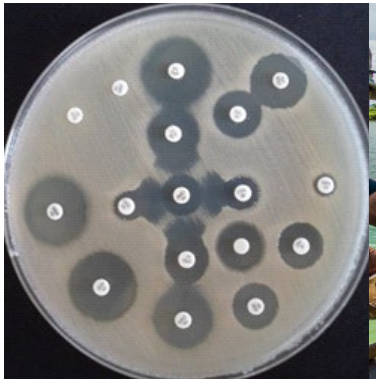
Organización Mundial de Sanidad Animal
Fundada como OIE

Vigilancia de la Resistencia Antimicrobiana: Bases y Herramientas Microbiológicas y Genómicas

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Universidade de São Paulo, Brasil

ICB USP

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Tópicos

- Conceptos en RAM y producción.
- Bases microbiológicas/genéticas de la RAM.
- Antibióticos en acuicultura.
- Principales mecanismos de RAM.
- Bases genéticas de la RAM en acuicultura.
- RAM y Salud Única
- Conclusiones.

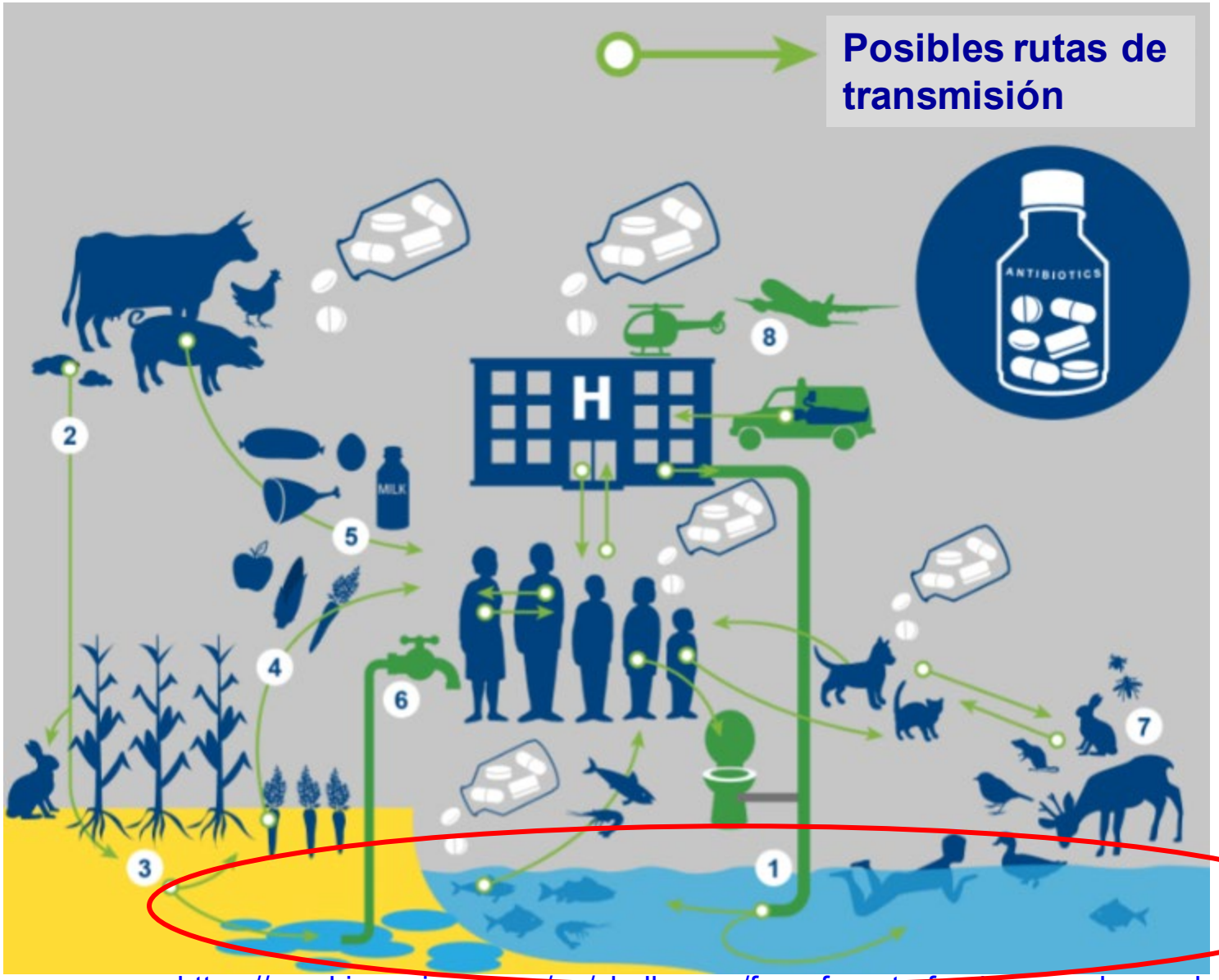
Conceptos en RAM y producción

- ✓ La microbiota es esencial para los seres vivos y ecosistemas.
- ✓ Esta microbiota es especifica para cada especie animal.
- ✓ ATMs seleccionan y reducen la diversidad de la microbiota.
- ✓ La disminución de la microbiota favorece infecciones.
- ✓ El uso de ATM favorece la emergencia/transferencia horizontal de la RAM.

Conceptos en RAM y producción

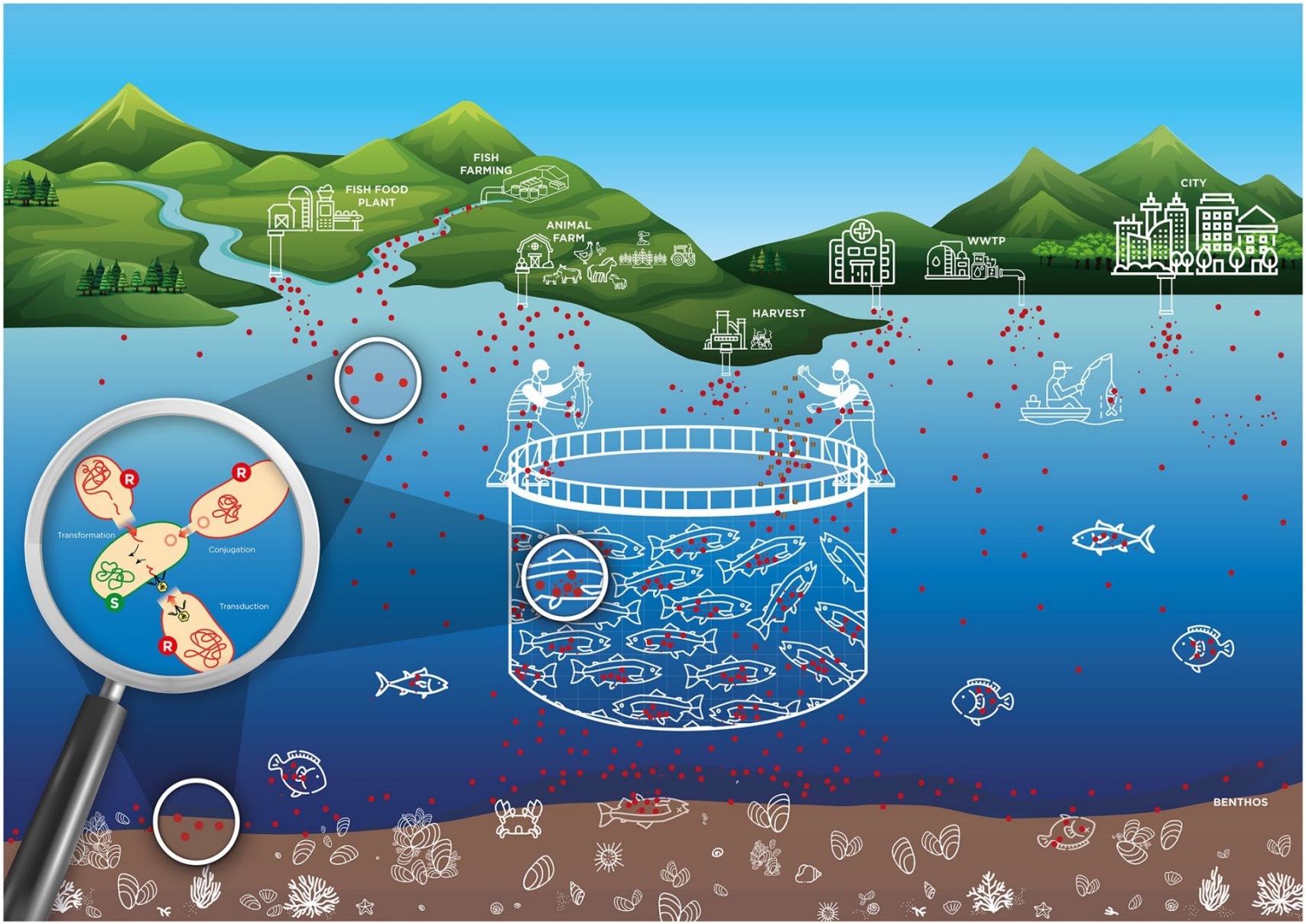
- ✓ ATM en producción generan residuos.
- ✓ Alimentos derivados pueden contener residuos y/o bactérias resistentes.
- ✓ Bacterias en alimentos pueden transmitir AMR para patogenos o comensales humanos.
- ✓ Residuos son descartados para el ambiente, o reutilizados (abono orgánico).
- ✓ Ambientes acuáticos son *hotspots* para transferencia de genes RAM.

Dissemination of AMR



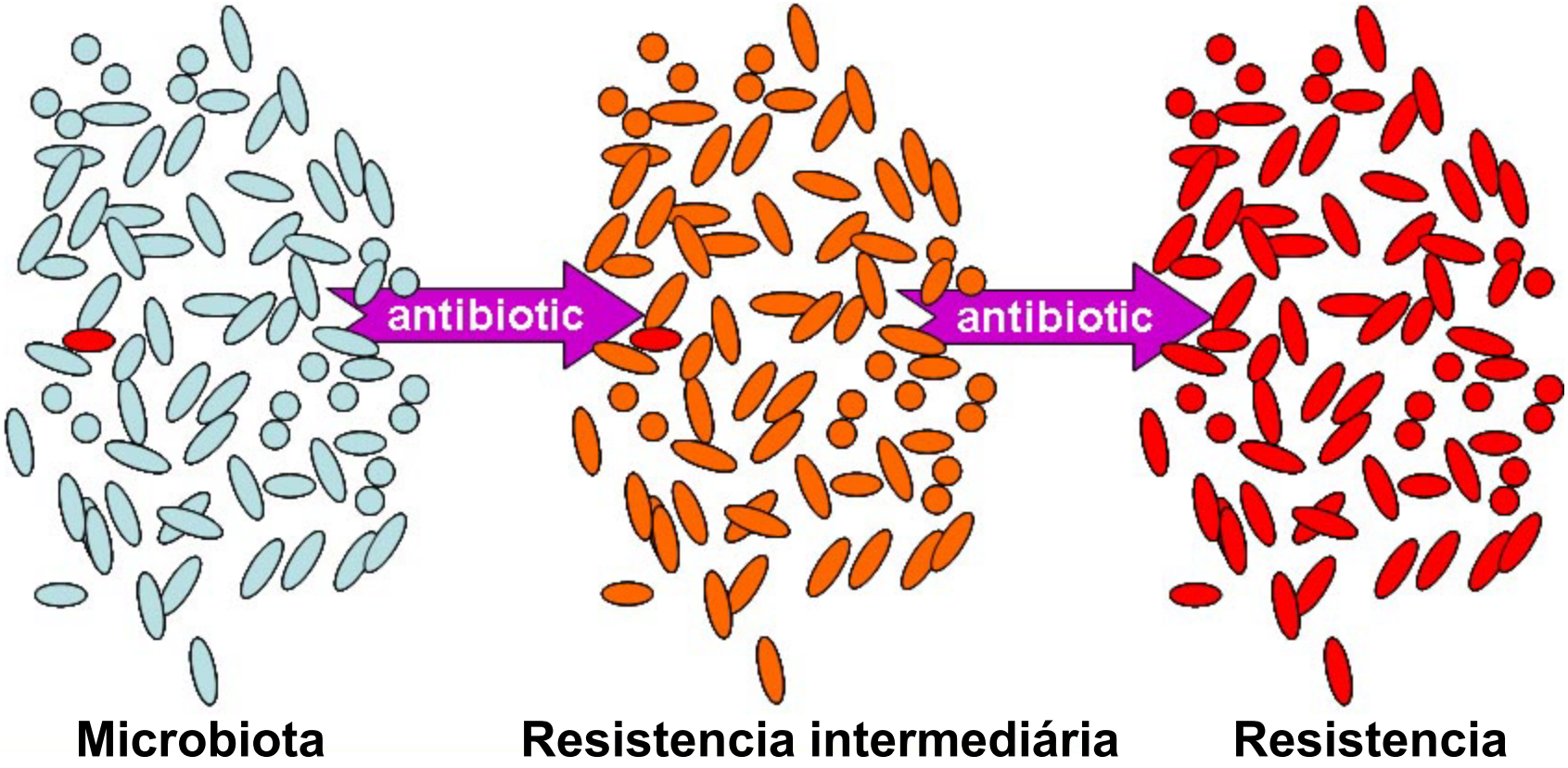
https://amr.biomerieux.com/en/challenges/from-farm-to-food-to-people-one-health/

Origen de la RAM en ambientes acuáticos

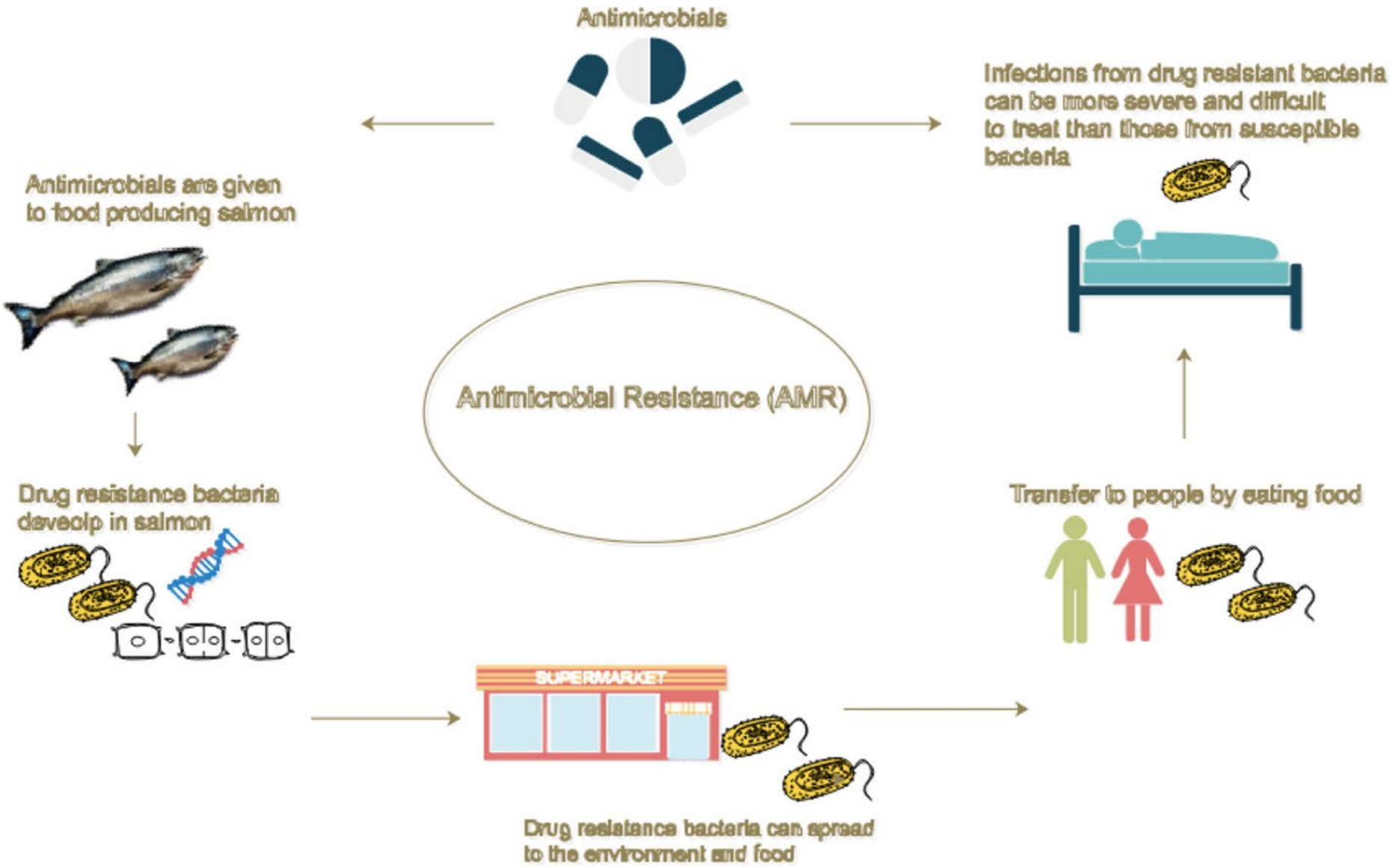


Rev Aquac. 2023, 15: 89-111, 2023

RAM y presión selectiva

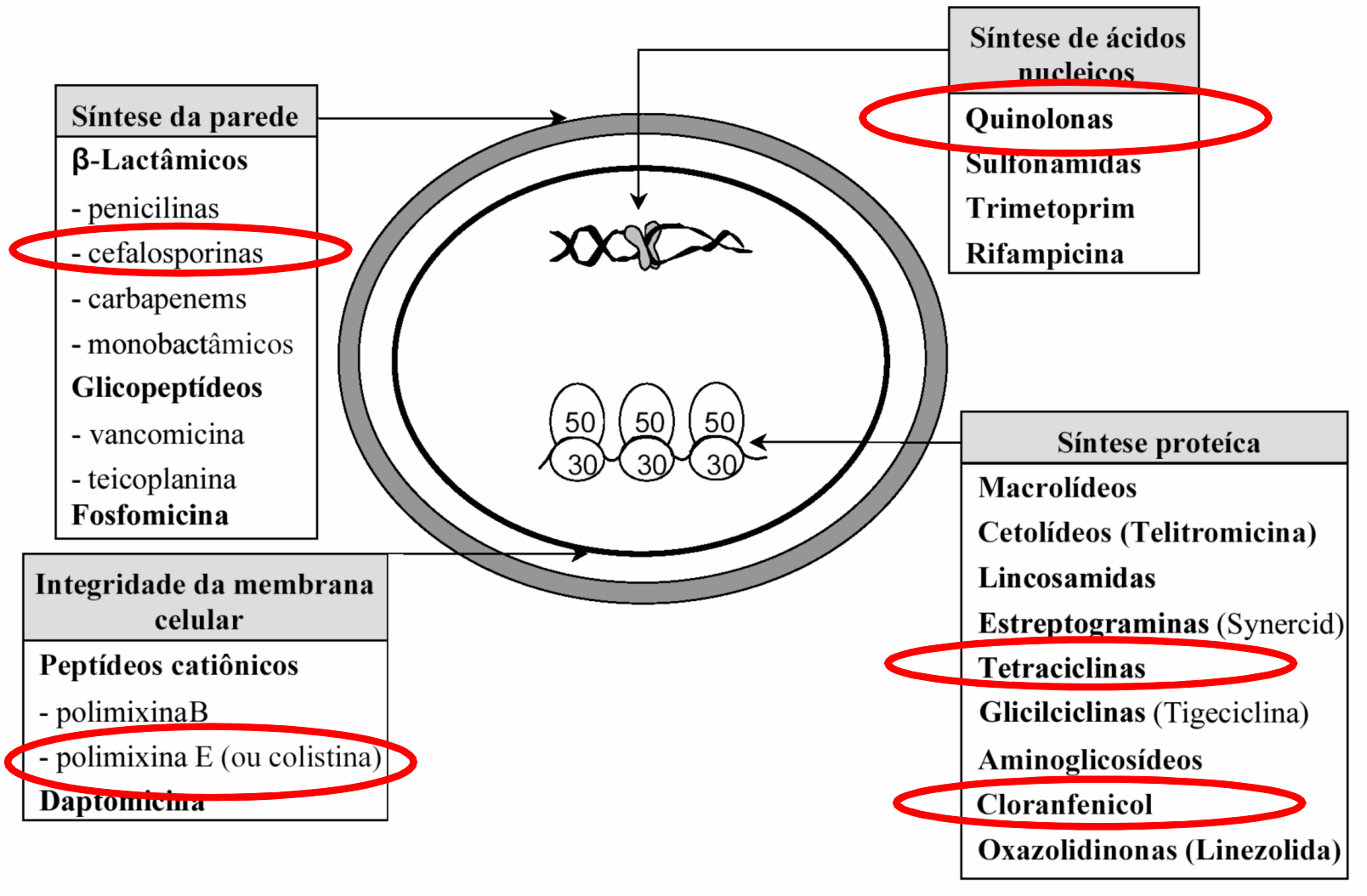


Importancia de la RAM en acuicultura

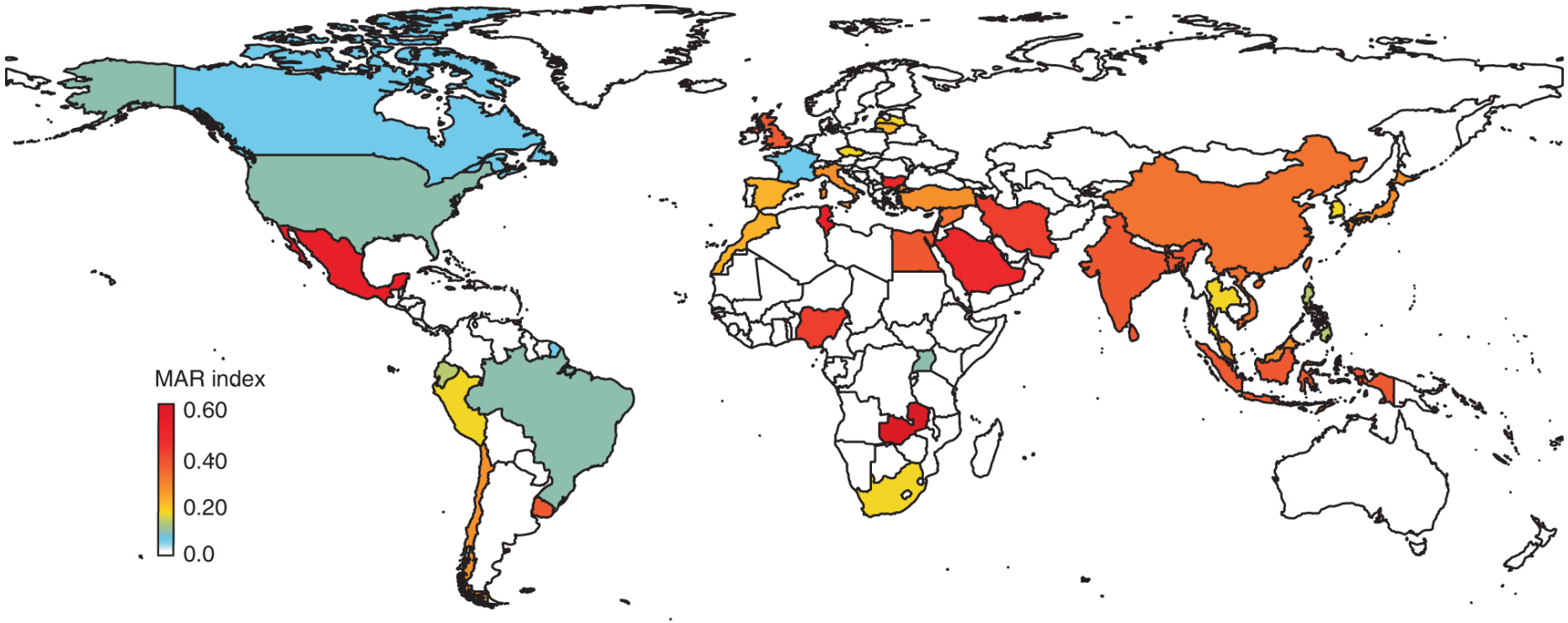


One Health . 2021 Jan 24;12:100219.

Antibacterianos en animales de producción

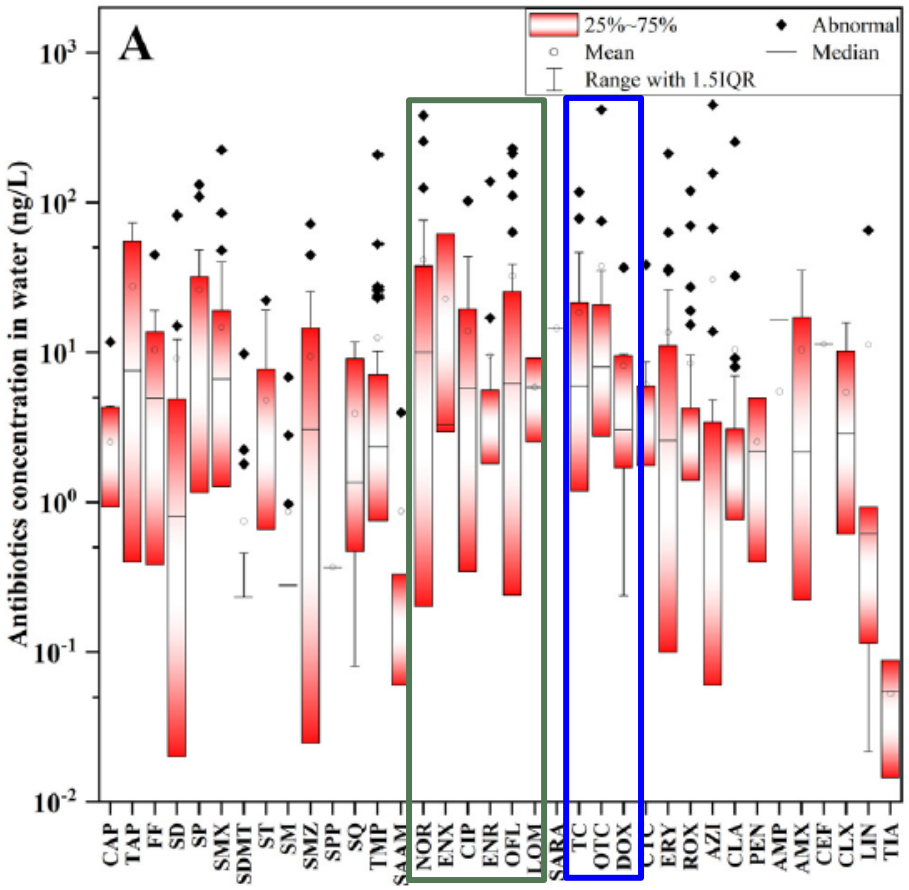


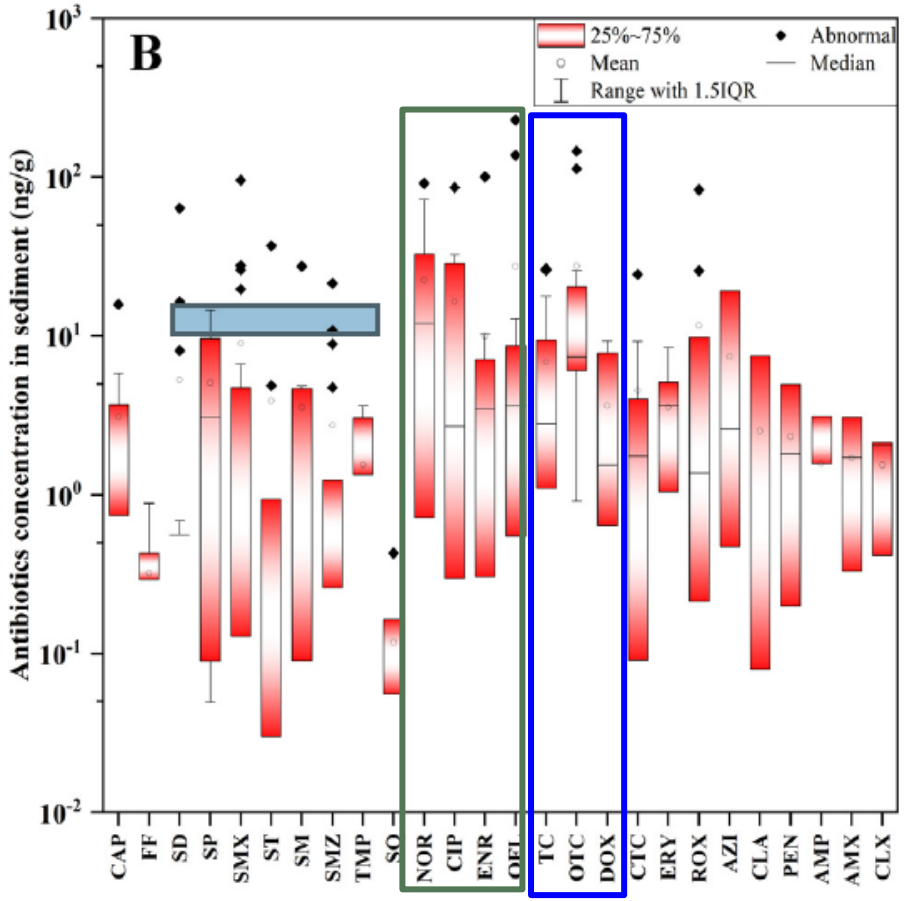
Índice RAM Global en acuicultura



Nat Commun. 2020 Apr 20;11(1):1870.

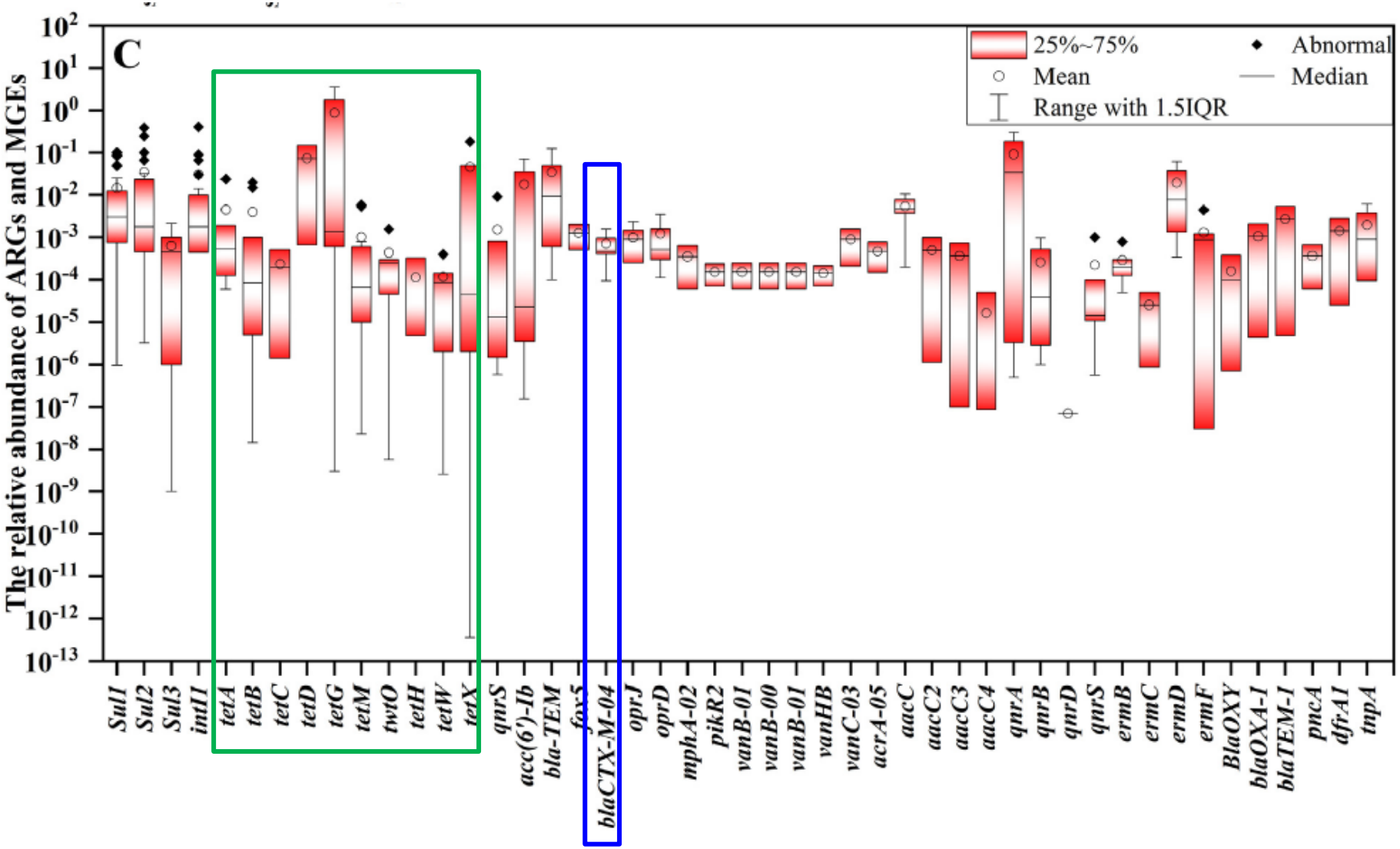
Concetración de ATB en ambiente estuarino/costero





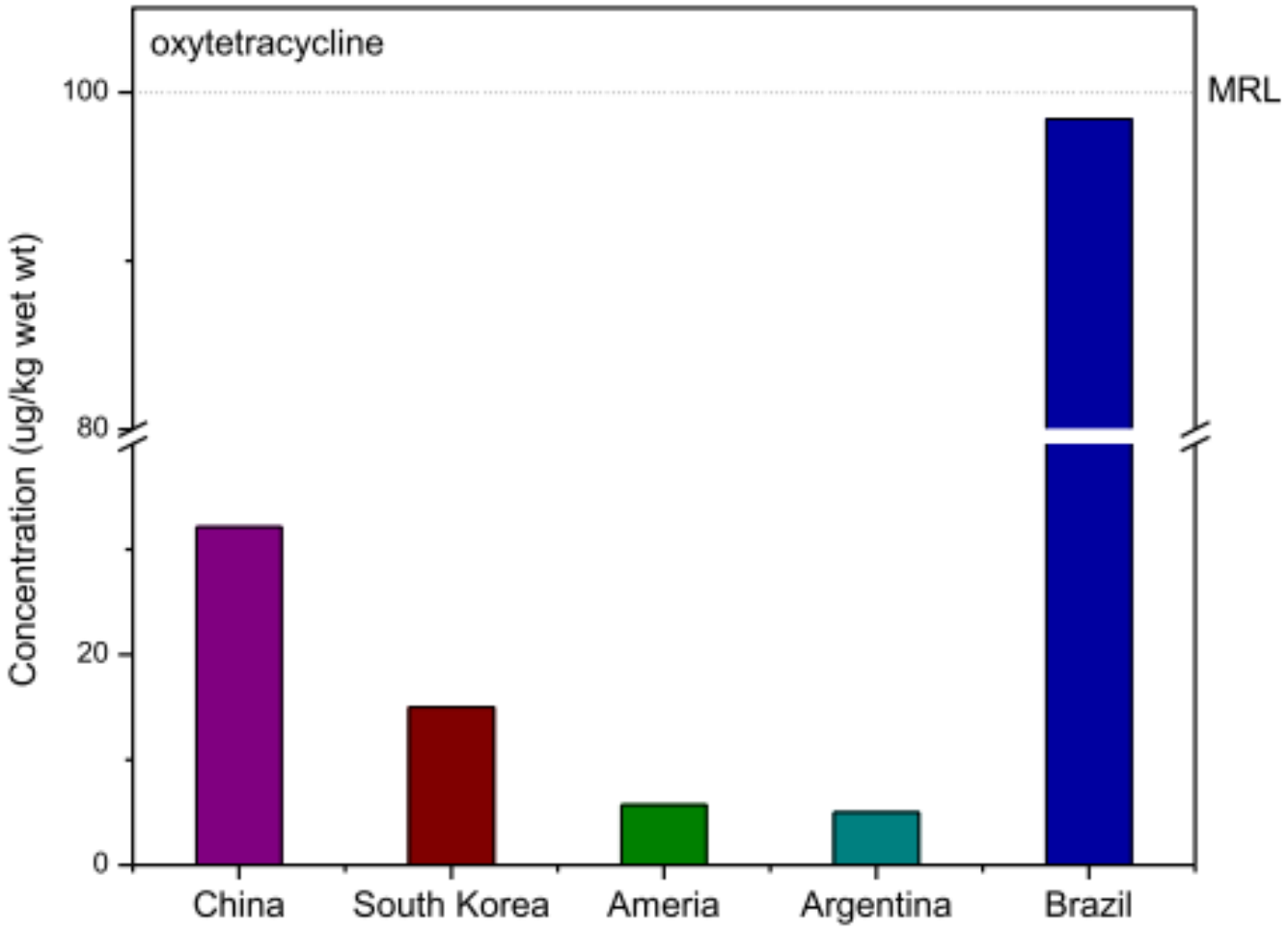
Sci Total Environ. 2021 Jul 10;777:146009

Genes de resistencia en ambiente estuarino/costero



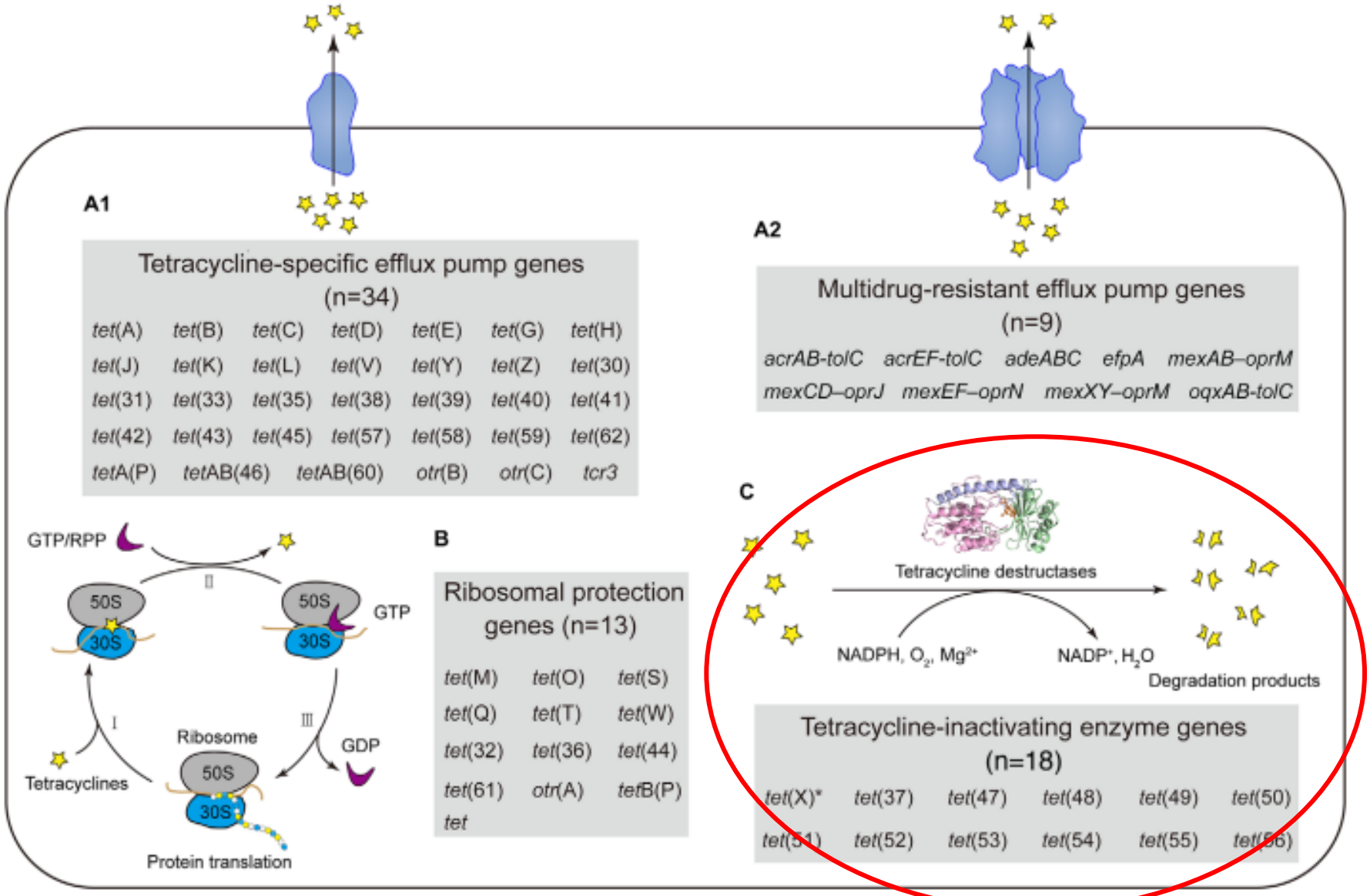
Sci Total Environ. 2021 Jul 10;777:146009

Oxitetraciclina en productos de acuicultura



J Agric Food Chem 2020 Oct 28;68(43):11908-11919.

Resistência a las tetraciclinas



Bioessays. 2020 Aug;42(8):e2000014.

antibiotics

MDPI

Article

Genetic Characterization of the Tetracycline-Resistance Gene *tet*(X) Carried by Two *Epilithonimonas* Strains Isolated from Farmed Diseased Rainbow Trout, *Oncorhynchus mykiss* in Chile

Christopher Concha [1], Claudio D. Miranda [1,2,*], Javier Santander [3] and Marilyn C. Roberts [4]

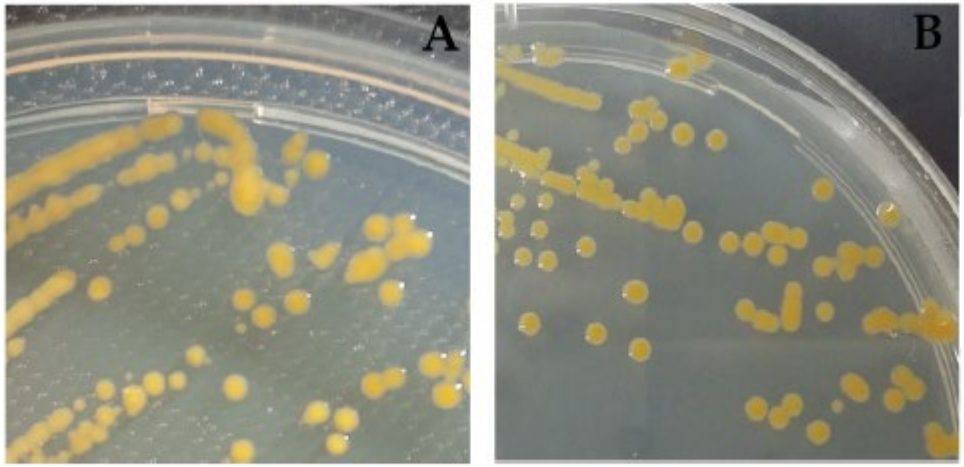
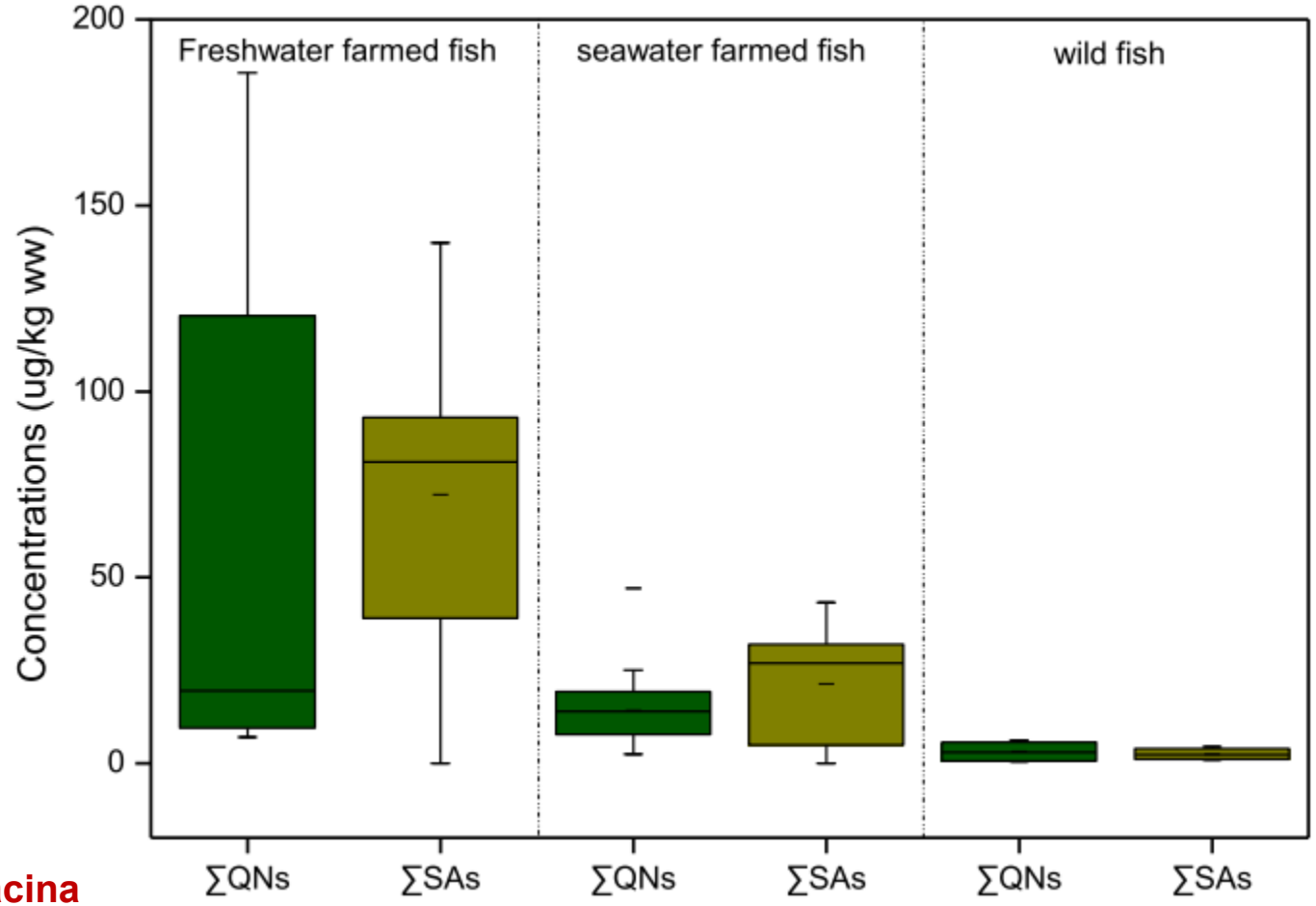


Figure 1. Colony morphotypes of the *Epilithonimonas* strains recovered from diseased rainbow trout from Chilean farms grown on TYES agar: (**A**) FP105; (**B**) FP211-J200.

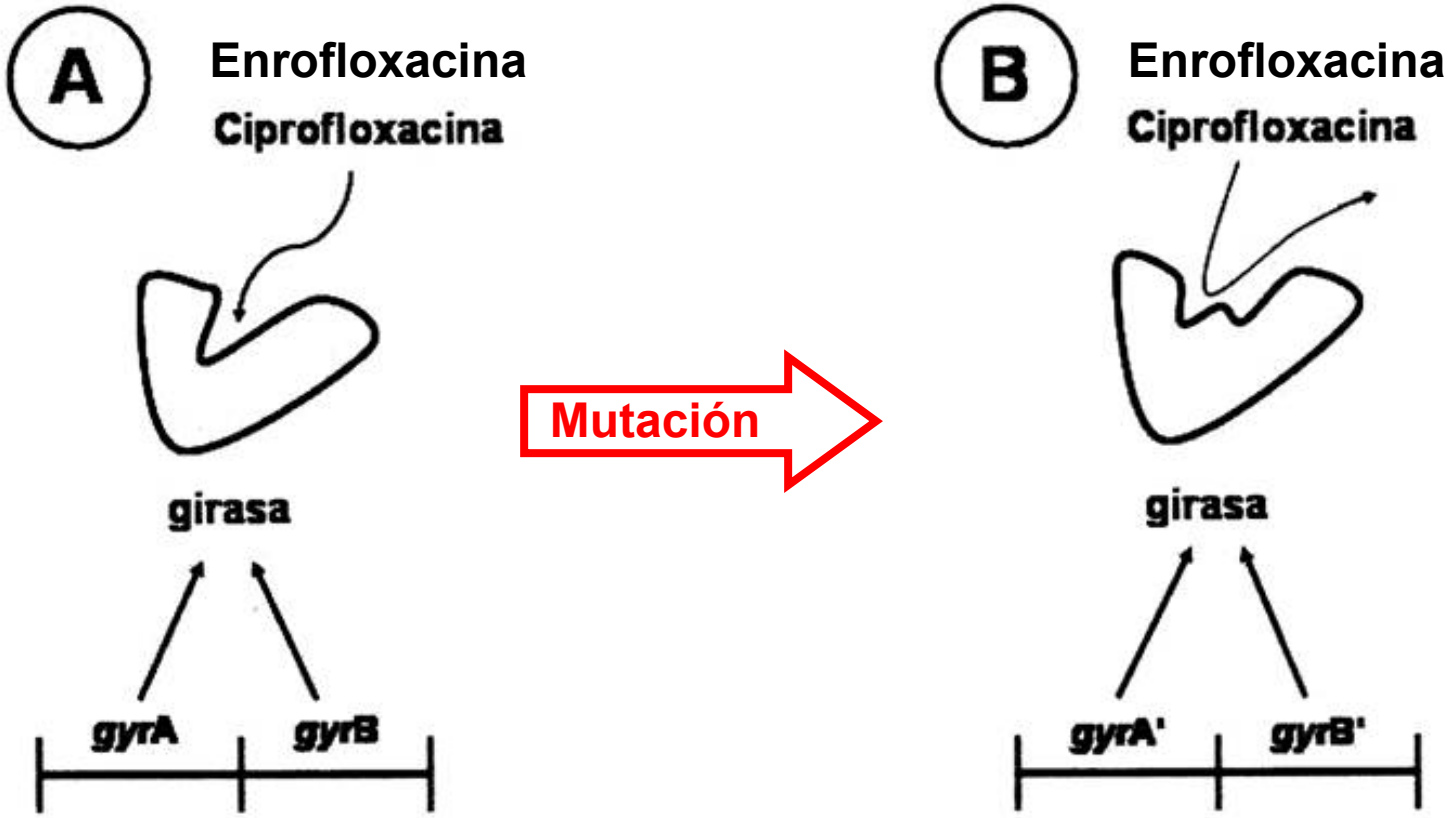
Residuos de fluoroquinolonas y sulfas en pescados



Enrofloxacina
Norfloxacina
Ciprofloxacina

J Agric Food Chem 2020 Oct 28;68(43):11908-11919.

Resistencia a las fluoroquinolonas

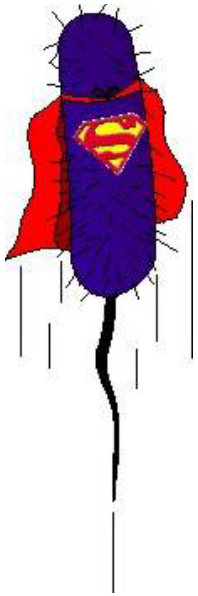


Bactéria Suscetível

Bactéria Resistente

Nature Rev Microbiol 2015, 13:42–51.

Patógenos de prioridad crítica



World Health Organization

Priority 1: CRITICAL

- *Acinetobacter baumannii*, carbapenem-resistant
- *Pseudomonas aeruginosa*, carbapenem-resistant
- *Enterobacteriaceae*, carbapenem-resistant, ESBL-producing

Priority 2: HIGH

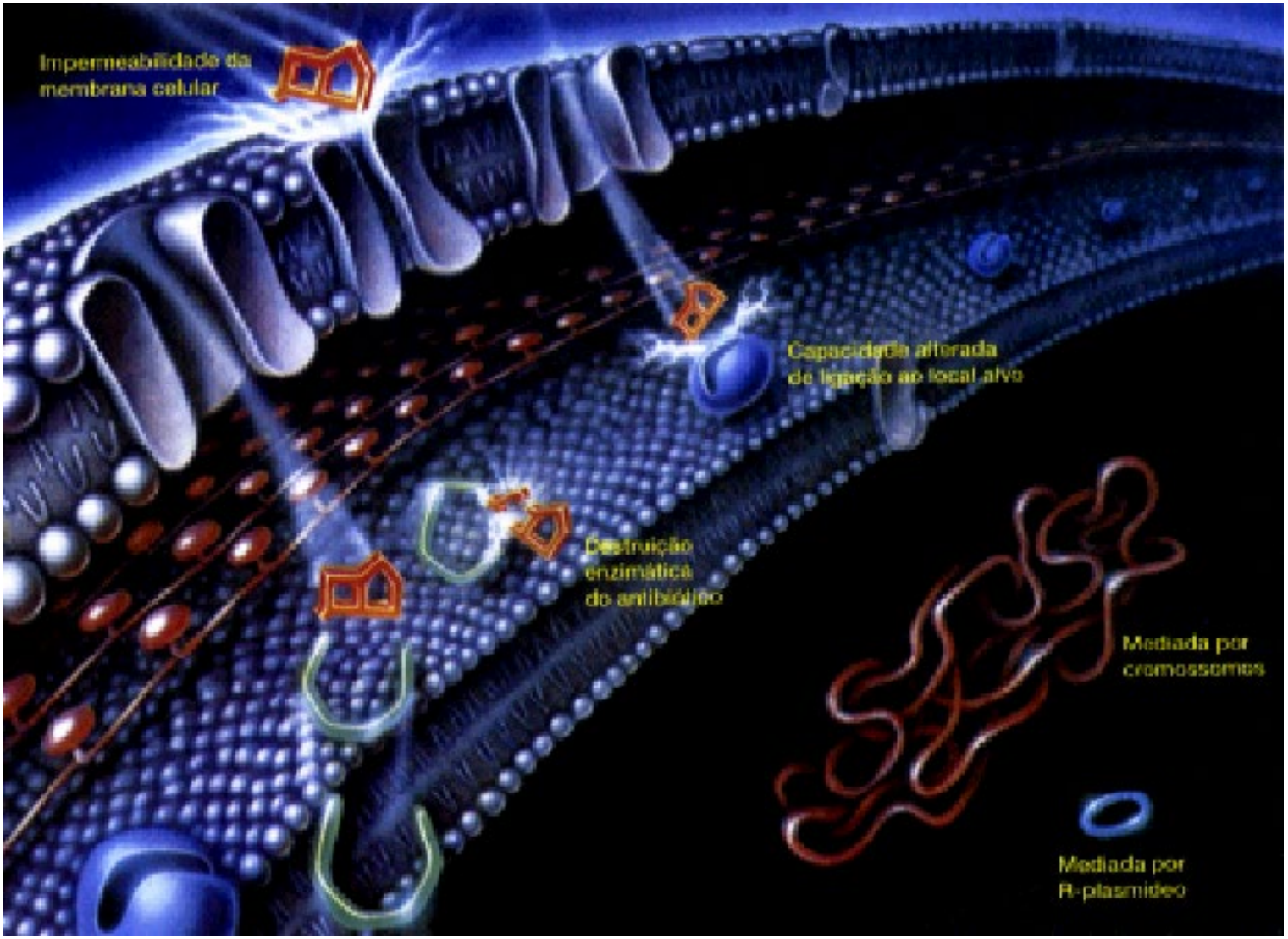
- *Enterococcus faecium*, vancomycin-resistant
- *Staphylococcus aureus*, methicillin-resistant, vancomycin-intermediate and resistant
- *Helicobacter pylori*, clarithromycin-resistant
- *Campylobacter* spp., fluoroquinolone-resistant
- *Salmonellae*, fluoroquinolone-resistant
- *Neisseria gonorrhoeae*, cephalosporin-resistant, fluoroquinolone-resistant

Priority 3: MEDIUM

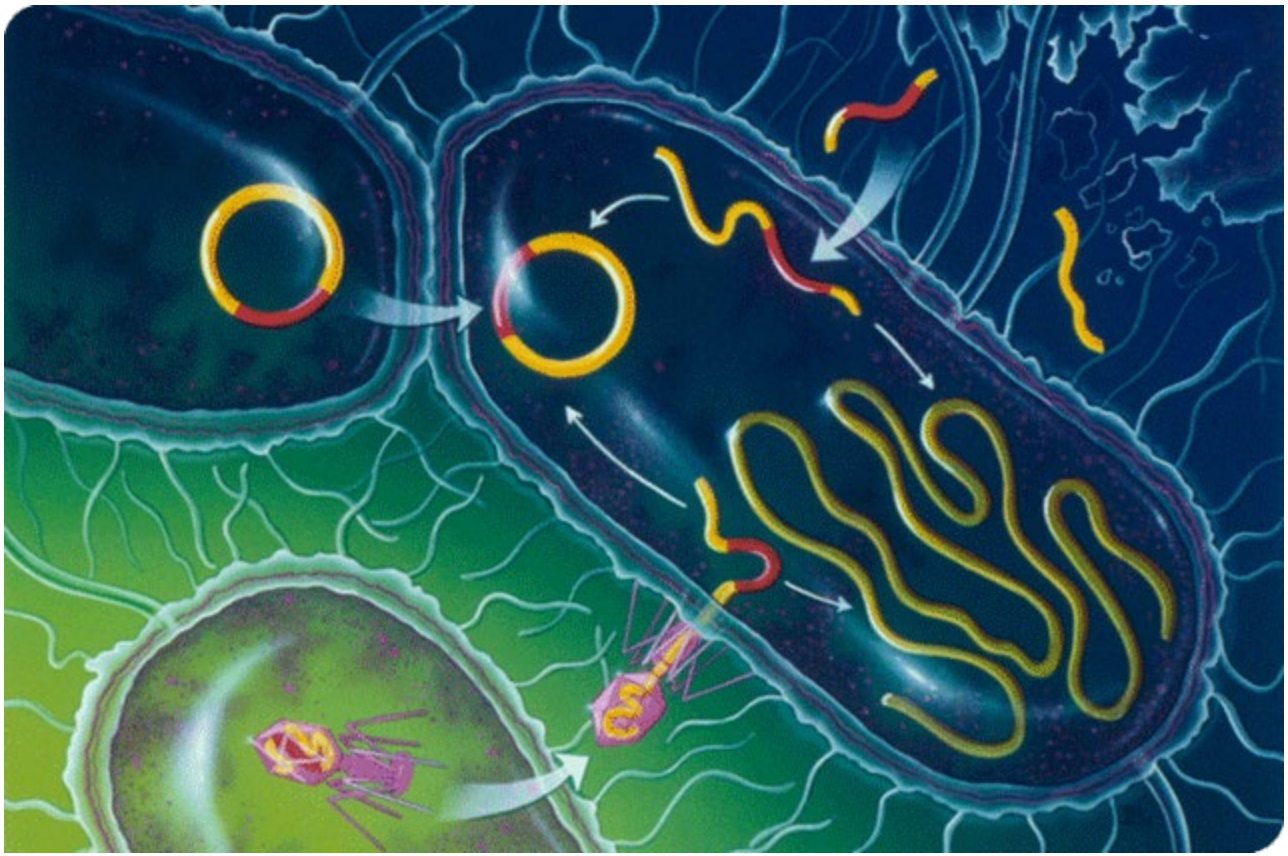
- *Streptococcus pneumoniae*, penicillin-non-susceptible
- *Haemophilus influenzae*, ampicillin-resistant
- *Shigella* spp., fluoroquinolone-resistant

https://www.who.int/medicines/publications/WHO-PPL-Short_Summary_25Feb-ET_NM_WHO.pdf

Resistencia a los beta-lactámicos (BLEE/Carba)



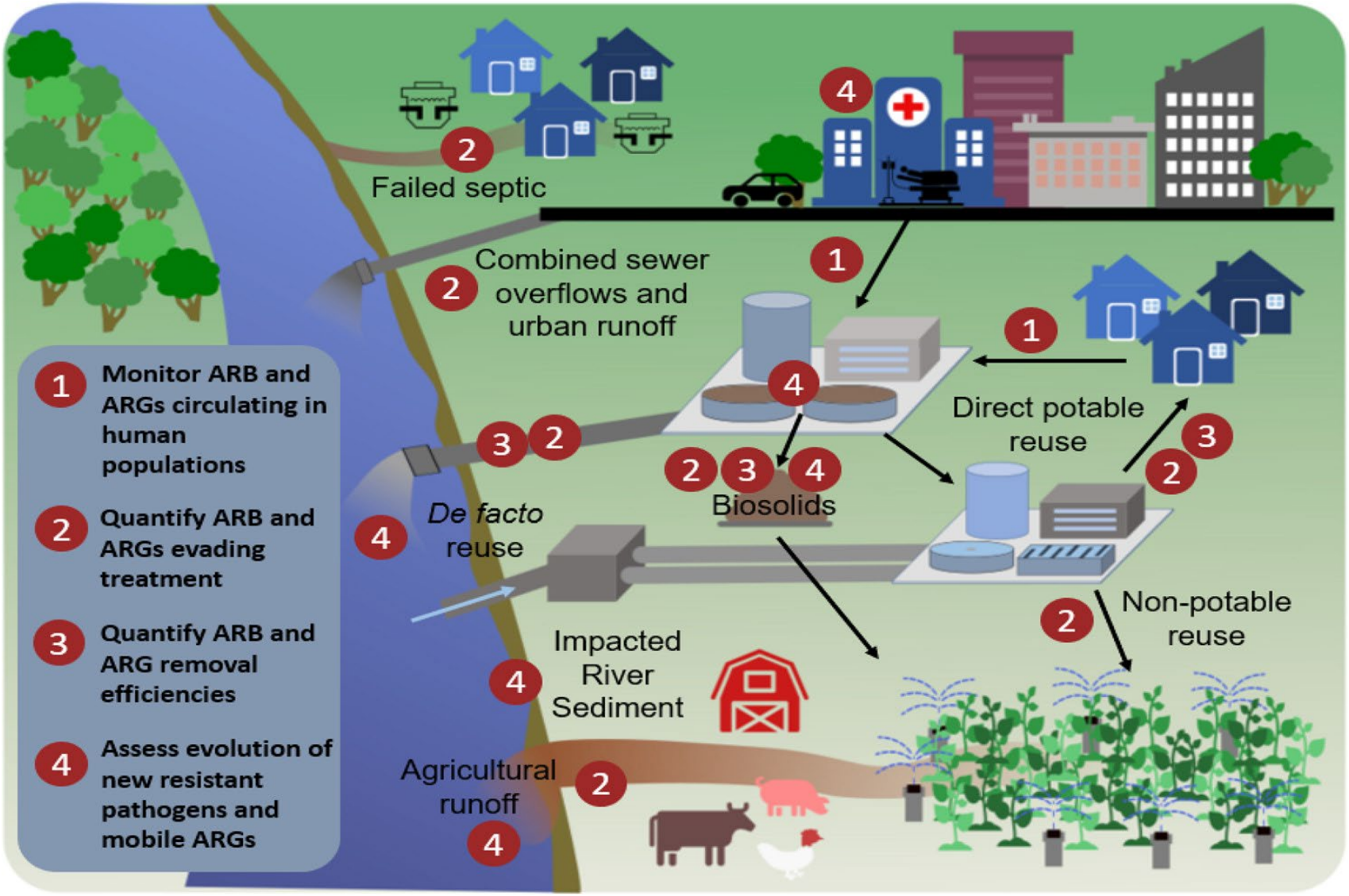
Mobilización genética



1. **Conjugación**
2. **Transformación**
3. **Transducción**

Nature Rev Microbiol.13:42–51. 2015.

Vigilancia de la RAM



Environ. Sci. Technol. 2022, 56, 13, 9149-9160

1. Vigilancia: bacterias bioindicadoras

Available at www.veterinaryworld.org/Vol.15/April-2022/33.pdf

Table-1: Bacterial species for inclusion in AMR surveillance programs in animals.

Bacterial Species	Category	Associated Animal Species	Reference
Methicillin-resistant *Staphylococcus pseudintermedius*	Animal-only pathogens	Companion animals	[25]
Mannheimia haemolytica, *Pasteurella multocida*, and *Histophilus somni*	Animal-only pathogens	Cattle	[24]
Actinobacillus pleuropneumoniae, *Haemophilus parasuis*	Animal-only pathogens	Pig	[26]
Pasteurella multocida	Animal-only pathogens	Cattle, pig	[21]
Enterotoxigenic *E. coli*	Animal-only pathogens	Pig, calves	[21]
Salmonella spp.	Animal-only pathogens	Slaughtered food animals	[21]
Methicillin-resistant *Staphylococcus aureus* and extraintestinal pathogenic *E. coli*	Zooanthroponotic pathogens	Dog, cat, horse	[21]
Salmonella spp. and *Campylobacter* spp.	Zoonotic foodborne pathogens	Cattle, pig and poultry	[21]
Enterococcus spp. and *E. coli*	Indicator bacteria	Healthy livestock and poultry	[27]

¿Acuicultura?

Renibacterium salmoninarum
Streptococcus iniae
Flavobacterium psychrophilum
Aeromonas spp.
Vibrio spp.
Edwarsiella
Flavobacterium spp.
Piscirickettsia salmonis

Vet World. 2022 Apr;15(4):1066-1079.

2. Vigilancia: cultivo de bacterias

Available at www.veterinaryworld.org/Vol.15/April-2022/33.pdf

Table-2: Media used for culture of bacteria recommended for AMR surveillance programs in animals.

Bacterial Species	Pre-enrichment		Selective enrichment		Isolation		Reference
	Media	Incubation	Media	Incubation	Media	Incubation	
Staphylococcus spp.	-	-	-	-	Baird-Parker agar	35-37°C (45-48 h)	[38]
Mannheimia haemolytica	-	-	-	-	Blood agar	37°C (24 h)	[29]
Pasteurella multocida	-	-	-	-	Blood agar	37°C (24 h)	[29]
Escherichia coli	Lactose broth	35±2°C (24 h)	EC broth	44.5°C (24 h)	L-EMB, EMB agar	35±2°C (24 h)	[39]
Salmonella spp.	Lactose broth	35°C (24 h)	TT broth	35±2.0°C (24 h)	XLD agar	35°C (24 h)	[40]
	BPW	35±2°C (24 h)	RV broth	42°C (24 h)	BS agar HE agar	35°C (24 h) 35°C (24 h)	
Campylobacter spp.	Bolton broth	37°C (4 h)	Bolton broth	42°C (48 h)	mCCDA AHB agar	37-42°C (24-48 h) 37-42°C (24-48 h)	[41]

BPW=Buffered peptone water, TT=Tetrathionate, RV=Rappaport-Vassiliadis, L-EMB=Levine's eosin-methylene blue, EMB=Eosin-methylene blue, XLD=Xylose lysine desoxycholate, BS=Bismuth sulfite, HE=Hektoen enteric, mCCDA=Modified campy blood-free agar, AHB=Abeyta-Hunt-Bark

Vet World. 2022 Apr;15(4):1066-1079.

3. Vigilancia: antibiótico (biomarcador)

Table-3: Suggested antimicrobials for inclusion in AMR surveillance programs in animals.

Antibiotic class	Antibiotic	Target bacterial species	Reference
Aminoglycosides	Gentamicin	*Salmonella*, *E. coli*, *Campylobacter*, *Enterococcus*, *Staphylococcus*	[11,21,28,29]
	Streptomycin	*Campylobacter*, *Enterococcus*	
Amphenicols	Chloramphenicol	*Salmonella*, *E. coli*, *Enterococcus*, *Staphylococcus*	
Second generation cephalosporins	Cefoxitin	*Salmonella*, *E. coli*, *Staphylococcus*	
Third generation cephalosporins	Cefatoxime	*Salmonella*, *E. coli*	
	Ceftriaxone	*Salmonella*, *E. coli*	
	Ceftazidime	*Salmonella*, *E. coli*	
Quinolones	Ciprofloxacin	*Salmonella*, *E. coli*, *Campylobacter*, *Enterococcus*, *Staphylococcus*	
	Nalidixic acid	*Salmonella*, *E. coli*, *Campylobacter*	
	Pefloxacin	*Salmonella*, *E. coli*	
Rifamycins	Rifampicin	*Staphylococcus*	
Sulfonamides	Sulfisoxazole	*Salmonella*, *E. coli*, *Staphylococcus*	
	Trimethoprim-sulfamethoxazole	*Salmonella*, *E. coli*, *Staphylococcus*	
Trimethoprim	Trimethoprim	*Salmonella*, *E. coli*, *Staphylococcus*	
Tetracyclines	Tetracycline	*Salmonella*, *E. coli*, *Campylobacter*, *Enterococcus*, *Staphylococcus*	
	Doxycycline	*Campylobacter*	
Carbapenems	Imipenem	*Salmonella*, *E. coli*	
	Meropenem	*Salmonella*, *E. coli*	
Polymyxins	Colistin	*Salmonella*, *E. coli*	

Vet World. 2022 Apr;15(4):1066-1079.

4. Vigilancia: método fenotípico

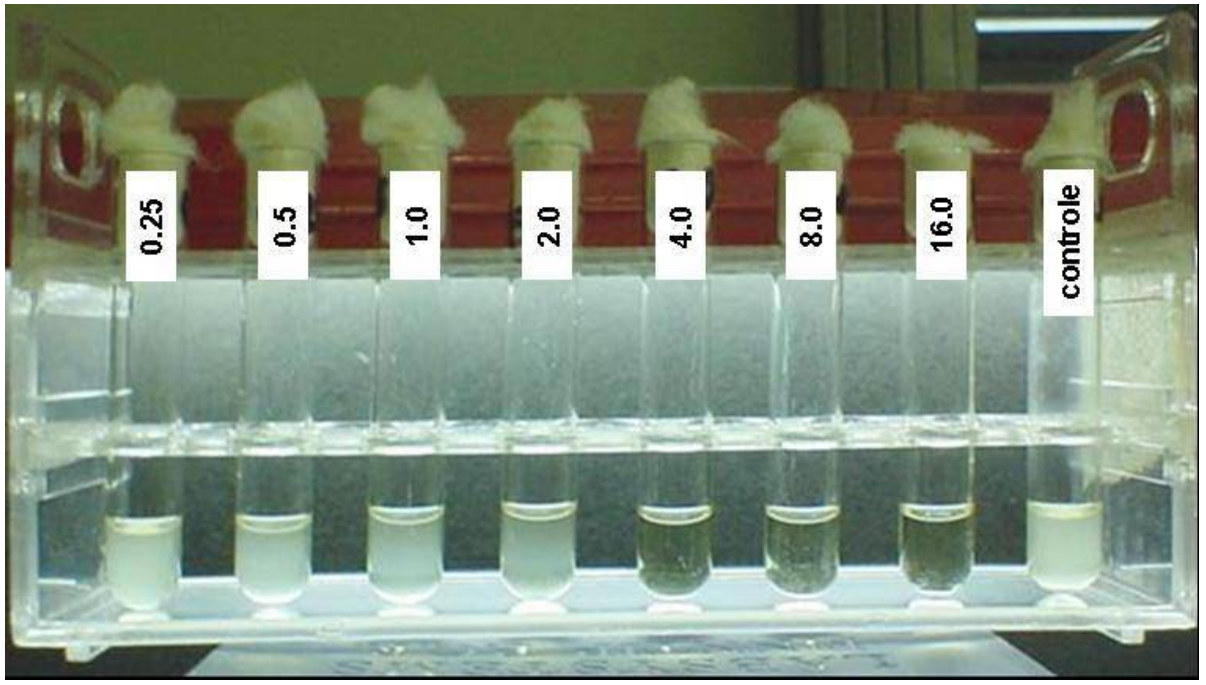
Table-4: Phenotypic antimicrobial susceptibility test methods commonly used in laboratories.

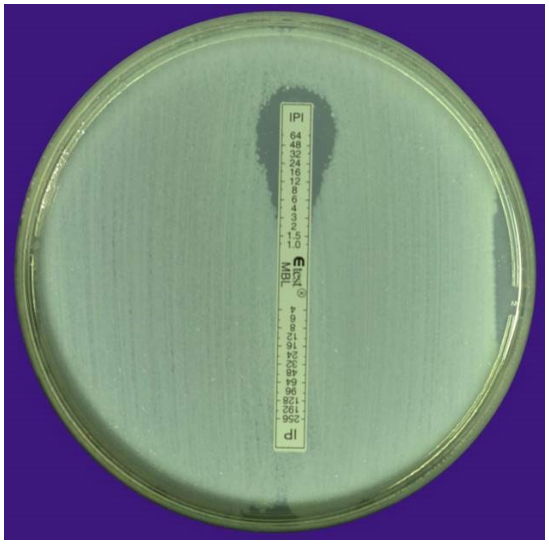
Name of the AST	Nature of the AST	Media used	Time required (h)	Antibiotics that can be tested	Reference
Disk diffusion method	Phenotypic, qualitative	MHA	18-24	All antibiotics except colistin	[12,46]
Broth dilut method			24	All antibiotics	[12,45,46]
Agar dilut method			24	All antibiotics except colistin and sulfa drugs	[45]
Etest®			24	All antibiotics	[46]
Sensitire™			18-24	All antibiotics	[46]
Vitek 2®			4-10	All antibiotics	[46]
BD Phoeni			6-16	All antibiotics	[46]
MicroScan			4.5-7	All antibiotics	[46]

MHA=Mue =Aspartate aminotransferase

Vet World. 2022 Apr;15(4):1066-1079.

4. Vigilancia: método fenotípico





AMERICAN SOCIETY FOR MICROBIOLOGY | Journal of Clinical Microbiology®

BACTERIOLOGY

Optimizing a Screening Protocol for Potential Extended-Spectrum β-Lactamase *Escherichia coli* on MacConkey Agar for Use in a Global Surveillance Program

Megan E. Jacob,[a] Shivaramu Keelara,[a] Awa Aidara-Kane,[b] Jorge R. Matheu Alvarez,[b] Paula J. Fedorka-Cray[a]

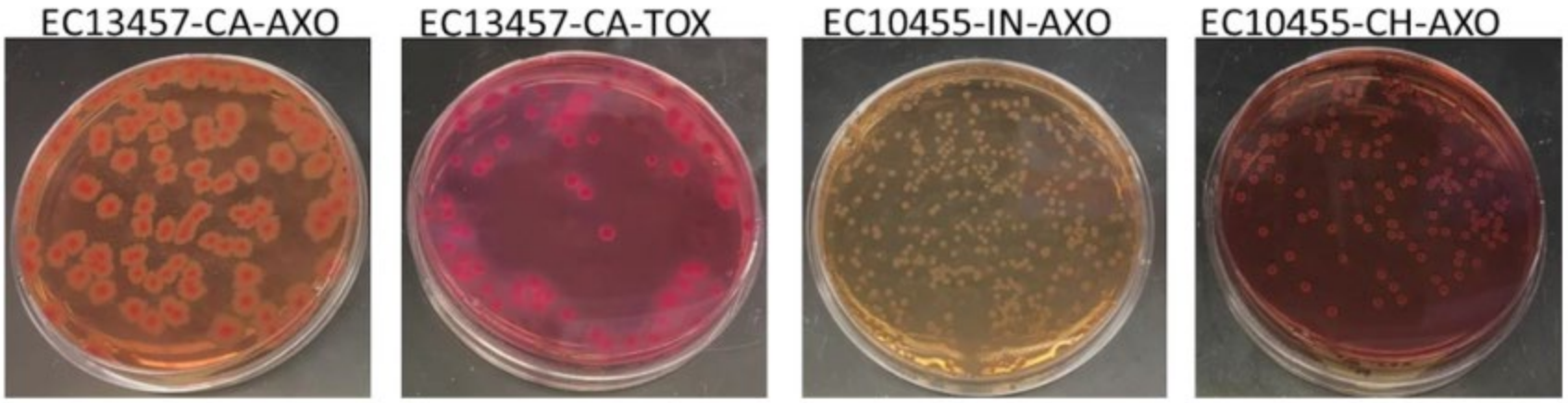
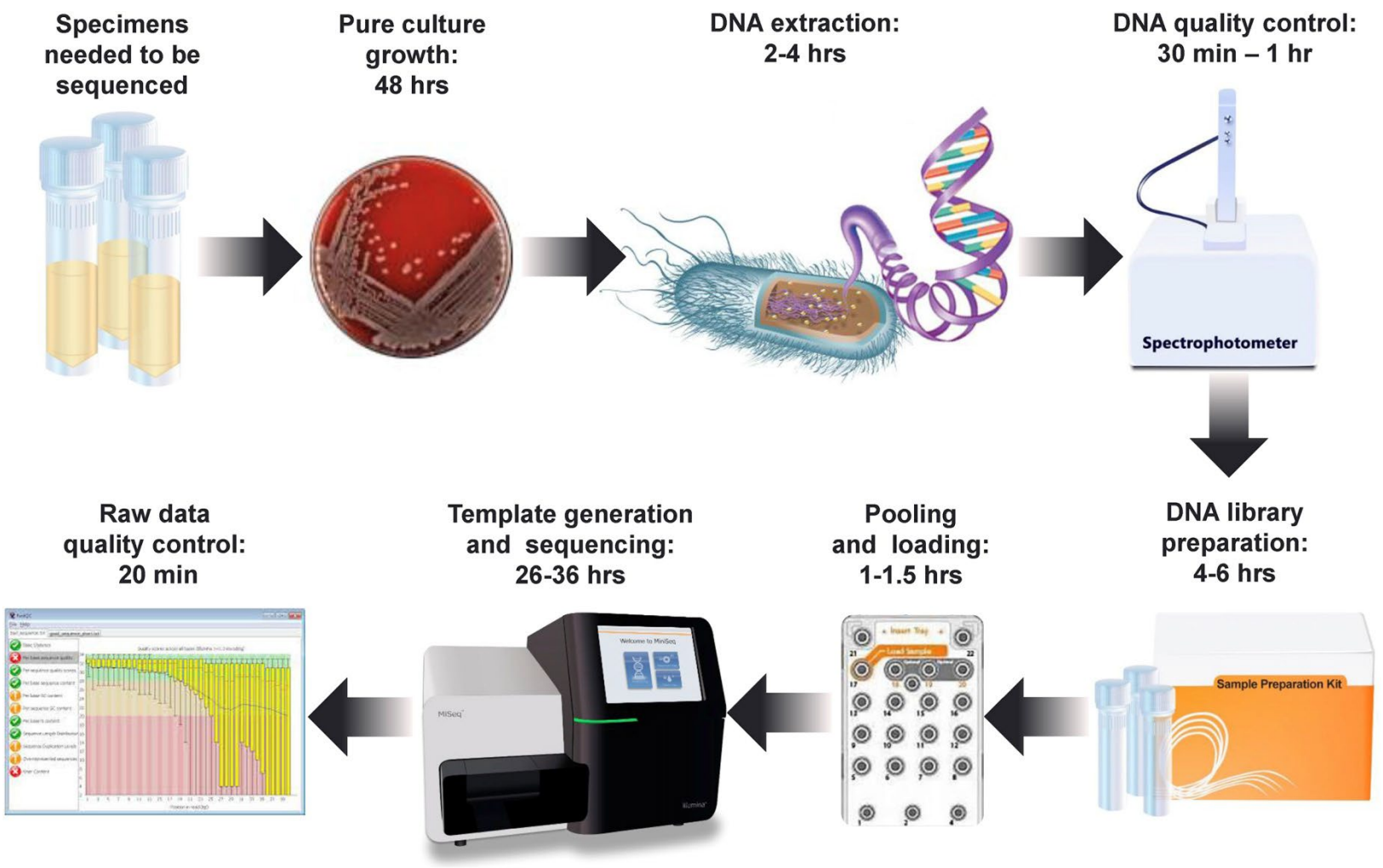


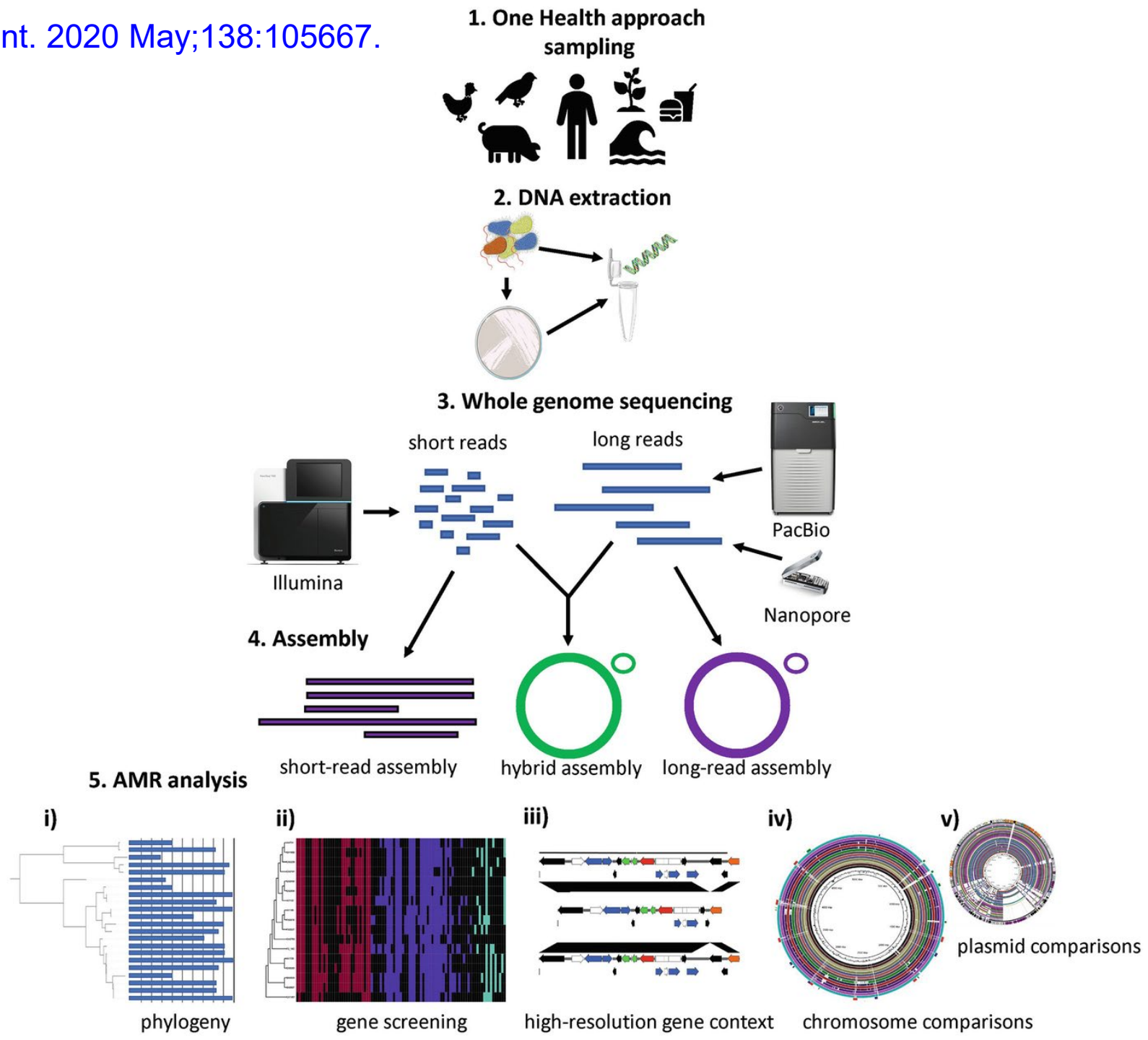
FIG 2 Phenotypic appearance of pure cultures of *Escherichia coli* (EC) 13457 and *E. coli* 10455 on MacConkey agar manufactured in Canada (CA), India (IN), and China (CH) supplemented with 4 μg/ml either cefotaxime (TOX) or ceftriaxone (AXO).

5. Vigilancia genómica/epidemiológica

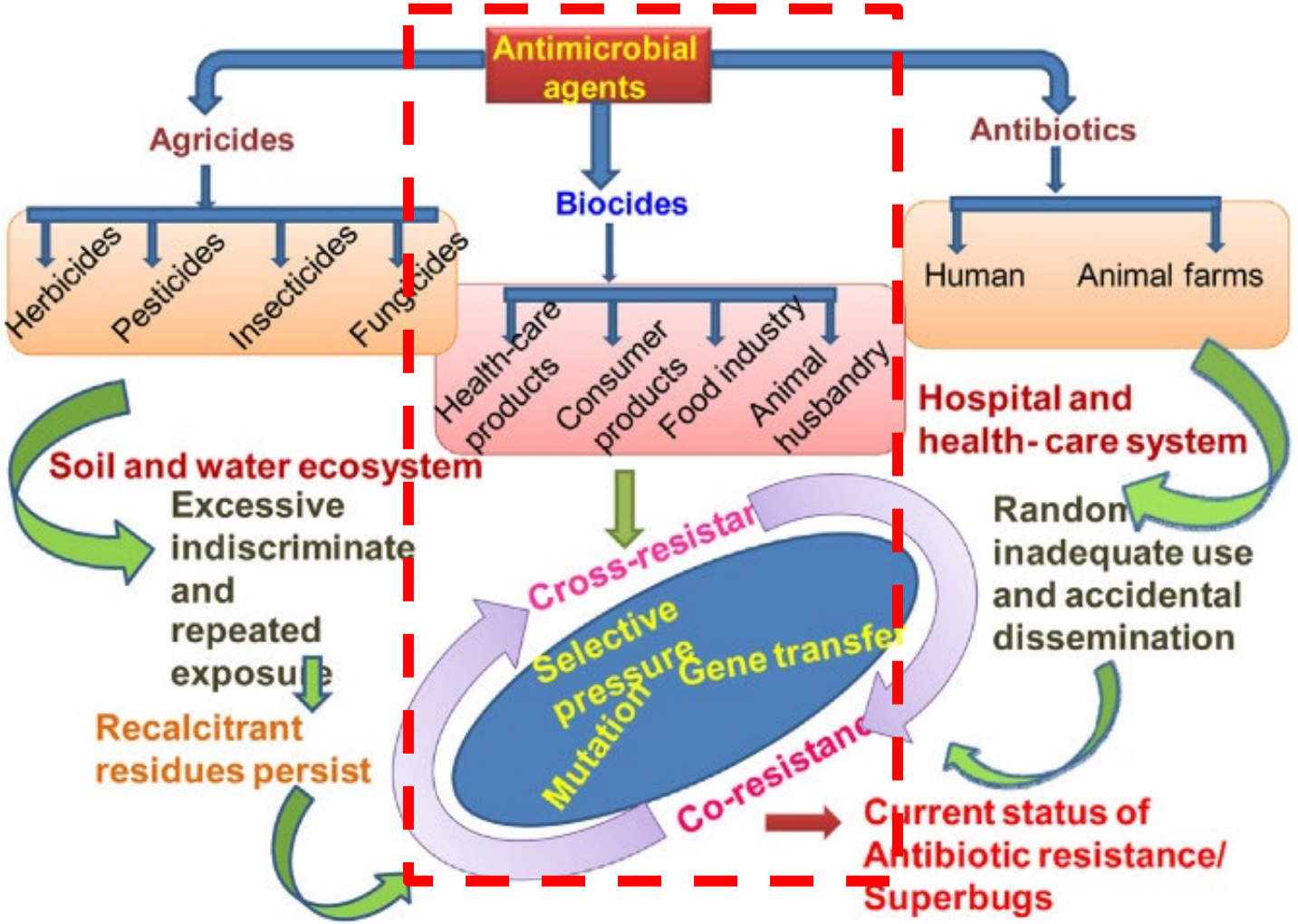


Besser J., *et al. Clinical Microbiology and Infection* 2018, 24:335-341.

Environ Int. 2020 May;138:105667.



Desinfectantes y Biocidas: resistencia/tolerancia y resistencia cruzada/co-resistencia ATM



Paul *et al*., 2019. *Ecotoxicol Environ Saf*. 174:601-610.
Ansari et al., *JAC Antimicrob Resist*. 2021;3:dlab038

Gracias por la atención!

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