Bacitracin
50S
30S
50S subunit
Macrolides
Clindamycin
Linezolid
Chloramphenicol
Streptogramins
Cell Membrane
Polymyxins
30S subunit
Tetracyclines
Aminoglycosides
Protein Synthesis
©2011 TheMedSchool.com


Antibiotic Targets
Antibiotic Resistance
Cell Wall
β-lactams
Vancomycin
DNA/RNA Synthesis
Fluoroquinolones
Rifamycins
Folate Synthesis
Trimethoprim
Sulfonamides
Cell Membrane
Daptomycin
Protein Synthesis
Linezolid
Tetracyclines
Macrolides
Efflux
Fluoroquinolones
Aminoglycosides
Tetracyclines
β-lactams
Macrolides
Immunity
& Bypass
Tetracyclines
Trimethoprim
Sulfonamides
Vancomycin
Target Modification
Fluoroquinolones
Rifamycins
Vancomycin
Penicillins
Macrolides
Aminoglycosides
Inactivating Enzymes
β-lactams
Aminoglycosides
Macrolides

Phenotypic resistance and mechanisms of resistance

- When identical phenotypic resistance is detected in two isolates eg

  - one from aquatic environment

  - another from a clinical case,

- The two isolates may have different resistance genes with different mechanisms

  Eg: tetracycline resistance could be due to

  (a) over production of efflux proteins or

  (b) production of ribosomal protection proteins

  (c) production of tetracycline inactivating proteins

Antimicrobial resistance is ancient, natural and is found in environments with no exposure to antibiotics

- Viable multidrug-resistant bacteria have been cultured from the Lechuguilla Cave in New Mexico, isolated for >4 million years (Bhullar et al., 2012)
- Antibiotic resistant marine bacteria have been found as far as 522KM offshore and in deep sea at depths of 8200m (Aminov, 2011)
- Evolution of antibiotic resistance genes predates evolution of Actinomycetes
- Some of the antibiotic resistance genes have not evolved to protect against antibiotics but have other metabolic functions

Resistance genes have other functions in the cell

- ampC beta-lactamase is involved in maintaining normal morphology in *Escherichia coli*
- Efflux pumps are involved in efflux of several compounds
- bla_{oxy} beta-lactamase has metabolic function in *Klebsiella oxytoca*

Resistance genes found in environmental bacteria without exposure to antibiotics

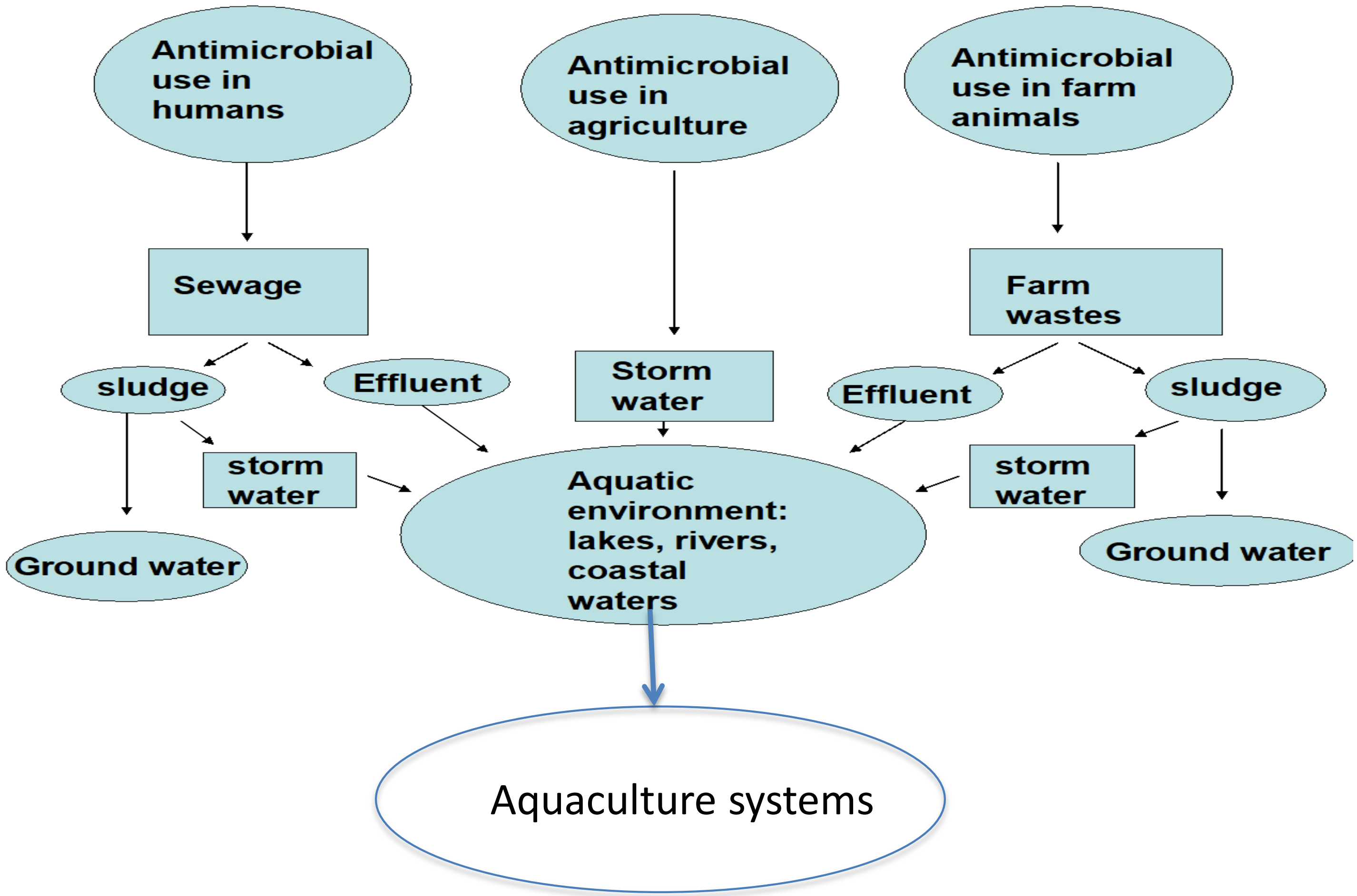
- *qnr* gene conferring resistance to quinolones are found in marine bacteria like *Shewanella algae* and *Vibrio* spp.
- CTX-M beta-lactamase is present in environmental bacteria like *Kluyvera*

AMR not always related to use of antibiotics in aquaculture

- Culture-independent studies in the Baltic sea, show presence of resistance genes encoding resistance to sulphonamides, trimethoprim, tetracycline, aminoglycoside, chloramphenicol

- Genes encoding multidrug efflux pumps in sediments below fish farms, though some antibiotics like tetracyclines, aminoglycosides and chloramphenicol are not used in this area (Muziasari et al., 2017)

- Most *Vibrio vulnificus* strains isolated from Dutch eel farms showed resistance to cefoxitin, though this antibiotic was not used in eel aquaculture (Haenen et al., 2014)



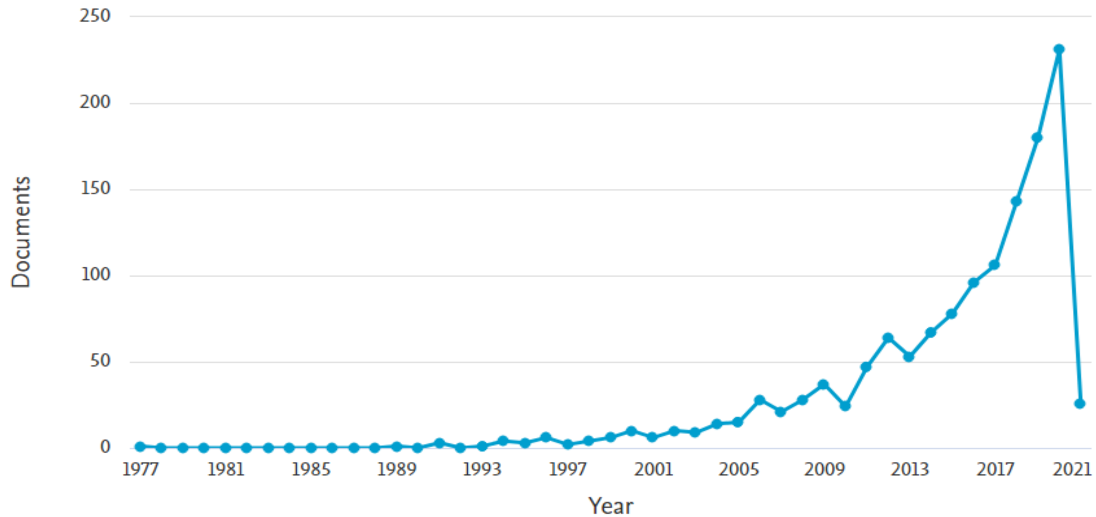
Antimicrobial resistance from all sectors end up in aquatic environment

1,324 document results

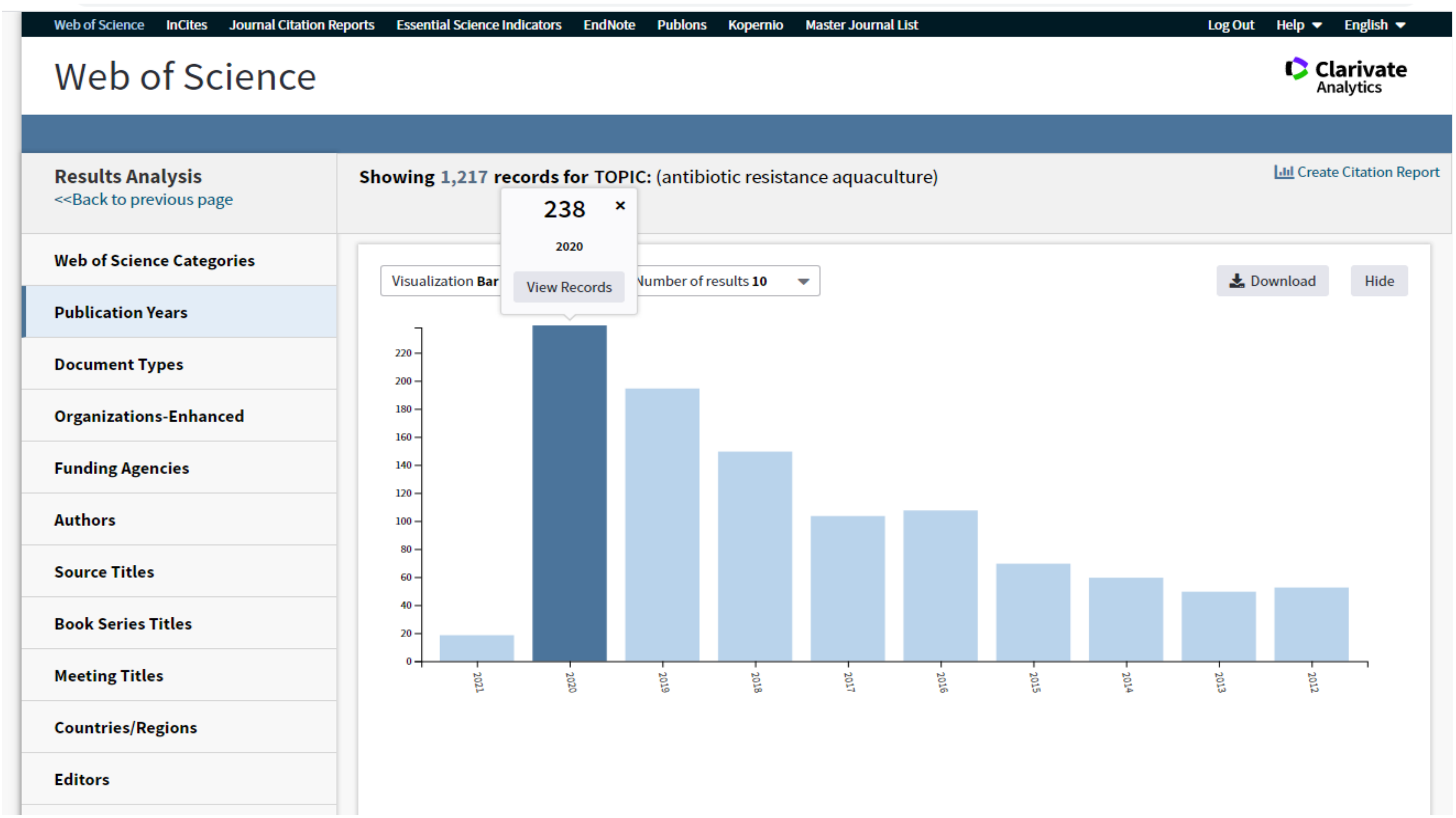
Select year range to analyze: 1977 to 2021 Analyze

Year	Documents
2021	26
2020	231
2019	180
2018	143
2017	106
2016	96
2015	78
2014	67
2013	53
2012	64

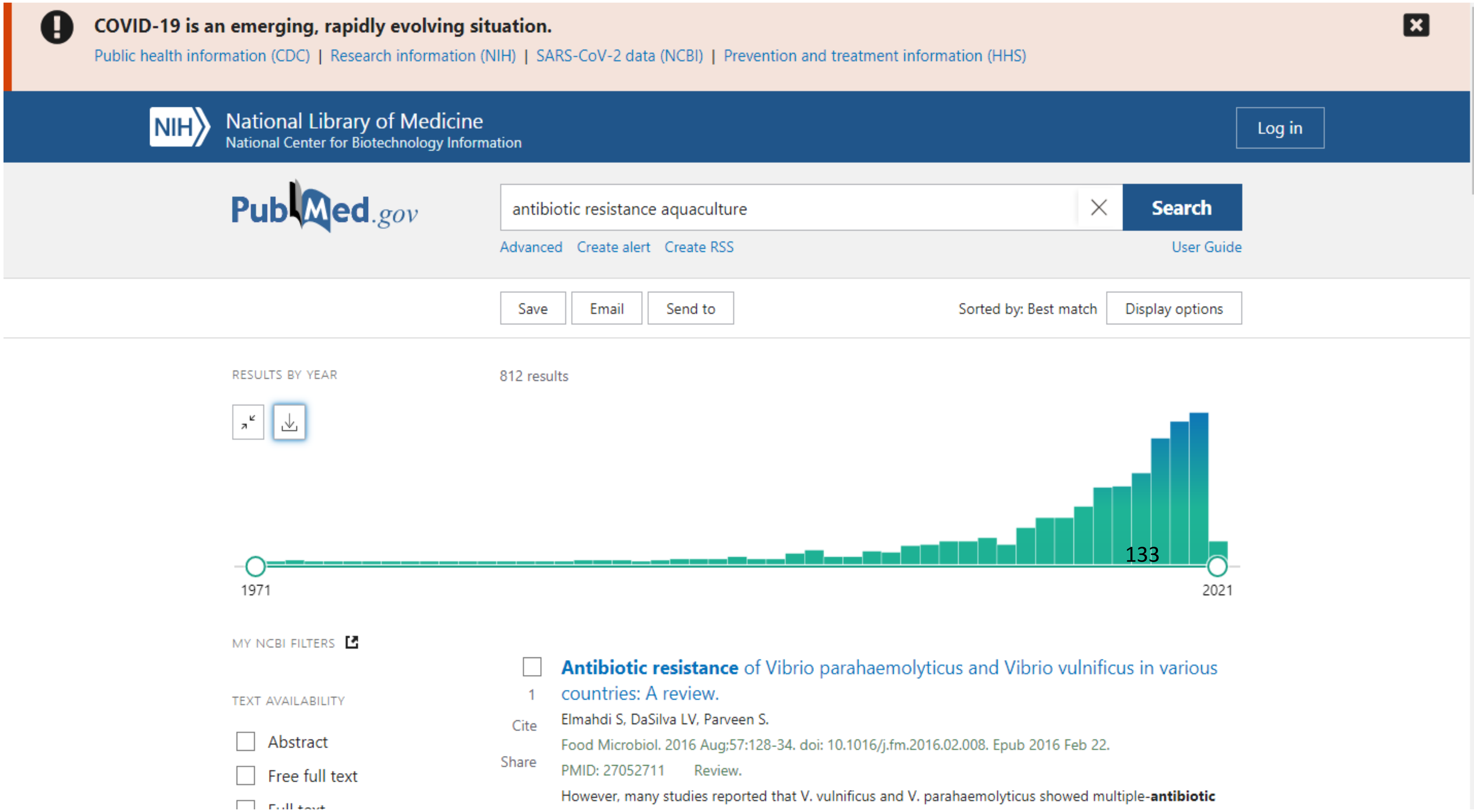
Documents by year



Web of Science search “Antibiotic resistance aquaculture”



Pubmed search “antibiotic resistance aquaculture”



Aspects not considered in many publications on AMR associated with aquaculture

- Intrinsic resistance in many aquatic bacteria – *Aeromonas* to ampicillin

- Selection of antibiotic resistant bacteria due to exposure to chemical pollutants, heavy metals

- AMR introduced into aquaculture environment from other sectors

- Change of microflora that happens during the processing of fish – at retail stage, flora present could be totally different

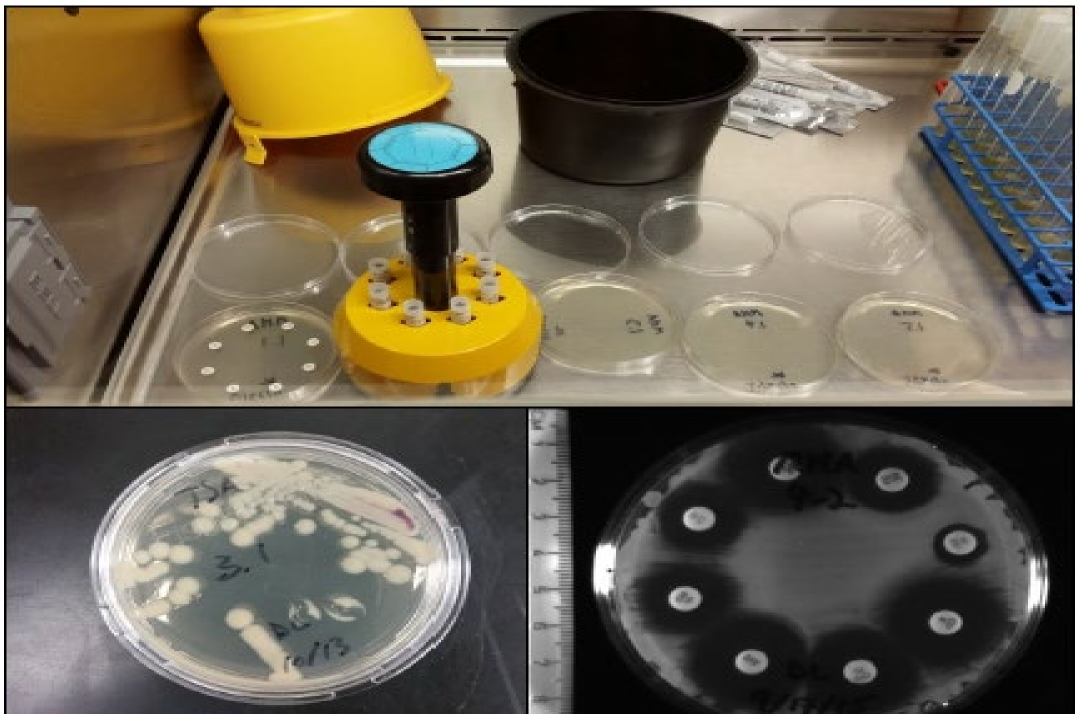
Food and Agriculture
Organization of the
United Nations

FIAA/C1191 (En)

FAO
Fisheries and
Aquaculture Circular

ISSN 2070-6065

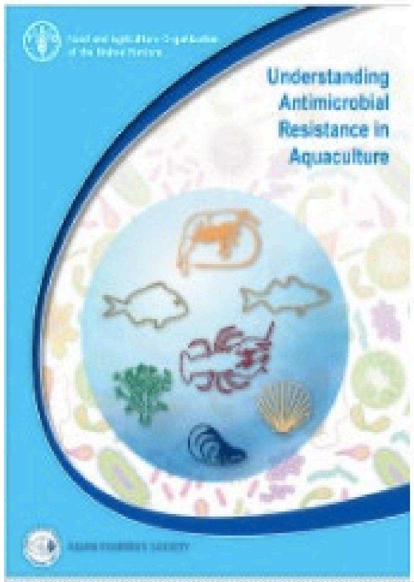
THE PERFORMANCE OF ANTIMICROBIAL SUSCEPTIBILITY TESTING PROGRAMMES RELEVANT TO AQUACULTURE AND AQUACULTURE PRODUCTS



What is the way forward?

- We need to understand aquatic environment as reservoir of resistance determinants
- Integrated surveillance with human, veterinary and other environments will give a better picture of the selection pressure in different sectors
- One Health approach in collaboration with clinicians and veterinarians is needed to minimize antimicrobial use and selection pressure

Asian Fisheries Science



Volume 33S1 (2020)

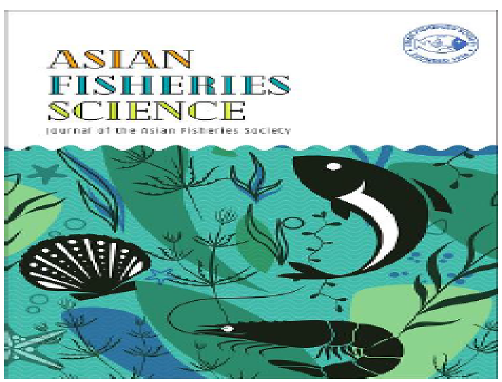
Understanding Antimicrobial Resistance in Aquaculture

Full version of Volume 33S

EDITED BY J. RICHARD ARTHUR, MELBA G. BONDAD-REANTASO, IDDYA KARUNASAGAR, CELIA LAVILLA-PITOGO, BRETT MACKINNON AND DEE MONTGOMERY-BROCK

Date: 2020/12/25

Page : 1-124



Review of National Residue Control Programme for Aquaculture Drugs in Selected Countries

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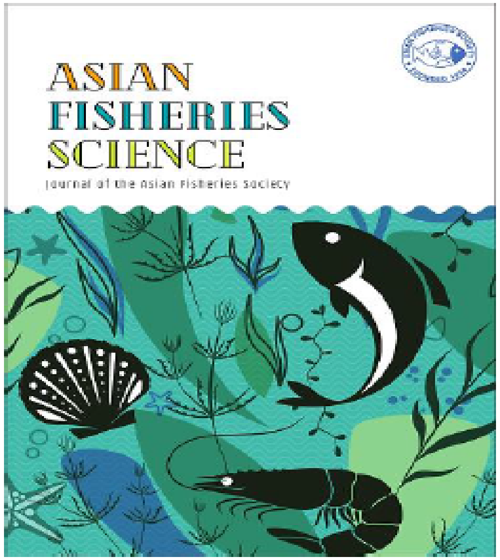
Nitte University, Mangalore-575018, India

*E-mail: iddya.karunasagar@nitte.edu.in



Complexities Involved in Source Attribution of Antimicrobial Resistance Genes Found in Aquaculture Products

IDDYA KARUNASAGAR[1,*], INDRANI KARUNASAGAR[1], MELBA G. BONDAD-REANTASO[2]

[1]Nitte University, Medical Enclave, Deralakatte, Mangalore, Karnataka, India

[2]Fisheries Division, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy

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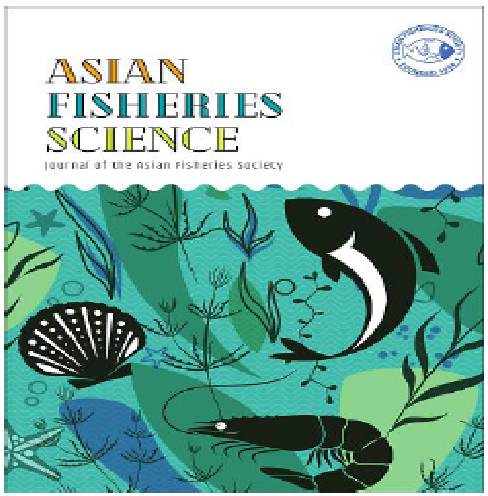

Contact-Zoonotic Bacteria of Warmwater Ornamental and Cultured Fish

OLGA HAENEN[1,*], IDDYA KARUNASAGAR[2], AMEDEO MANFRIN[3], SNJEZANA ZRNCIC[4], CELIA LAVILLA-PITOGO[5], MARK LAWRENCE[6], LARRY HANSON[6], ROHANA SUBASINGHE[7], MELBA G. BONDAD-REANTASO[8], INDRANI KARUNASAGAR[2]

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OUTPUTS AND ACTIVITIES OF FAO PROJECT FMM/RAS/298/MUL ON ANTIMICROBIAL RESISTANCE IN FISHERIES AND SUMMARY OF FAO'S RECENT WORK ON ANTIMICROBIAL RESISTANCE IN AQUACULTURE

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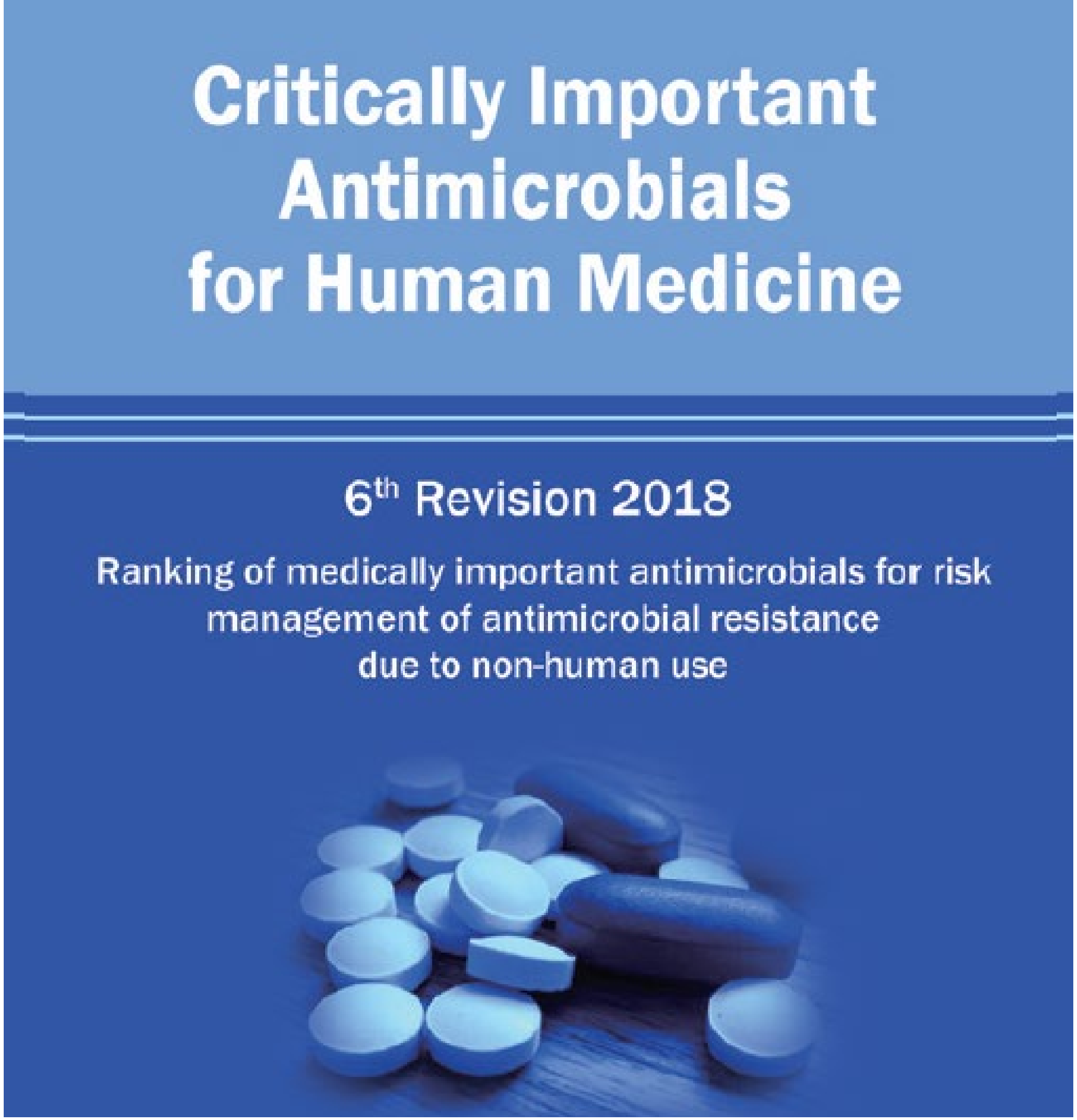
Codex texts on foodborne antimicrobial resistance
Textes du Codex concernant la résistance aux antimicrobiens d'origine alimentaire
Textos del Codex sobre resistencia a los antimicrobianos transmitida por los alimentos
CODEX ALIMENTARIUS
FAO FIAT PANIS
Food and Agriculture Organization of the United Nations
Organisation des Nations Unies pour l'alimentation et l'agriculture
Organización de las Naciones Unidas para la Alimentación y la Agricultura
World Health Organization

Joint FAO/WHO/OIE Expert Meeting on Critically Important Antimicrobials

Report of the FAO/WHO/OIE Expert Meeting

FAO Headquarters, Rome, 26-30 November 2007


Critically Important Antimicrobials for Human Medicine
6th Revision 2018
Ranking of medically important antimicrobials for risk management of antimicrobial resistance due to non-human use

- Aquaculture systems are a hub of several AMR pathogens

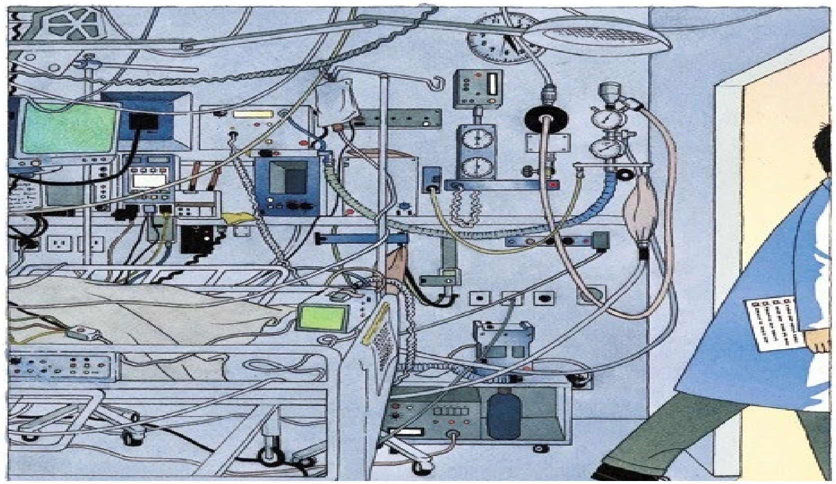
- Some may possess intrinsic resistance, some others may be selected by antibiotic use; some are derived from antibiotic use in other sectors

- Source of AMR found in aquatic bacteria is hard to trace

- Inter-sectoral collaboration is needed to trace the source of resistance determinants which is very complex

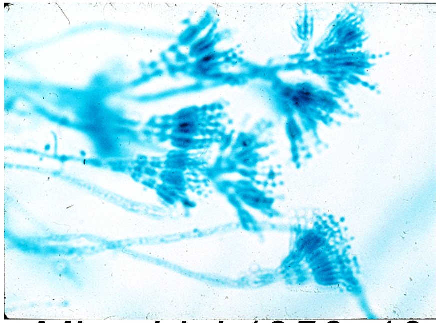
The continuing emergence of multi drug resistant organisms that cause infections in community and health care settings contribute substantially to the morbidity, prolonged hospital stay with increased treatment costs and mortality

Within the hospital, extensive data indicate that ICU's are the epicenter of the phenomenon



The Prophecy that went awry!

"On the whole, the position of antimicrobial agents in microbial therapy is highly satisfactory. The majority of bacterial infections can be cured simply, effectively and cheaply. The mortality and morbidity from bacterial diseases has fallen so low that they are no longer among the important unsolved problems of medicine..."



Jawetz E. Annu Rev Microbiol 1956; 10

- Resistance (often multiple) is an increasing threat to successful therapy of both hospital infections, aquaculture and veterinary sector

- Spreading & newly emerging patterns of resistance makes an ideal antibiotic a distant dream

Cause for emerging infections

- Change in human demographics and behavior
- Economic development and change in land use
- Increased transboundary movement of humans and animals
- Microbial adaptation and change
- Breakdown of public health measures and biosecurity in aquaculture and veterinary sector

All animals are equal but some are more equal than others

George Orwell

Difficult to treat super bugs!

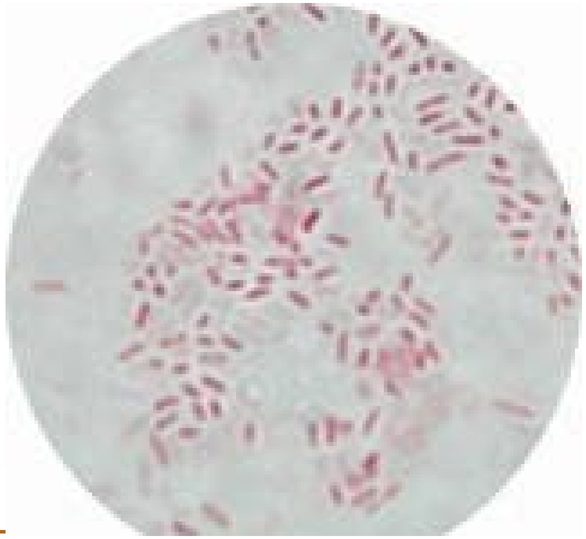
- Methicillin resistant *Staphylococcus aureus*
- Vancomycin resistant enterococci or staphylococci
- Extended spectrum beta lactamase producing gram negative bacilli
- Multidrug resistant *Pseudomonas or Acinetobacter*
- Pan resistant gram negative bacilli (***our worst nightmare***)

The plague....

Gram Negative Pathogens

Antibiotics with gram negative coverage

- ß lactams – Cephalosporins, Ampicillin, Penicillins
- Aminoglycosides
- Flouroquinolones
- Carbapenems
- Trimethoprim sulphamethoxazole
- Tetracyclines
- Macrolides
- Chloramphenicol
- Nalidixic acid

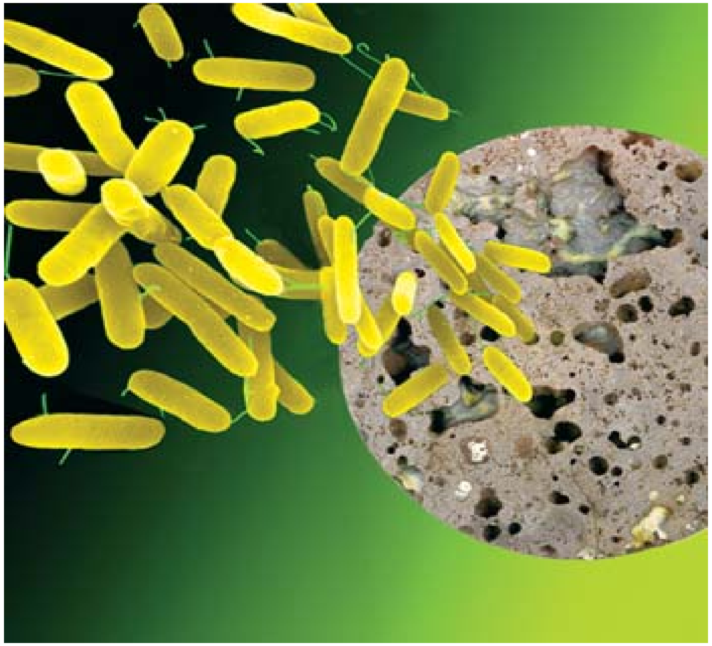


Unintended Consequences of Antibiotic Therapy

- 'Collateral damage' is a term used to refer to ecological adverse effects of antibiotic therapy; namely, the selection of drug-resistant organisms and the unwanted development of colonization or infection with multidrug-resistant organisms

Paterson DL. *Clin Infect Dis* 2004;38(Suppl 4):S341-S345

ESBL producing organisms



- **Most common**
  E.coli & Klebsiella
- **Others**
  Proteus, Enterobacter, Citrobacter,Providencia, Morganella, Shigella, Serratia ,Pseudomonas

Pseudomonas

- **Are intrinsically resistant to NS penicillins, 1^{st} and 2^{nd} GC & Cotrimoxazole**

- **Susceptible to aminoglycosides, 3^{rd} and 4^{th} GC, FQ, Aztreonam and ticarcillin/piperacillin**

- **Cefotaxime and Ceftriaxone are not the ideal 3GC**

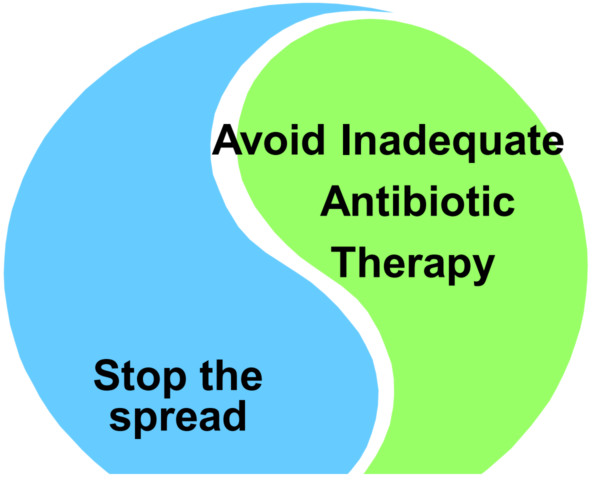
- **Multidrug resistance can emerge during course of treatment**


HAVE WE REACHED
THE END OF ROAD?

“Know thy enemy and know thyself: In a hundred battles you will never be in peril”

Sun Tzu from *“The art of war”*

Key factors in control…….



Combinations that do not go together….

Antibiotics	Organism
Amino glycosides	*Streptococcus*
TMP/SMX	*Klebsiella*
Beta lactams	MRSA
Cephalosporin	*Enterococcus*
1^{st} generation Cephalosporin	*Salmonella*
Cefotaxime	*Pseudomonas*
Cephalosporin	*ESBL producing K.pneumo/E.coli*
Meropenem	*S. maltophilia*
Ertapenem	*Psudomonas aeruginosa*

Government of India

NATIONAL POLICY FOR CONTAINMENT OF ANTIMICROBIAL RESISTANCE

INDIA

2011

Directorate General of Health Services
Ministry of Health & Family Welfare
Nirman Bhawan, New Delhi

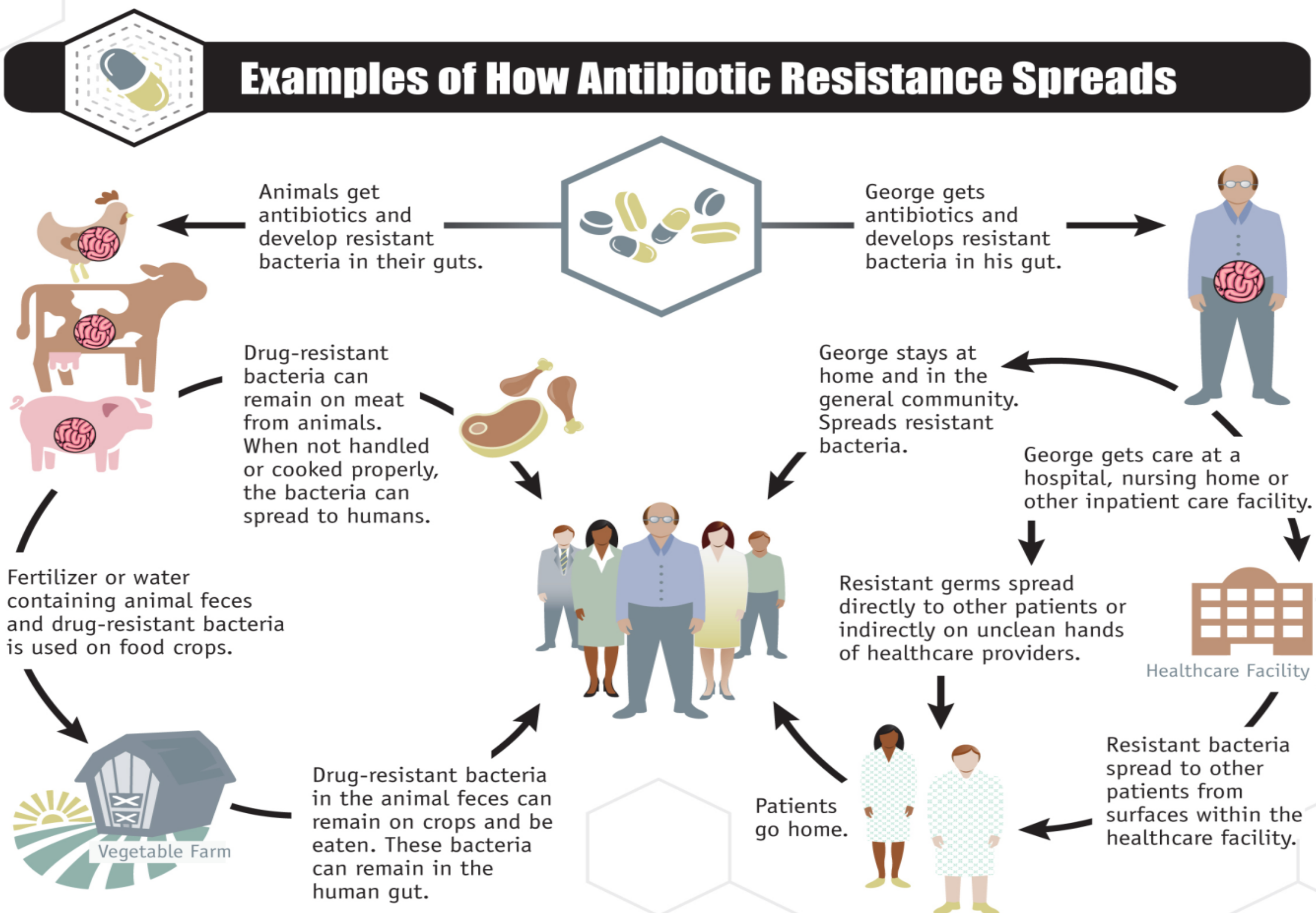
- Monitor antimicrobial resistance
- Regulations for use
- National surveillance system for antibiotic resistance,
- Monitoring prescriptions by audits
- Monitoring use of antibiotics

BAD BUGS, NO DRUGS

As Antibiotic Discovery Stagnates ...
A Public Health Crisis Brews

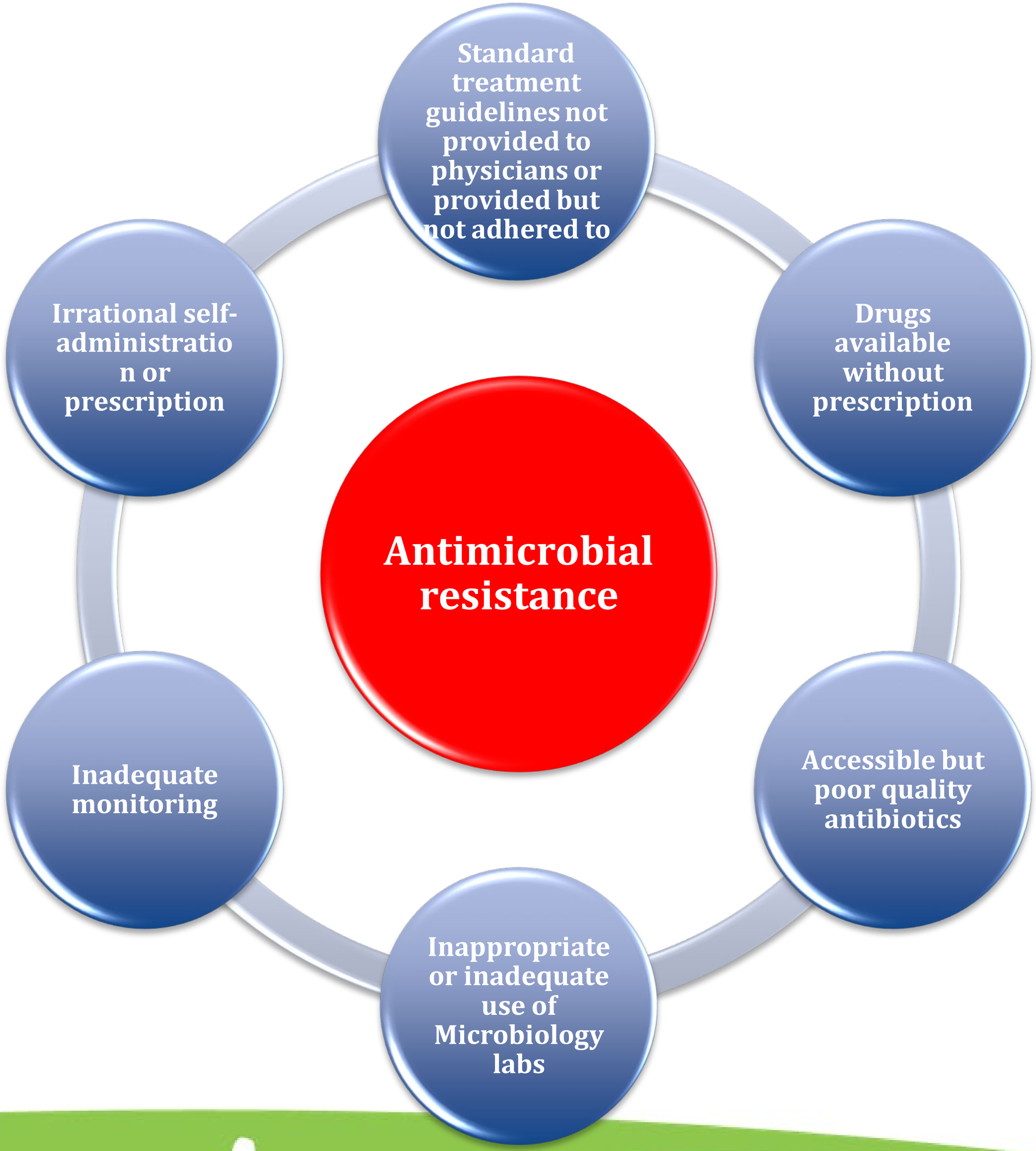
IDSA

Image courtesy of CDC / Melissa Brower
Centers for Disease Control and Prevention Public Health Image Librar
http://phil.cdc.gov/phil/home.asp



Simply using antibiotics creates resistance. These drugs should only be used to treat infections.

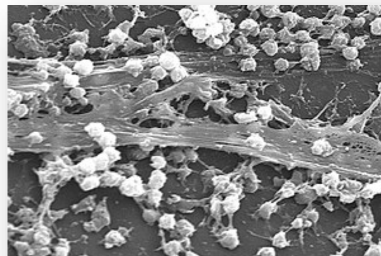
Resistance is accelerated through inappropriate use of antimicrobials



INSIDE HOSPITALS, THEY CAN BE LURKING….

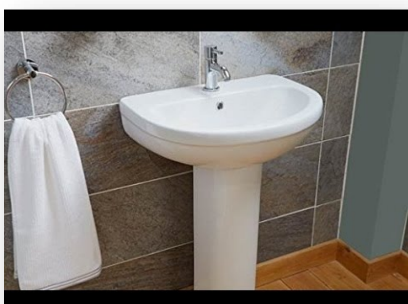
Colonized patients

Hospital Linen



Biofilms

Keyboards



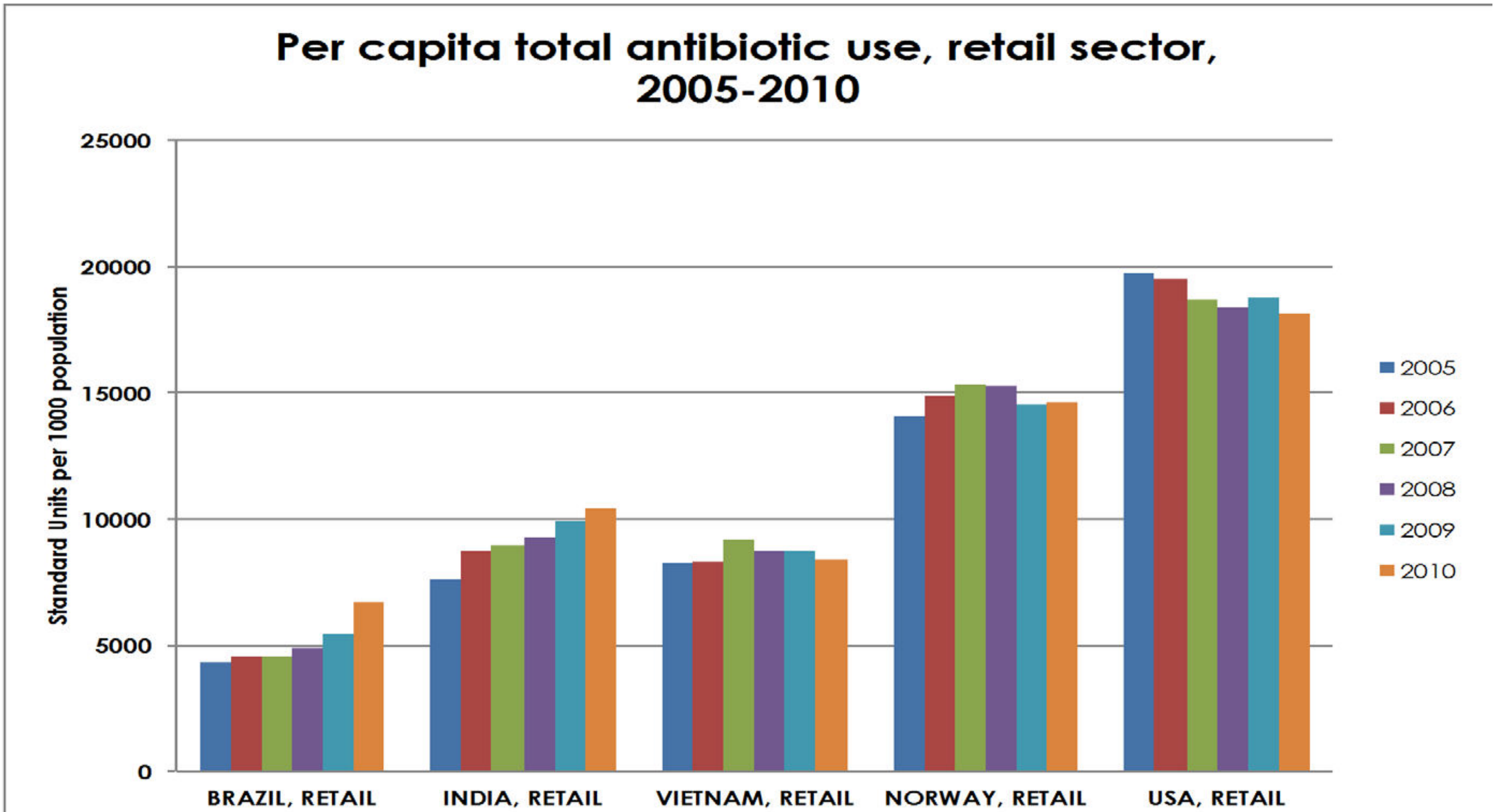
Handwash Basins

Toilet Rims

Endoscopes

Exner et al. GMS Hyg Infect Control. 2017; 12: Doc05.

Antibiotic consumption is increasing in developing countries...



ANTIBIOTIC RESISTANCE WHAT YOU CAN DO

HANDLE ANTIBIOTICS WITH CARE

Antibiotic resistance happens when bacteria change and become resistant to the antibiotics used to treat the infections they cause.

1. Only use antibiotics when **prescribed** by a certified health professional
2. Always take the **full prescription**, even if you feel better
3. **Never use left over** antibiotics
4. **Never share** antibiotics with others
5. **Prevent infections** by regularly washing your hands, avoiding contact with sick people and keeping your vaccinations up to date

www.who.int/drugresistance

#AntibioticResistance

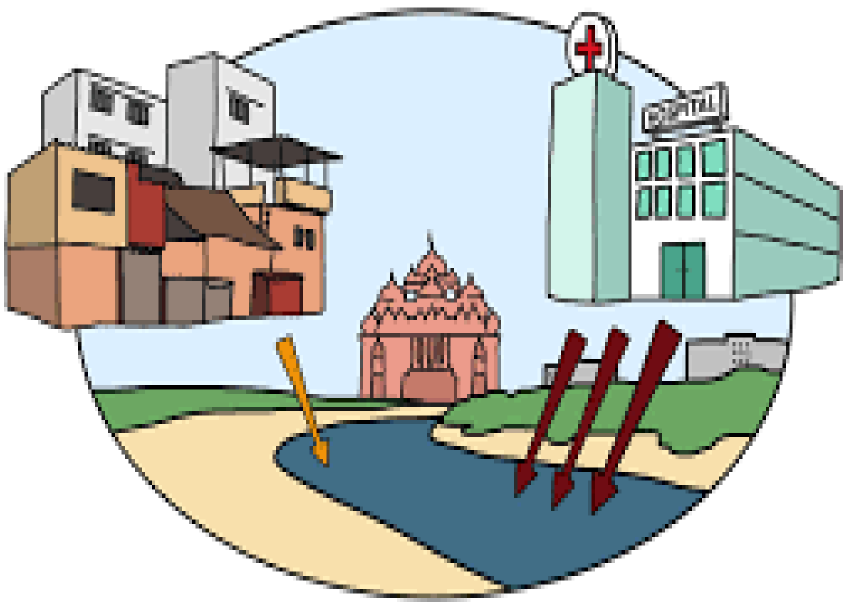
World Health Organization

Preventive strategies

- Curtail production, prescription and consumption of antibiotics both in human & veterinary medicine
- Education of the general population, of healthcare personnel, veterinarians and pharmacists about means of prevention and proper Rx of infections
- Offering access to clean, affordable water and sanitation to all people
- Promoting vaccination, and by introducing animal breeding and food-production processes which render the use of antibiotics unnecessary

THANK YOU

ANTIBIOTICS
USE-RESPONSIBLY



Hospital wastes seed carbapenem-resistance pathogens to Indian urban water systems


Thank you