Changing Practices to Reduce Antibiotic Resistance

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University of Arizona College of Agriculture and Life Sciences and
Department of Soil, Water and Environmental Science

Addressing Antibiotic Resistance Hotspots Session, APHL Annual Meeting
June 2, 2018

Antibiotic Resistance: the Quintessential One Health Issue

Multiple disciplines

- Clinical, Environmental
- Policy
- Statisticians

Working locally, nationally, and globally

To attain health for people, animals, and the environment

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What is known? What is not known?

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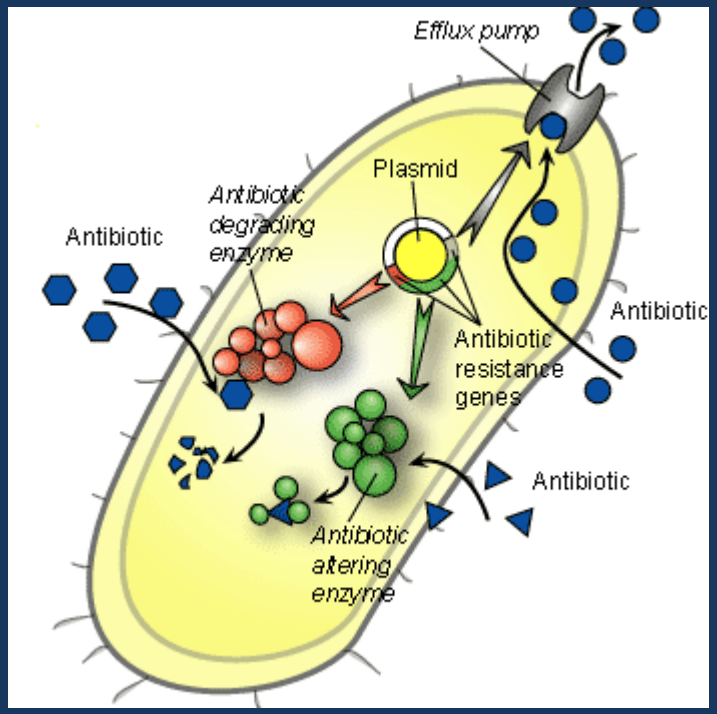
Antibiotic Resistant Bacteria



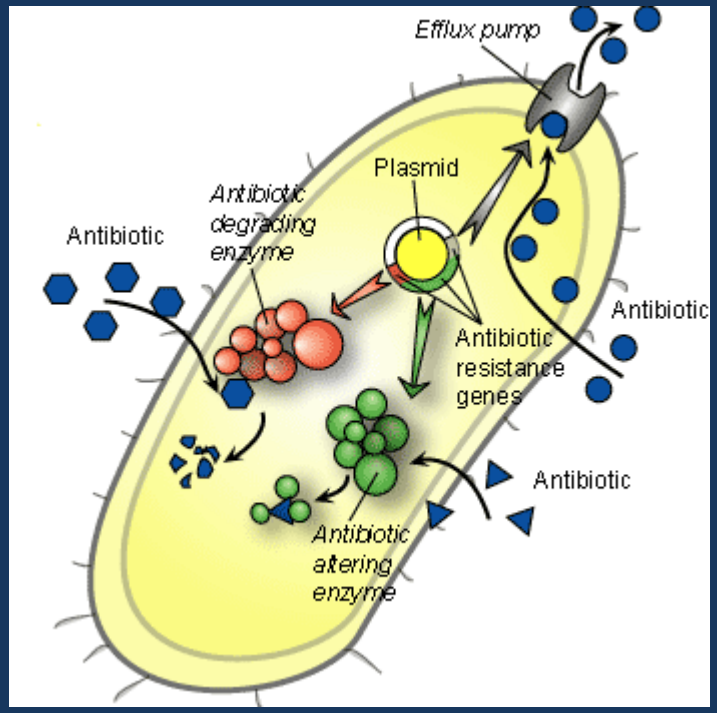
The ability of a bacterium to prevent an antibiotic from adversely affecting that isolate, strain, or group.

Horizontal Gene Transfer confers antibiotic resistance in response to selective pressure

Clinical settings
High antibiotic dosages

Resistance – anthropogenic?

Antibiotic Resistant Bacteria



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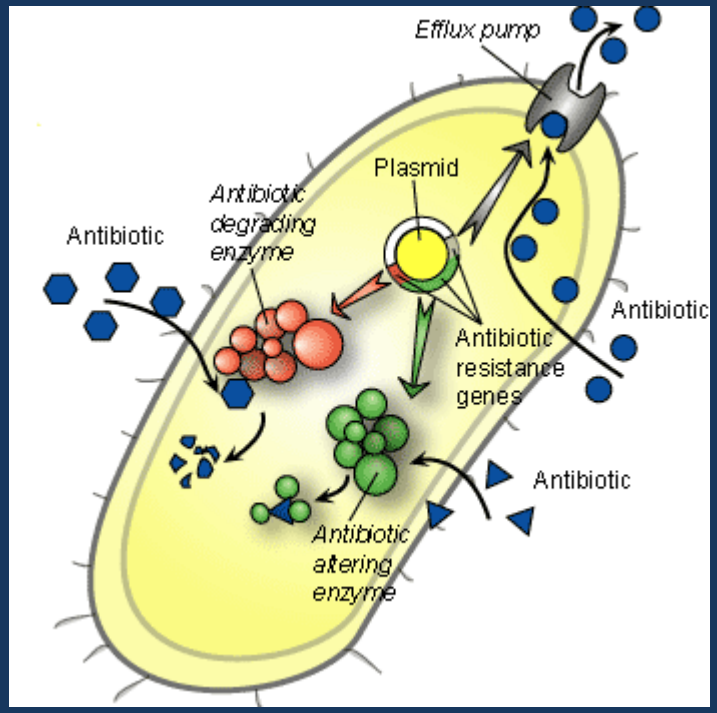

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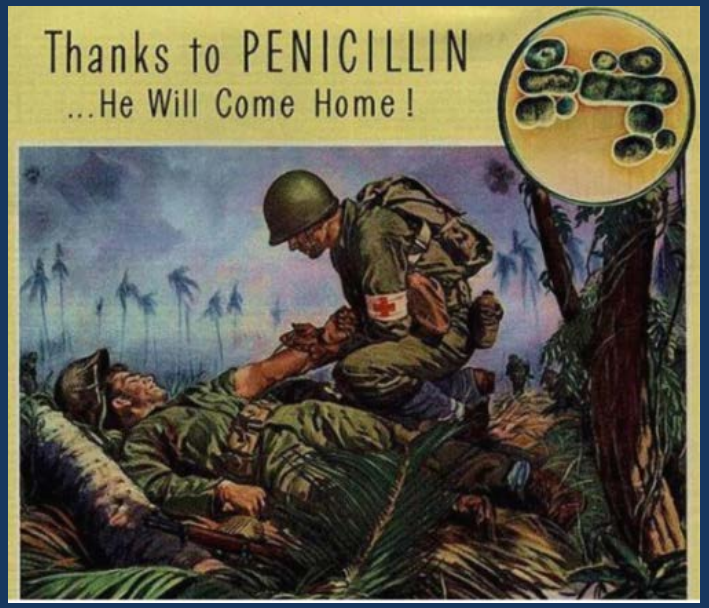

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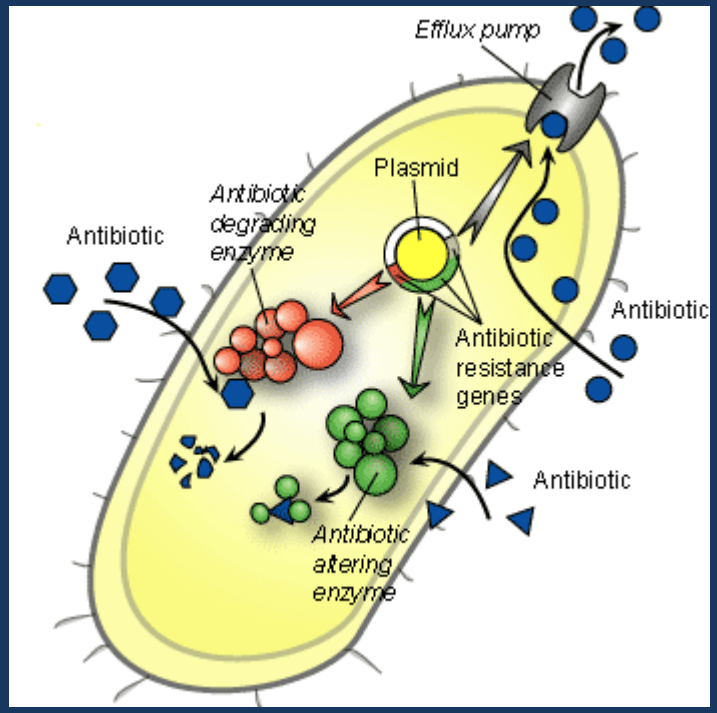

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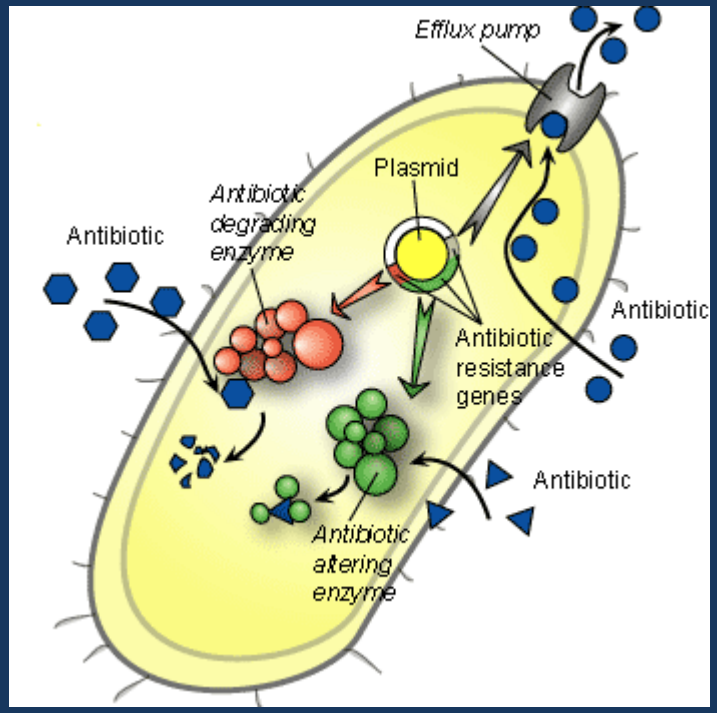

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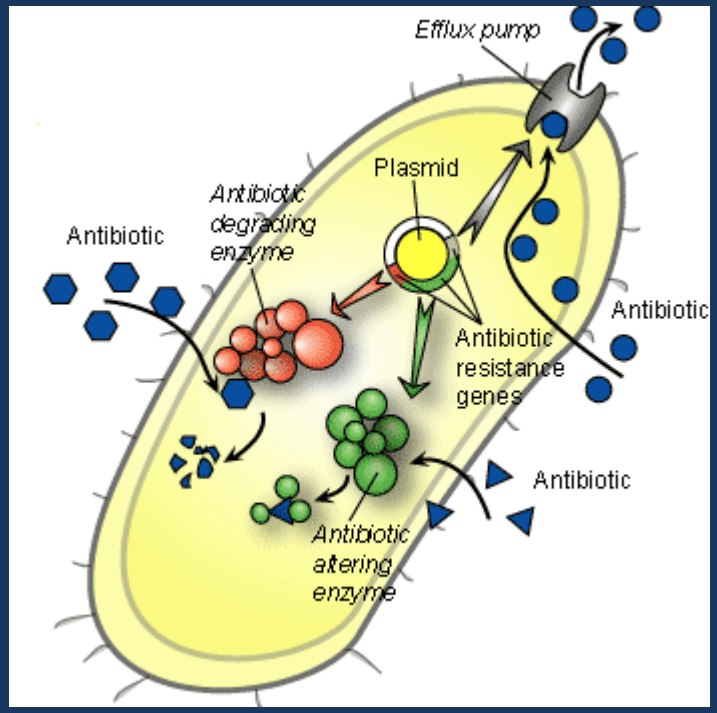

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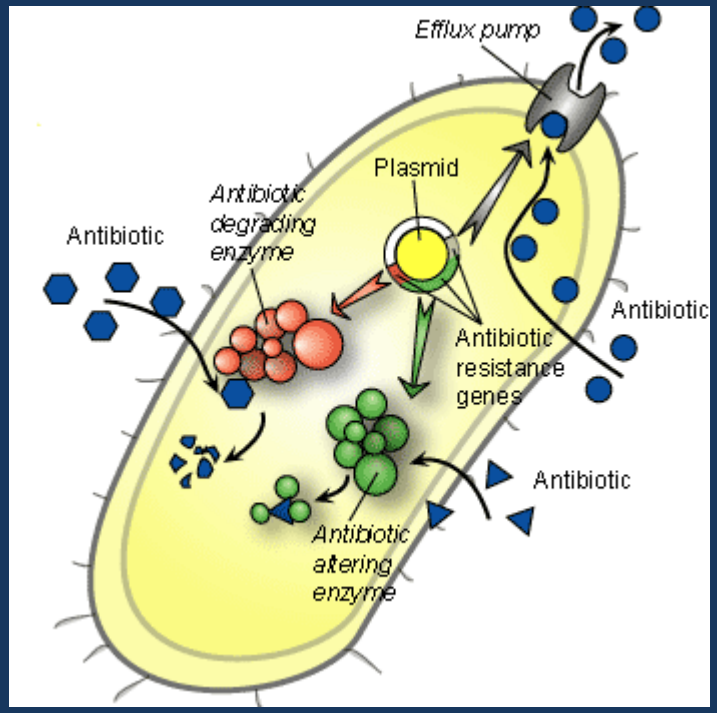

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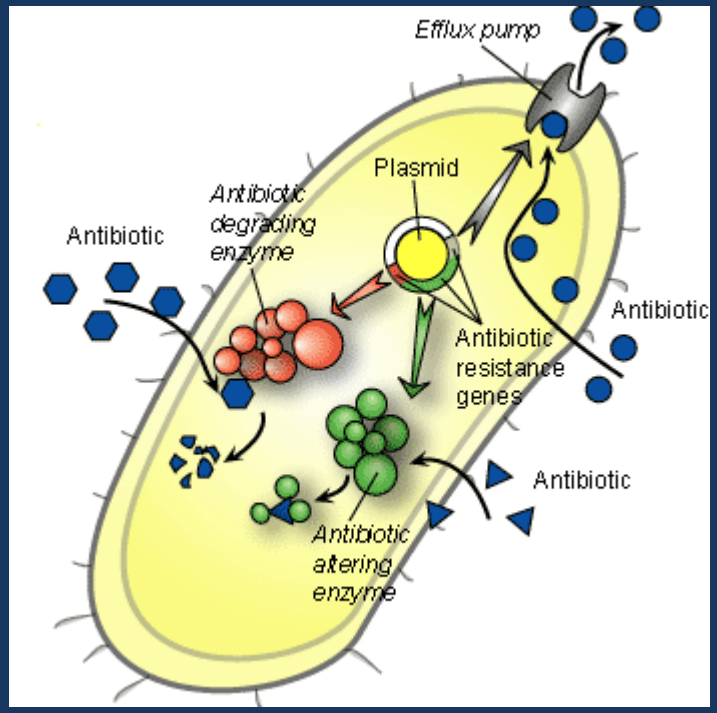

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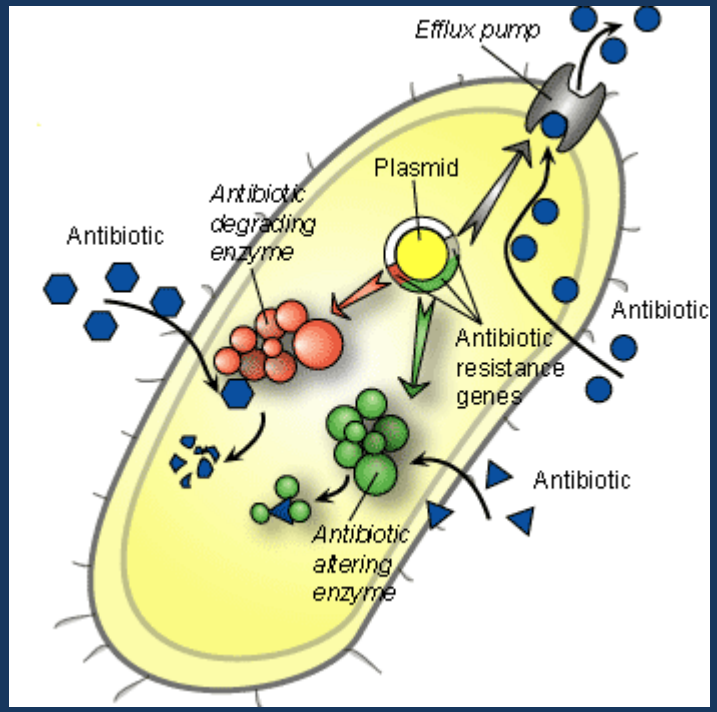

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Environment has a role in emergence and spread

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Recycled wastewater
Biosolids

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Recycled wastewater
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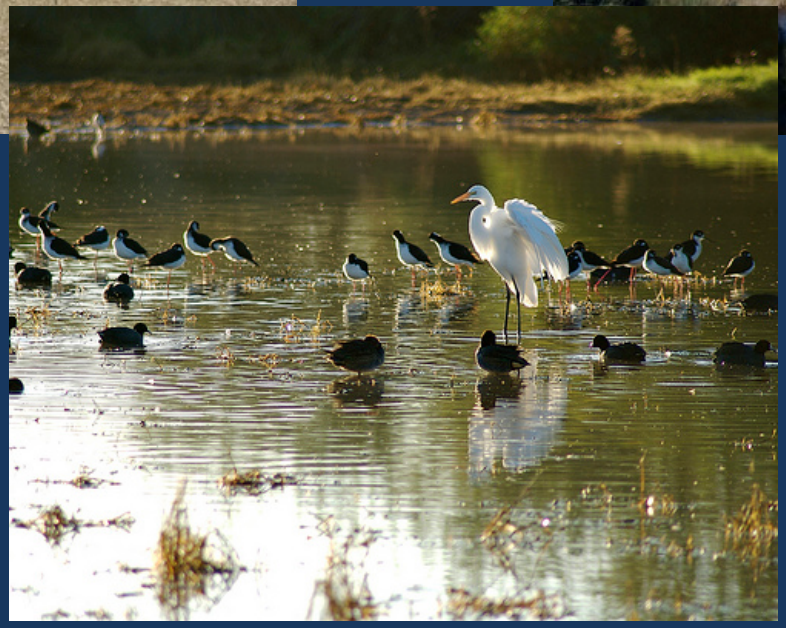
Proposed that this is a "key source of resistance to the environment"

Does Recycled Municipal Wastewater Induce Antibiotic Resistance?



Gilbert Riparian Preserve

Created in 1986, seven recharge basins receive tertiary-treated recycled water

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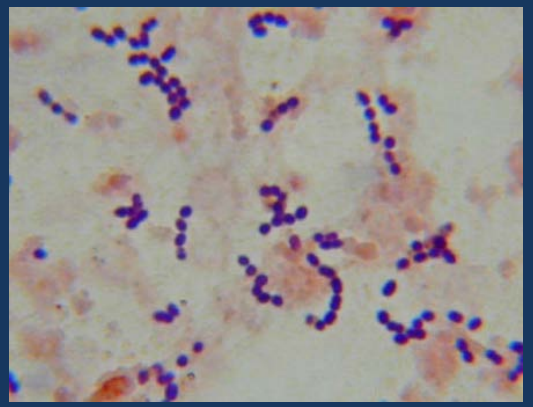
Control site: agricultural irrigation retention pond

Field Sampling over Two Years

Enterococcus spp.

GI tracts of humans and animals; environmental persistence

Great capacity for gene transfer



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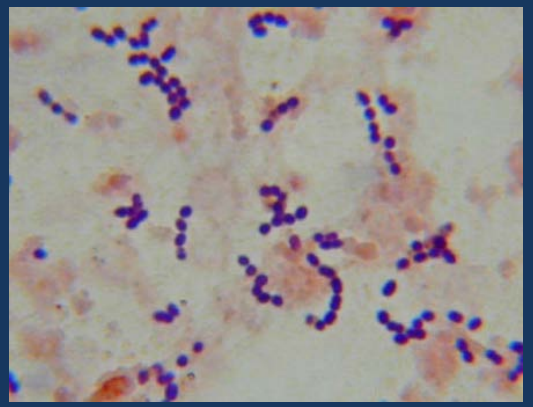
Emergence of multiple drug-resistant strains in clinical settings

Ideal bacterial group for investigating the ecology of resistance development



High Level Antibiotic Resistance

Antimicrobial	% Isolates with High-Level Resistance	
	Groundwater	Wastewater
Tigecycline	14.3	6.1
Erythromycin	42.8	21.2
Tetracycline	21.4	0.0
Ciprofloxacin	57.1	24.2
Chloramphenicol	7.1	0.0
Penicillin	14.3	6.1
Daptomycin	57.1	51.5
Vancomycin	7.1	3.0
Streptomycin	0.0	0.0
Nitrofurantoin	28.6	21.2
Tylosin Tartrate	25.0	3.0
Gentamycin	0.0	0.0
Quinupristin/Dalfopristin	3.6	27.3
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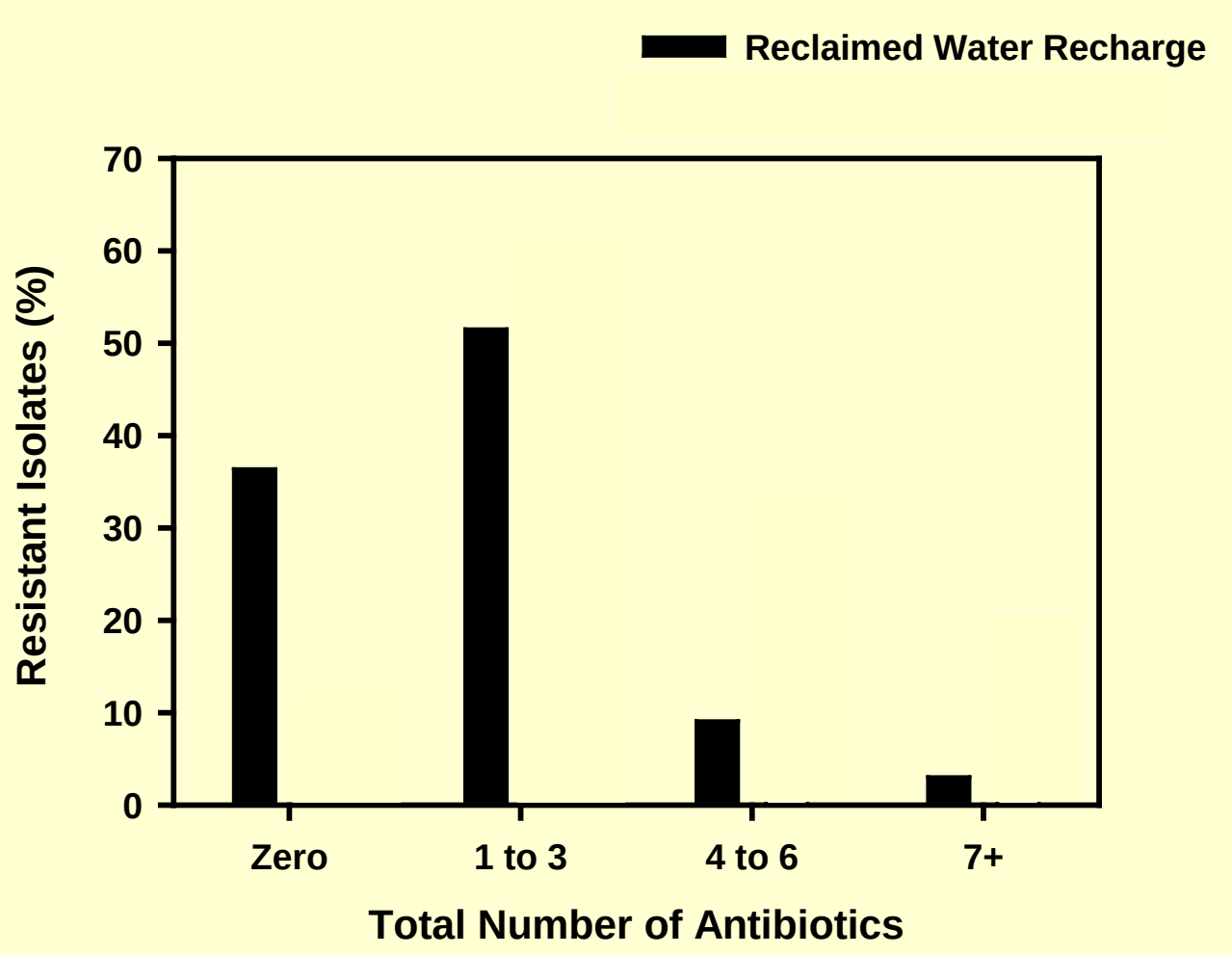
Multi-Antibiotic Resistance – “Superbugs”



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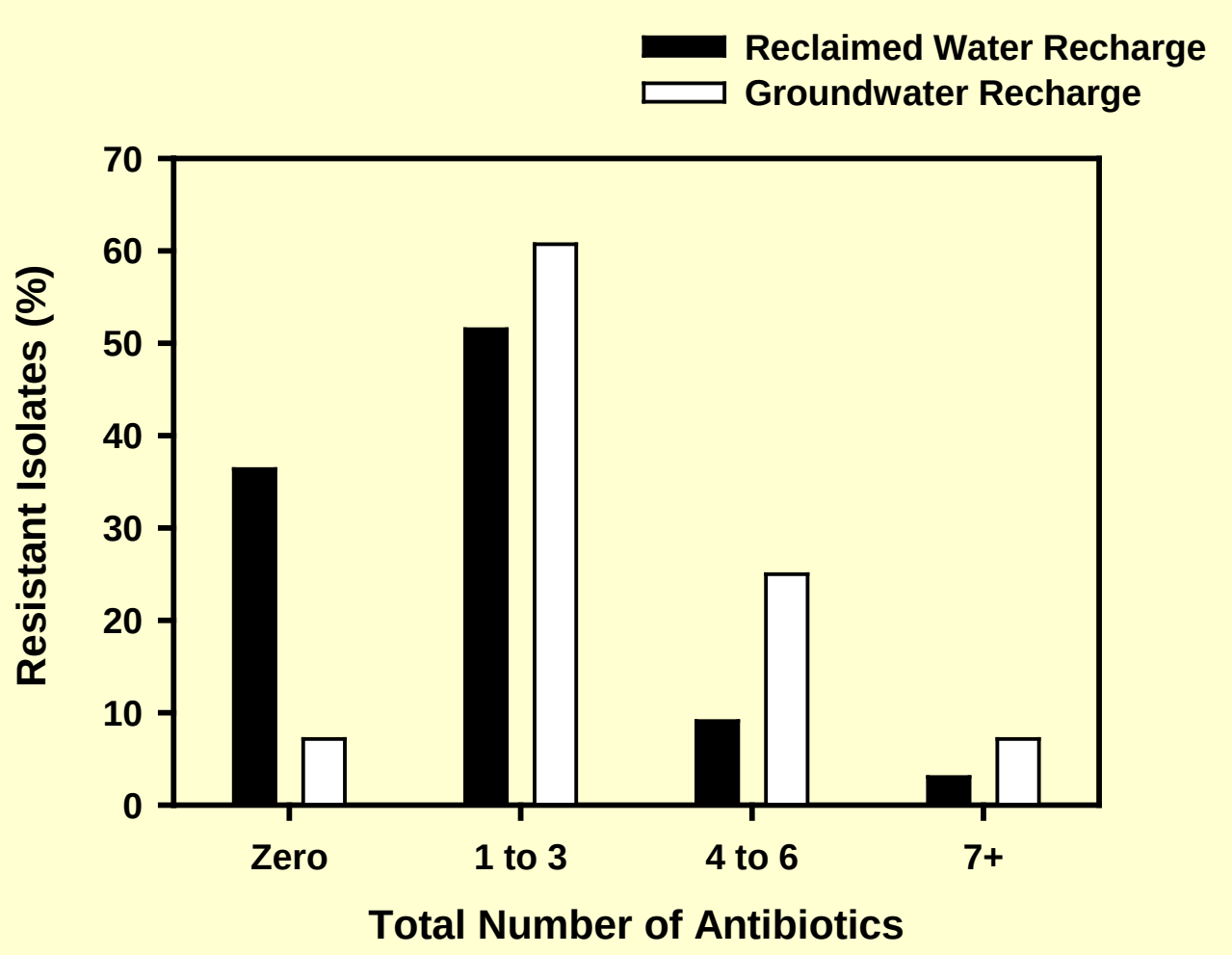

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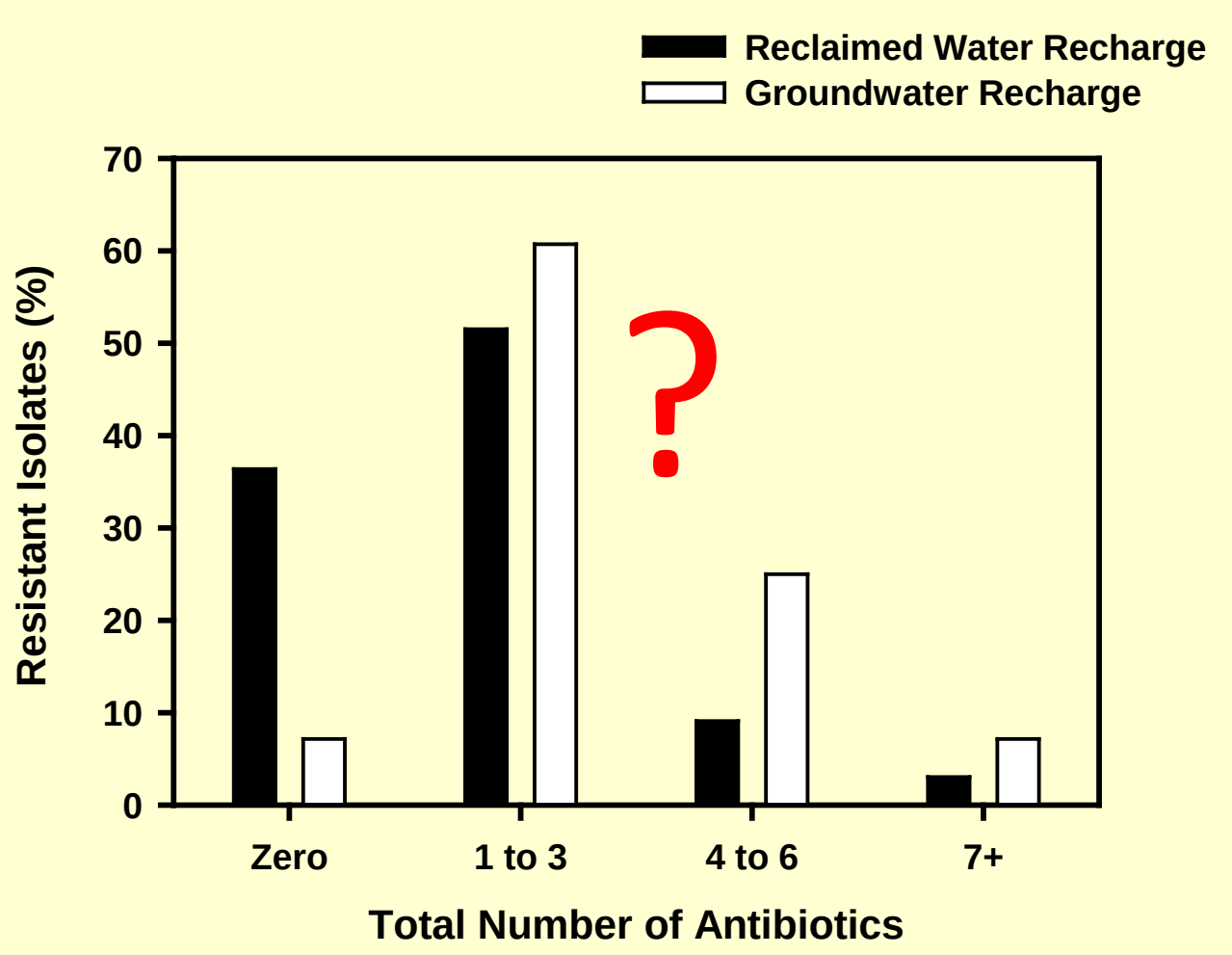

What Does This Mean?

Antibiotic resistance:
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Recycled Water, Biosolids = Adding Soil Carbon

McLain and Williams (2014) *Sustainability*, *6*, 1313-1327

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Environmental complexity – not a direct cause/effect

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Pollution via Antibiotic Resistance Genes

ELSEVIER

Science of The Total Environment

Volume 447, 1 March 2013, Pages 345-360

Review

Urban wastewater treatment plants as hotspots for antibiotic resistant bacteria and genes spread into the environment: A review

L. Rizzo [a], C. Manaia [b], C. Merlin [c], T. Schwartz [d], C. Dagot [e], M.C. Ploy [f], I. Michael [g], D. Fatta-Kassinos [g]

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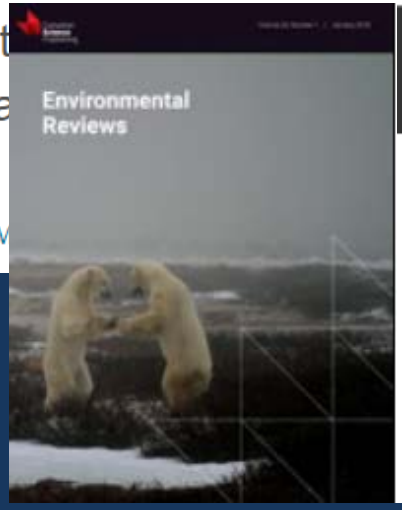

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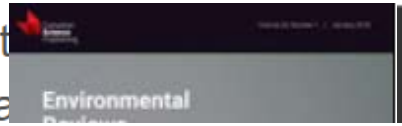

Review

ENVIRONMENTAL Science & Technology

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Cell-free DNA: A Neglected Source for Antibiotic Resistance Genes Spreading from WWTPs

Yan Zhang[†], Aolin Li[‡], Tianjiao Dai[§], Feifei Li[∥], Hui Xie[‡], Lujun Chen[*‡⊥], and Donghui Wen[*§]

[†] Jiangsu Key Laboratory of Anaerobic Biotechnology, School of Environment and Civil Engineering, Jiangnan University, Wuxi 214122, China

[‡] School of Environment, Tsinghua University, Beijing 100084, China

[§] College of Environmental Sciences and Engineering, Peking University, Beijing 100871, China

[∥] School of Water Resource and Environment, China University of Geosciences, Beijing, 100083, China

[⊥] Zhejiang Provincial Key Laboratory of Water Science and Technology, Department of Environmental Technology and Ecology, Yangtze Delta Region Institute of Tsinghua University, Zhejiang Jiaxing 314050, China

Antibiotic Resistance Genes and "Cell-Free DNA"

Water Environment Research Foundation Study (2014-2017) by Gerrity, Rock, and McLain

Antibiotic Resistance Genes and "Cell-Free DNA"

Water Environment Research Foundation Study (2014-2017) by Gerrity, Rock, and McLain

- As much as 50% of total DNA was "free DNA"
- Quantified intact resistance genes by PCR, qPCR

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It is ancient – studies need control sites

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Culturing studies do not show cause-and-effect

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- Appropriate drug
- Effective drug
- At right dose
- Correct length of time

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USA – FDA established rules aligning with EU in 2018

Aimed at controlling antibiotic resistant bacteria moving off farms

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Increased use of therapeutic antibiotics for food animals (48 tons in 1996; 94 tons in 2001)

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Changing Practices – is it effective?

World Health Organization: “one of the most critical human health challenges of the next century”

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Accurate assessments of environmental quality impacts – and accurate assessments of human health risk – increase in importance

Questions?

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