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EMERGING CONTAMINANTS IN WATER ENVIRONMENT

MUSSELS AS BIOINDICATOR OF THEIR POLLUTION IN WATER

Ts. Dr. Yong Ee Ling

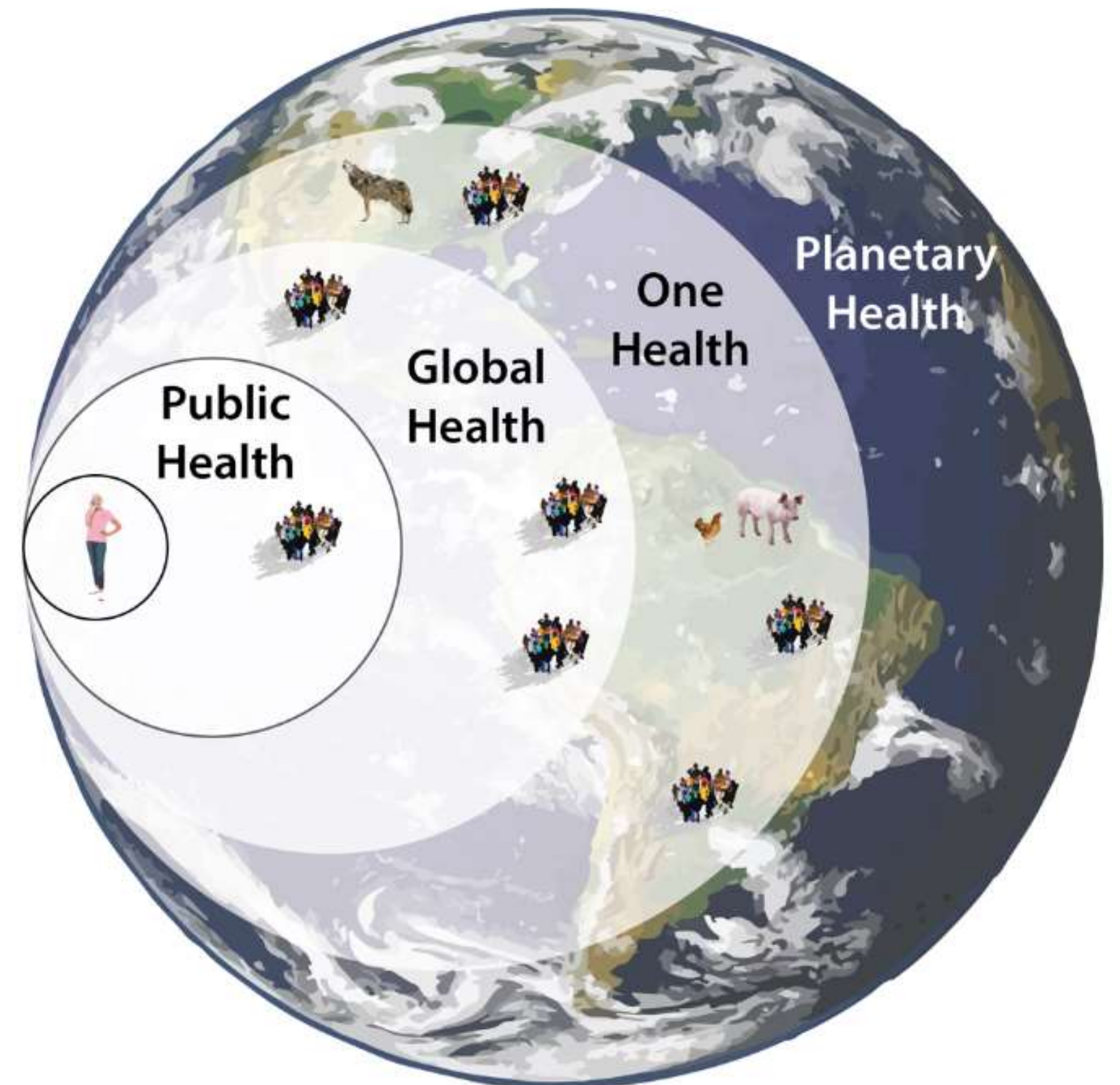
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Universiti Teknologi Malaysia*





PLANETARY HEALTH

- **Planet Health** – Human health is directly linked to the health of the environment they live in
- **One Health** – Human, animal and environmental health are interconnected
- **Global Health** – Improvement of health in a worldwide context
- **Public Health** – Improvement of health is within a local or national context



Planetary health recognizes the health of the planet as a system. ERIC MARTY

www.forbes.com/sites/johndrake/2021/04/22/what-is-planetary-

EMERGING CONTAMINANTS
NEW EMERGING POLLUTANTS
CONTAMINANTS OF EMERGING
CONCERNS

ARE THEY SOMETHING NEW?


The Innovation



Volume 5, Issue 4, 1 July 2024, 100612

Review

Emerging contaminants: A One Health perspective

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“Emerging contaminants (ECs), also referred to as contaminants of emerging concern (CECs), are newly identified synthetic or naturally occurring chemicals or biological agents that are detected in the environment and are potentially hazardous or recently determined to be hazardous to humans and ecosystems.”

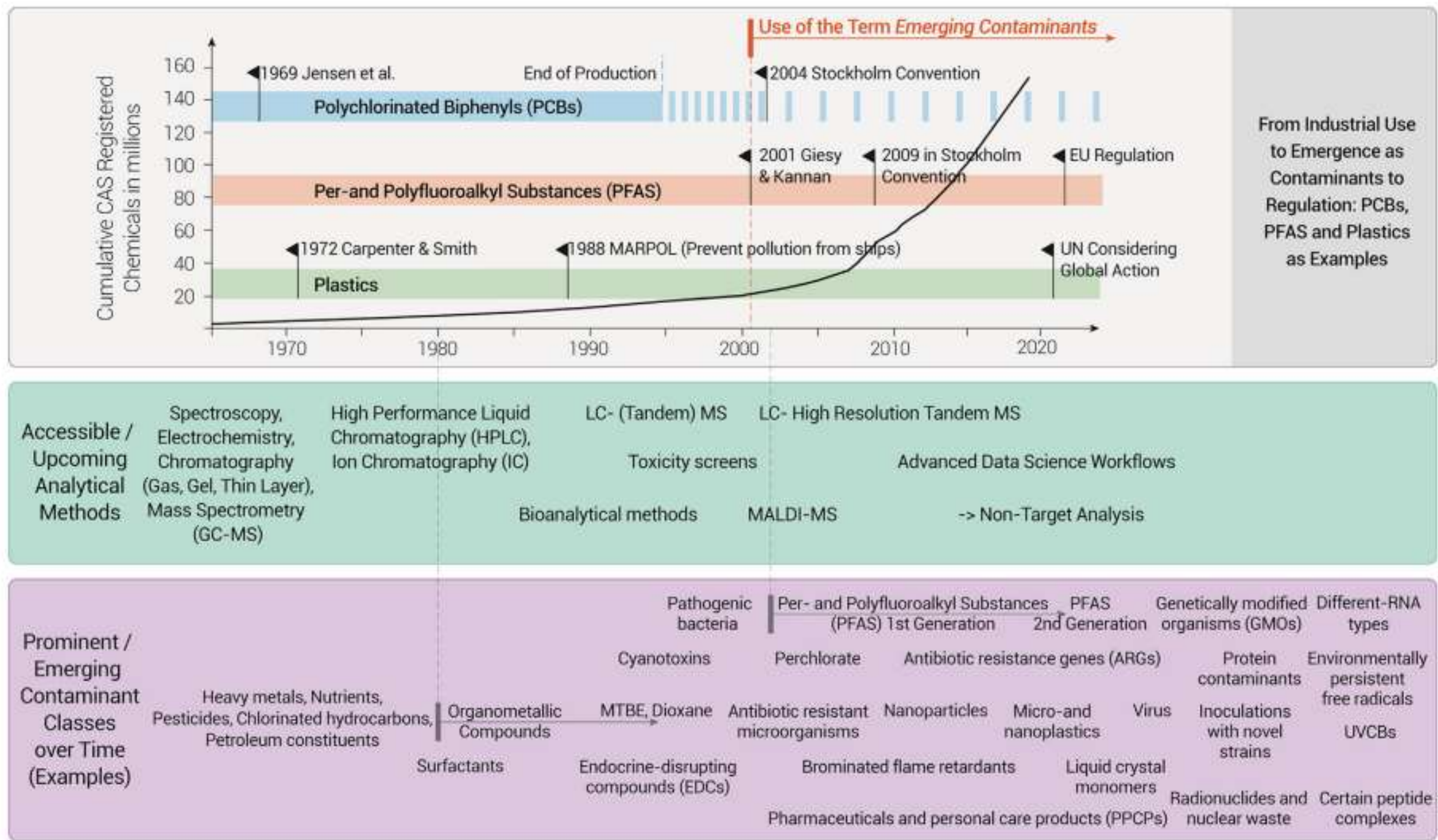


Figure 1. The evolution of ECs in relation to the advances in the detection and tracking of potentially toxic chemicals in the environment or biological systems, even at trace levels Since the early 2000s, the term ECs has been used to describe the discovery of new pollutant classes. Polychlorinated biphenyls (PCBs), per- and polyfluoroalkyl substances (PFAS), and plastics exemplify problematic substances that were in use for decades (gray bars) but emerged as contaminants (pins) and were regulated and discontinued (faded-out shadow) with different lag times. Arrows in the lower panel indicate ECs that originated as replacements for other pollutants.

**EMERGING CONTAMINANTS
NEW EMERGING POLLUTANTS
CONTAMINANTS OF EMERGING
CONCERNS**

ARE THEY SOMETHING FAR?



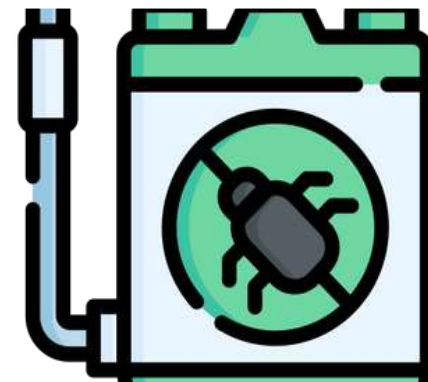
MEDICINE/DRUGS



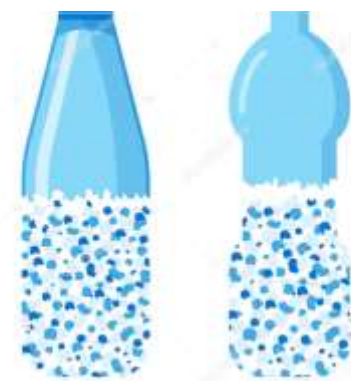
PERSONAL CARE PRODUCTS



HEAVY METALS



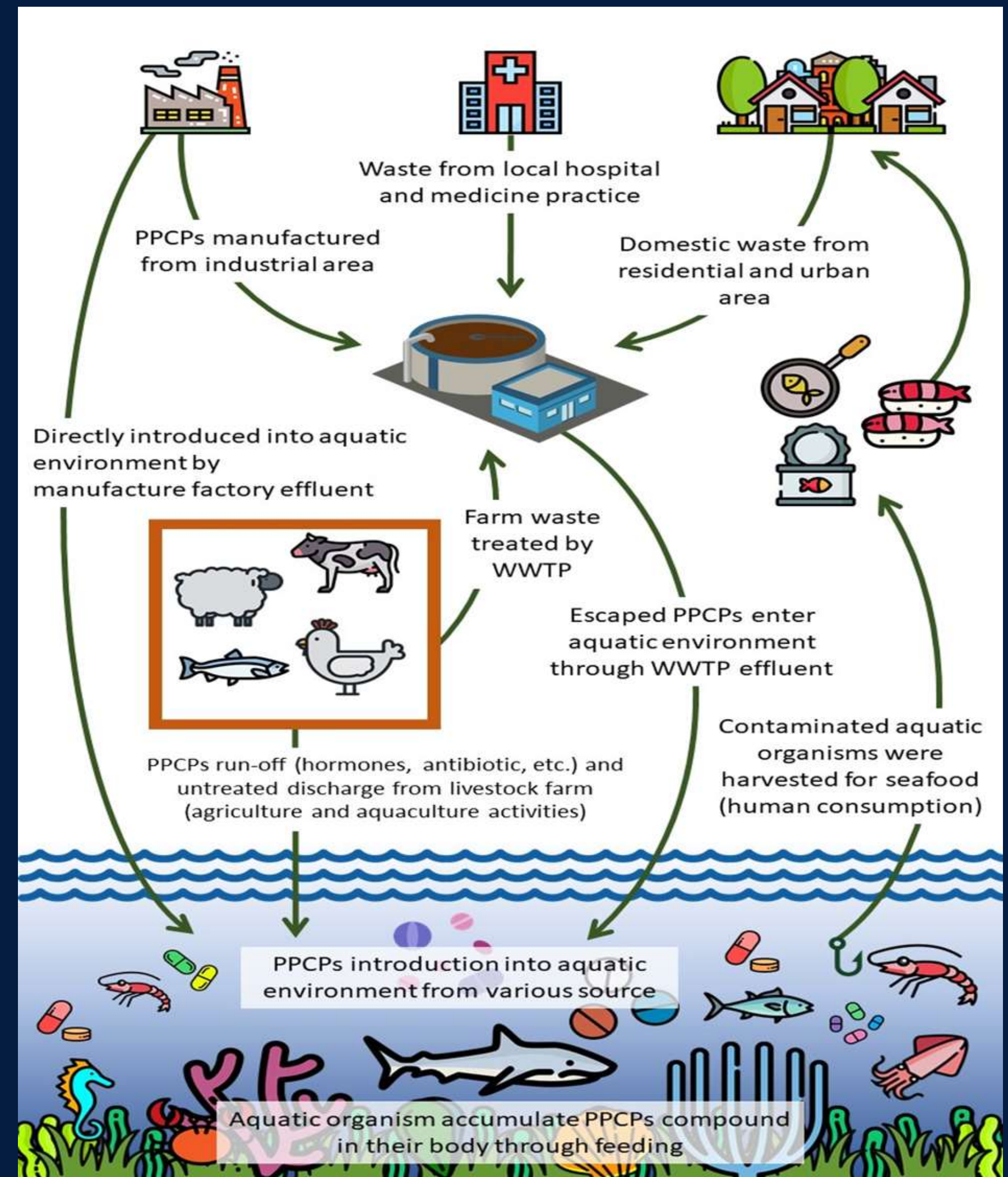
PESTICIDES

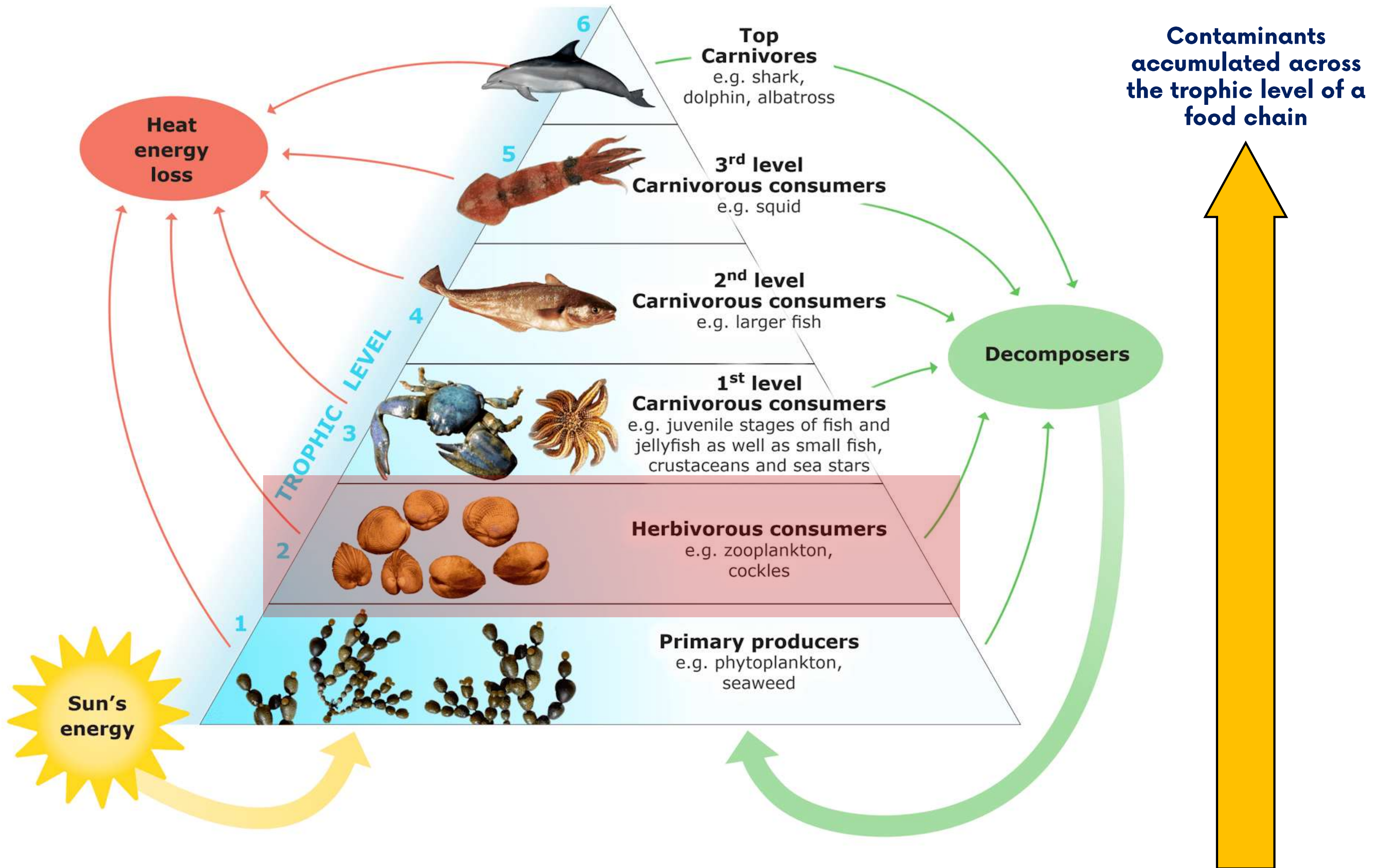


MICROPLASTICS

DO I NEED TO BE WORRIED?

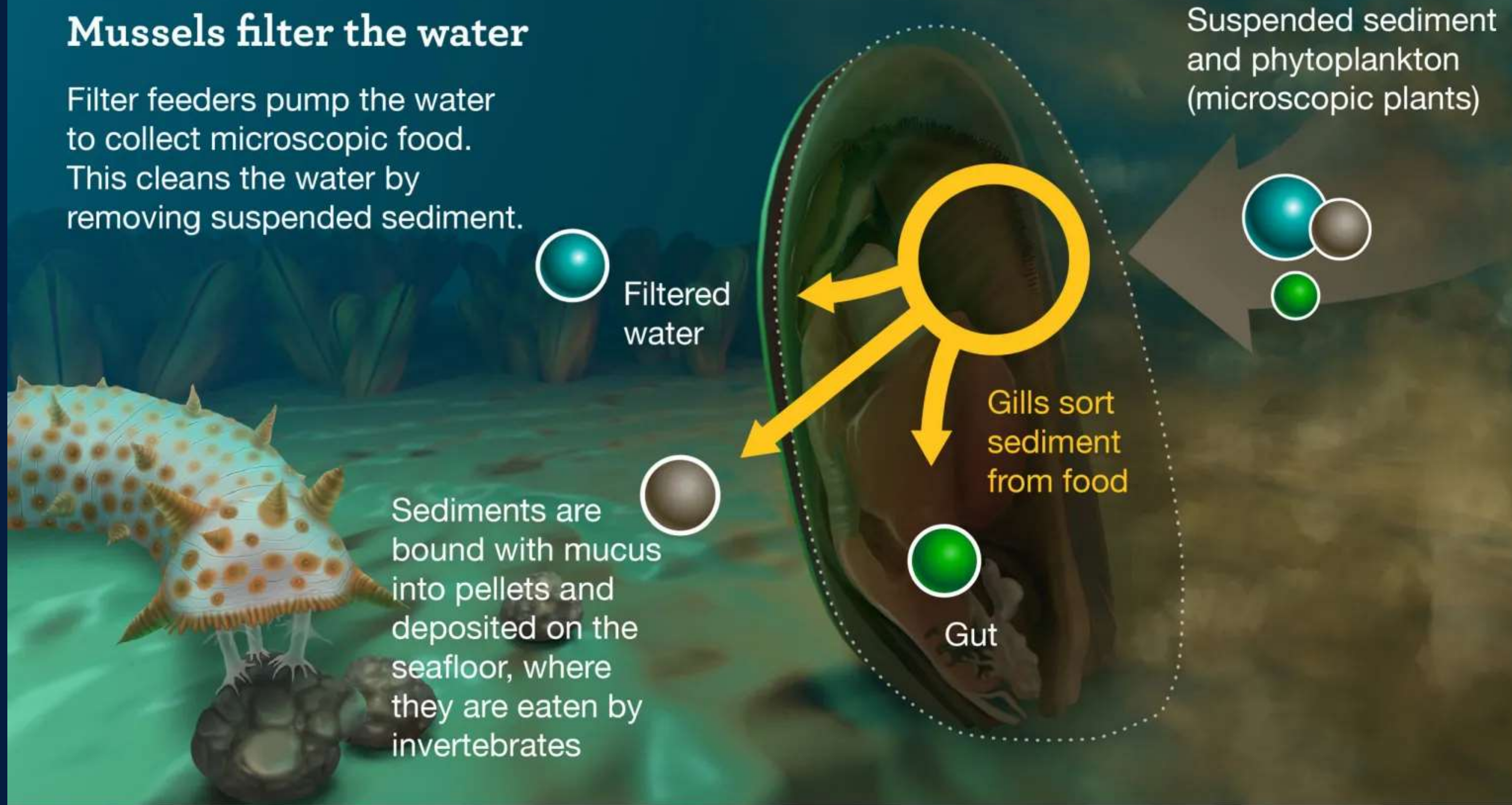
**WHAT GOES AROUND,
COMES AROUND**





Mussels filter the water

Filter feeders pump the water to collect microscopic food. This cleans the water by removing suspended sediment.



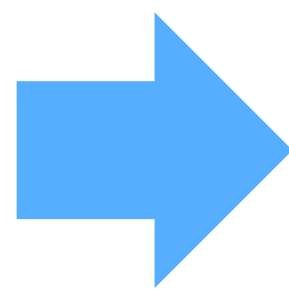
SAMPLING LOCATION



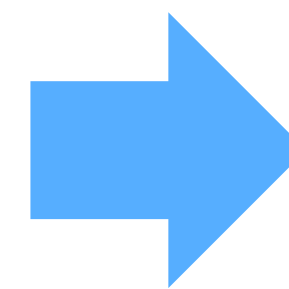
PROCEDURES



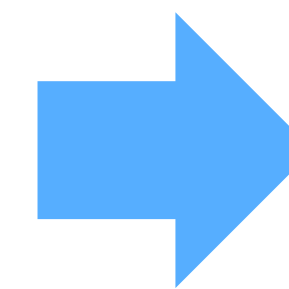
Sample collection



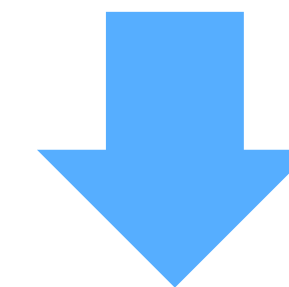
Flesh removal



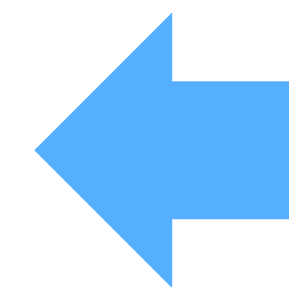
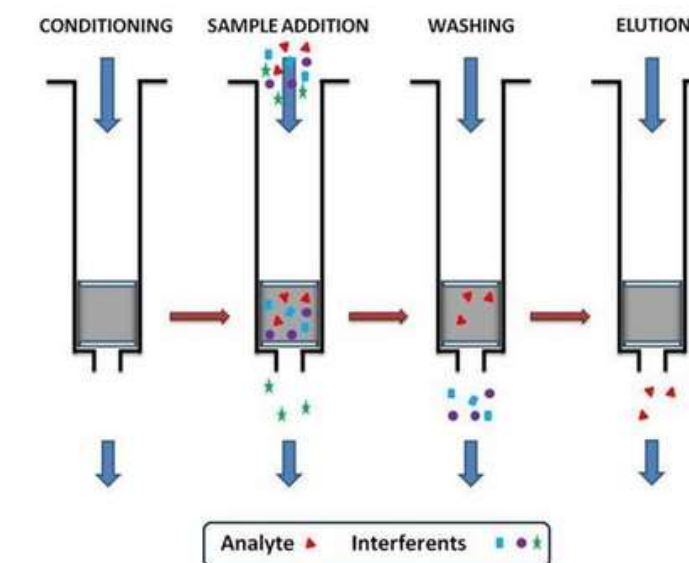
Homogenization



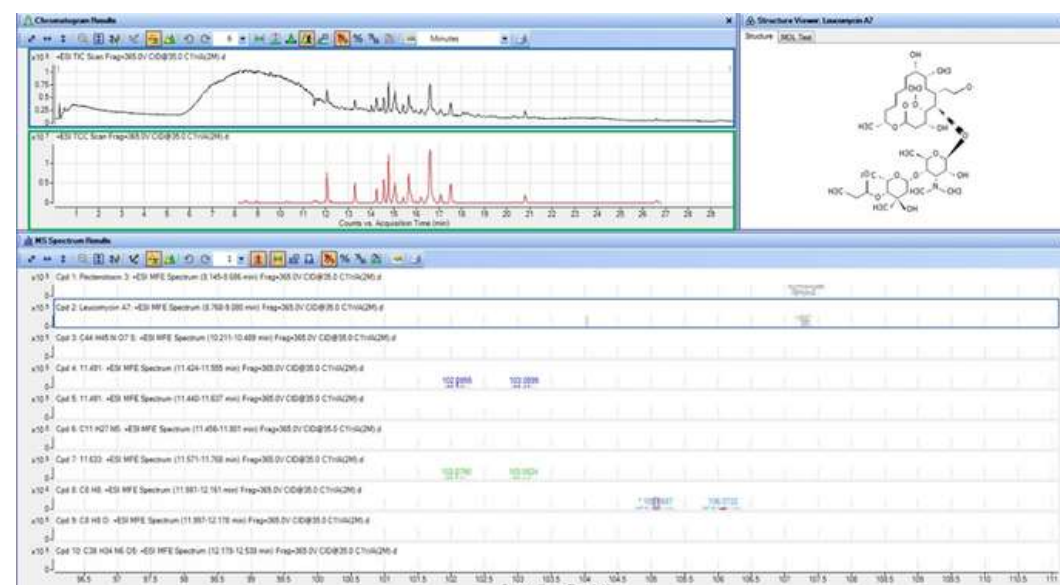
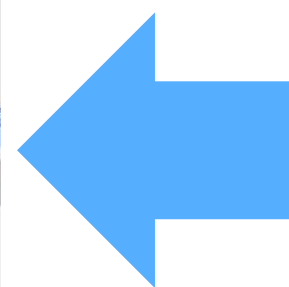
Evaporation



Extraction & concentration



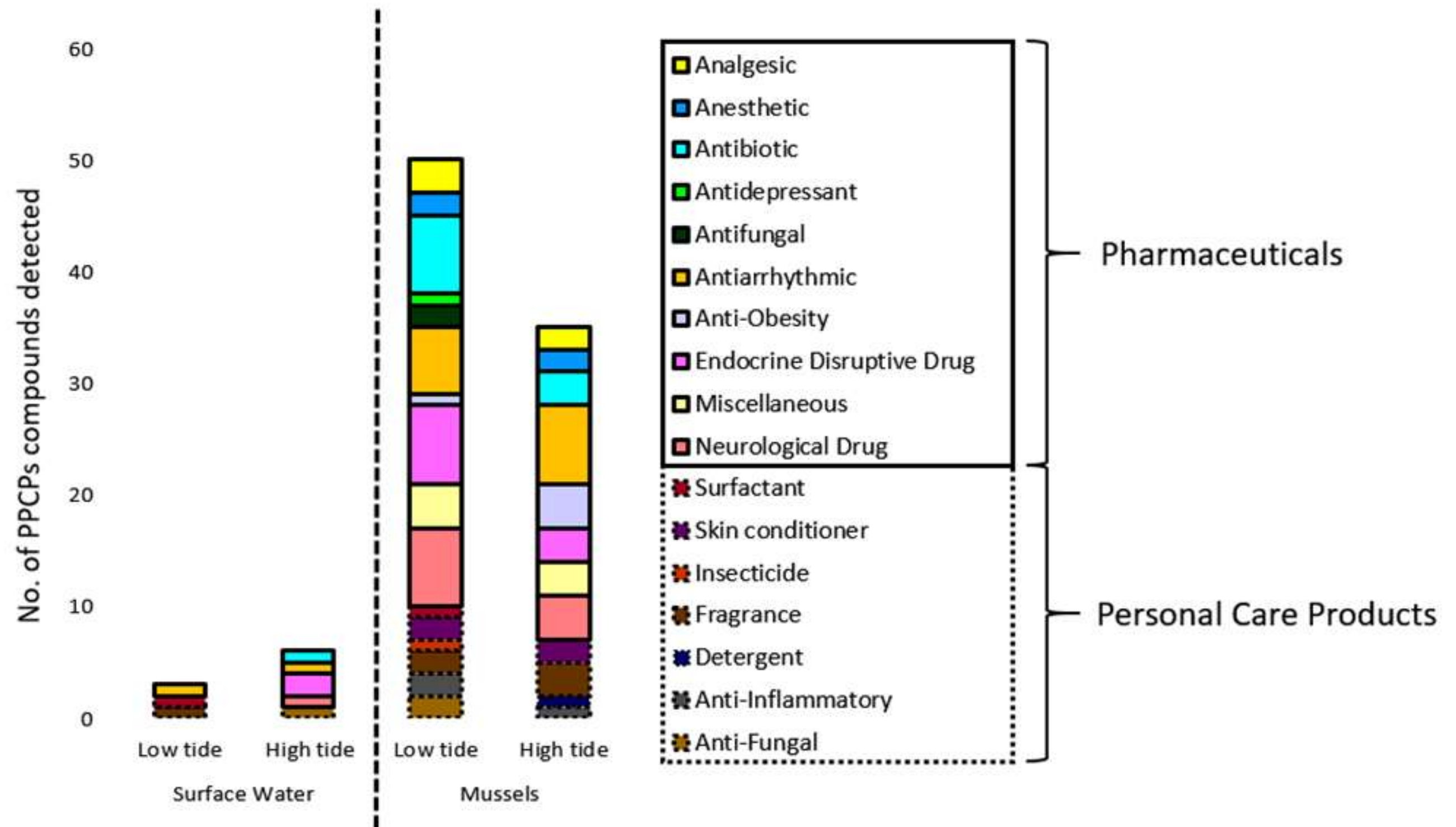
LC-MSMS Analysis



Tentative matching of PPCPs based on m/z % similarity

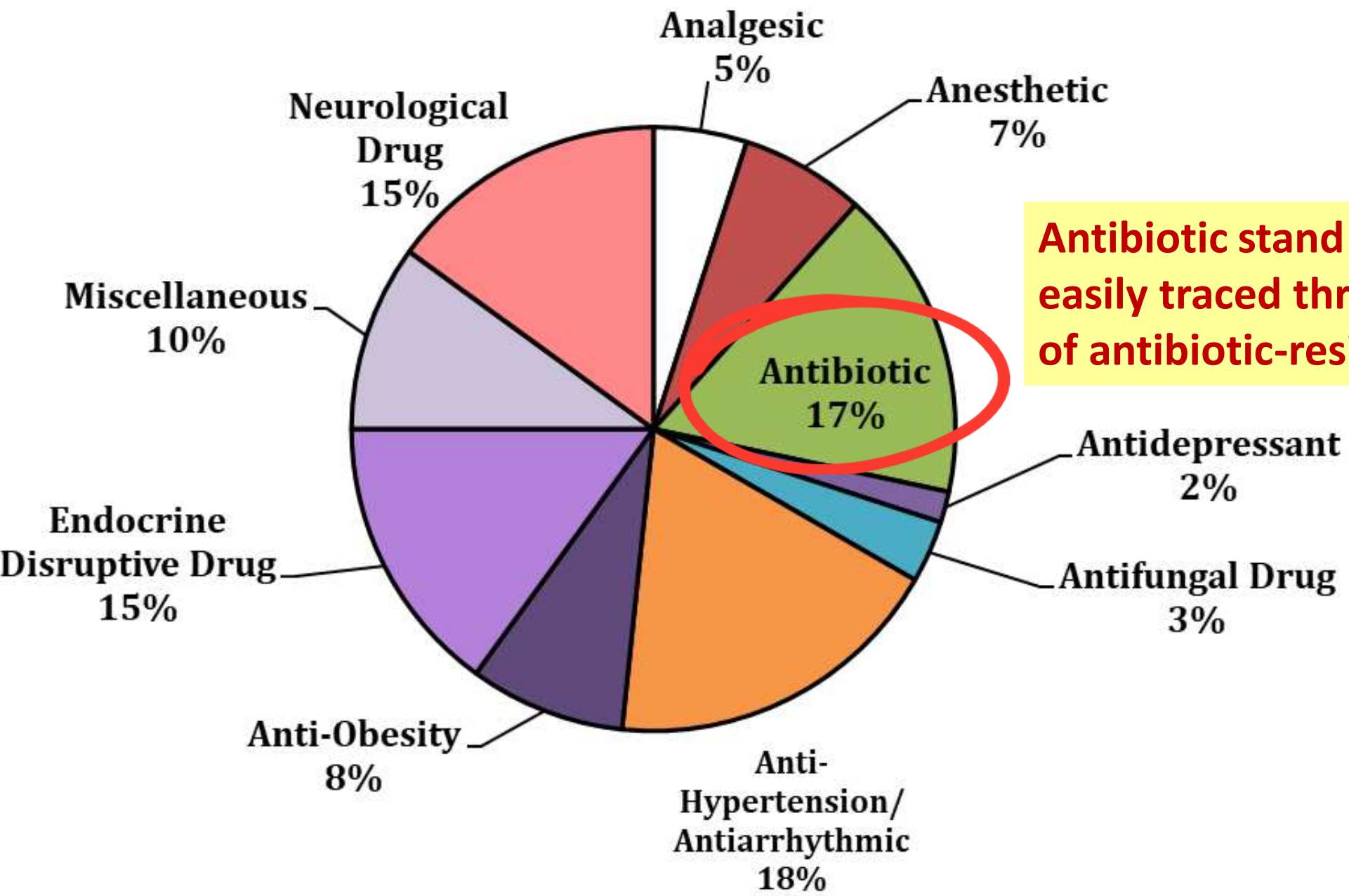
FINDINGS

- Surface water has **lesser PPCPs** with the number of PPCPs detected during **high tide was twice higher**.
- Mussels **accumulated more PPCPs during low tide** but the difference in number between high tide and low tide was only 20%.



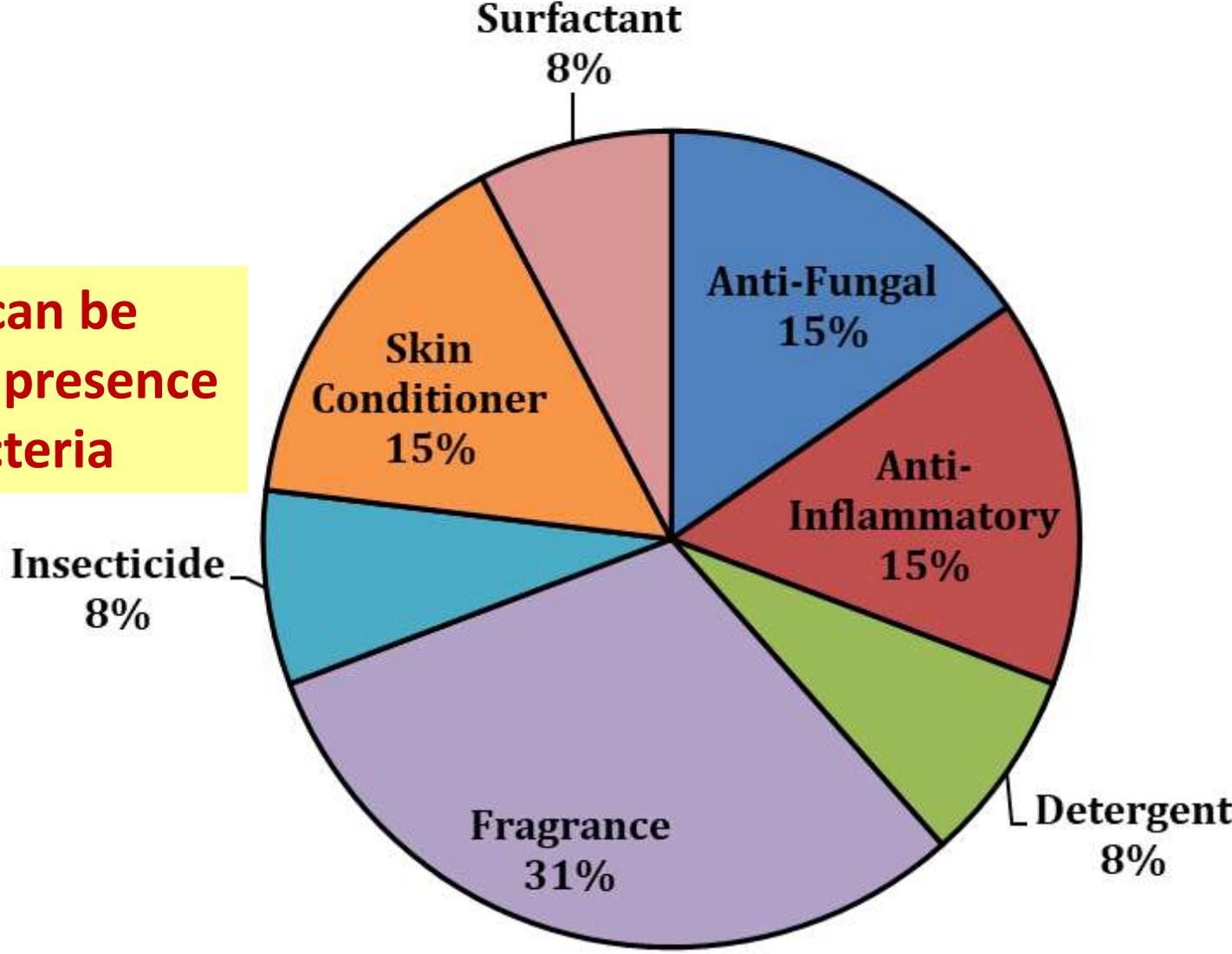
FINDINGS

PHARMACEUTICALS



Antibiotic stand out and can be easily traced through the presence of antibiotic-resistant bacteria

PERSONAL CARE PRODUCTS



ANTIMICROBIAL RESISTANCE ONE CRITICAL ISSUE AFFECTING US ALL

There is no time to wait. Unless the world acts urgently, antimicrobial resistance will have disastrous impact within a generation.

- Drug-resistant diseases already cause at least 700,000 deaths globally a year, including 230,000 deaths from multidrug-resistant tuberculosis, a figure that could increase to 10 million deaths globally per year by 2050 under the most alarming scenario if no action is taken. Around 2.4 million people could die in high-income countries between 2015 and 2050 without a sustained effort to contain antimicrobial resistance.

MALAYSIA

GENERAL

Malaysia To Face 87,000 Deaths Due To Antimicrobial Resistance By 2030 Without Intervention -- Dzulkefly

🕒 19/11/2024 06:30 PM



KUALA LUMPUR, Nov 19 (Bernama) -- Malaysia will witness a projected 87,000 deaths from 2020 to 2030 if there is no intervention to combat Antimicrobial Resistance (AMR), said Health Minister Datuk Seri Dr Dzulkefly Ahmad.

AMR Journey in Malaysia

myohar.moh.gov.my/human-health/

Malaysian Action Plan on Antimicrobial Resistance (MyAP-AMR) 2022-2026
Ministry of Health Malaysia
Ministry of Agriculture and Food Security

1952

2022

1998

2001

2003

2008

2009

2014

2015/2016

2017

2017 - 2021

2021

Establishment of National Surveillance of Antibiotic Resistance (NSAR)- IMR

Formation of National Infection and Antibiotic Control Programme

Establishment of HA- MDRO Surveillance Programme
Policies and Procedures on Infection Control 1st Edition

National Antibiotic Guideline 1st Edition
Annual Scientific Meeting on AMR (ASMAR)

Akta Makanan Haiwan 2009

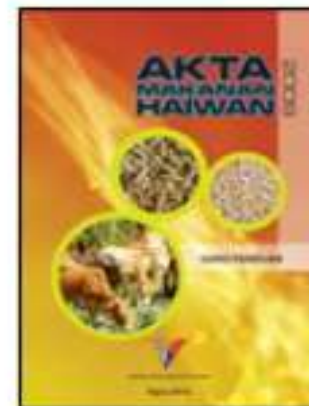
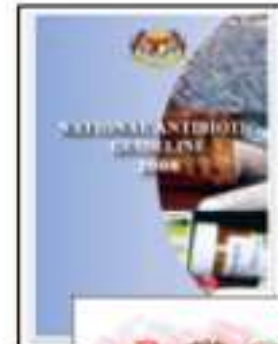
Development of AMS Protocol for Healthcare Settings

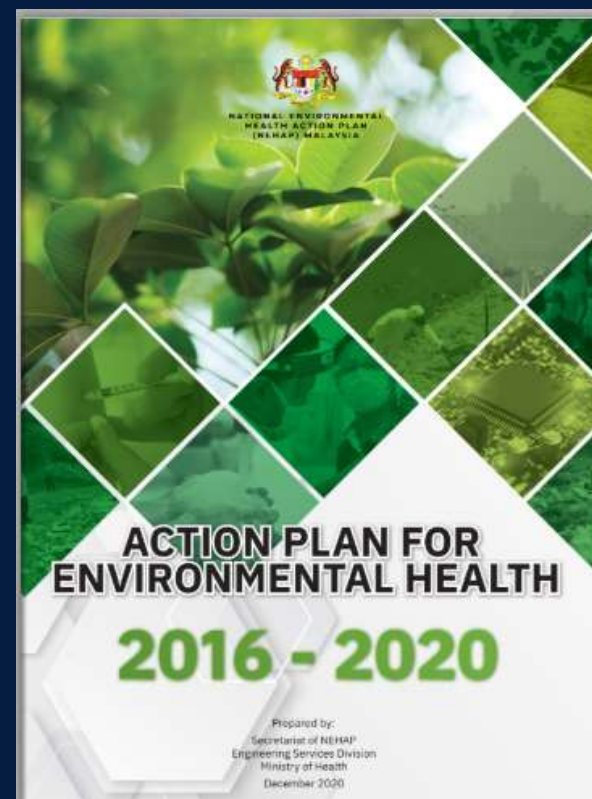
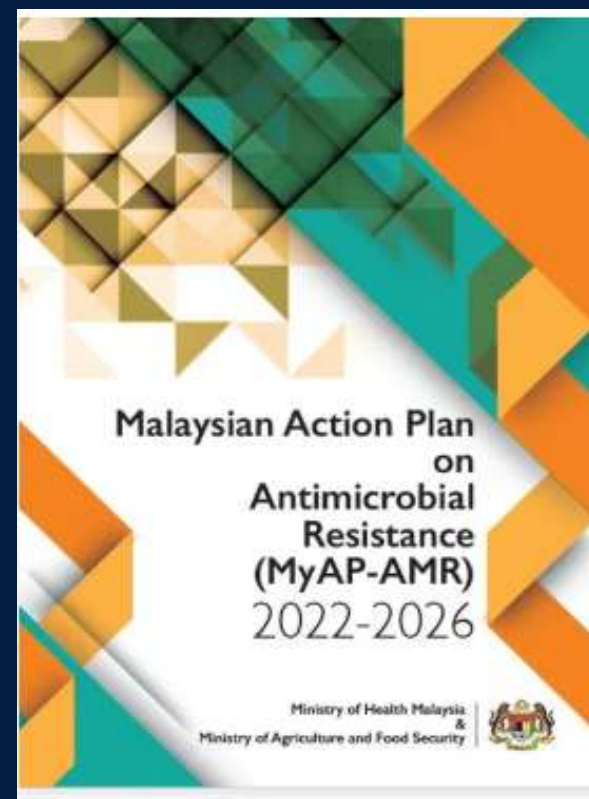
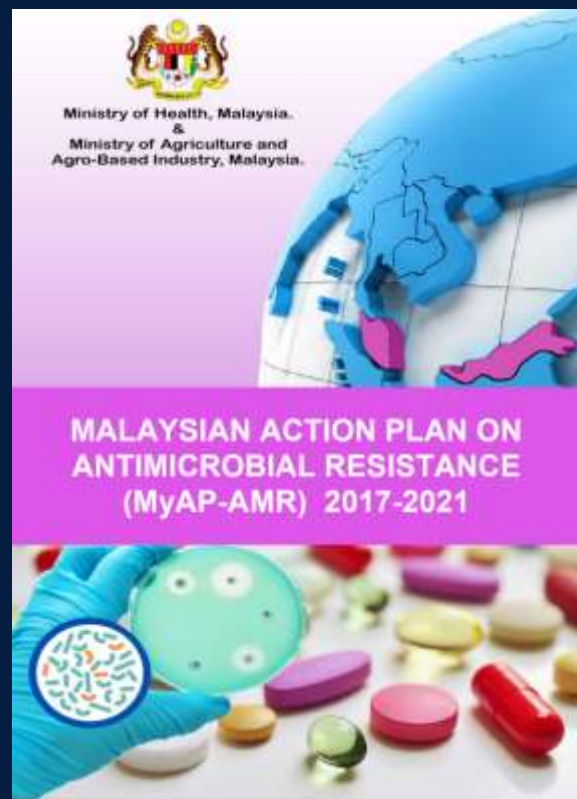
2015: 68th WHA endorsed Global Action Plan on AMR
2016: Malaysia started the discussion on the NAP

Development of Malaysian Action Plan on AMR (MyAP-AMR) 2017-2021
Establishment of NARC and 4 TWGs

Implementation of strategies and activities in MyAP-AMR

Development of NVAG 1st Edition
Review of MyAP-AMR 2017-2021 & Preparation of MyAP-AMR 2022-2026





**How many people are aware and really know
about the pollution of pharmaceutical and
personal care products?**



SURVEY ON PUBLIC AWARENESS AND PERCEPTION

Suspect Screening in Mussels Cultured in Straits of Tebrau Leading to Public Perception and Awareness Survey on Pharmaceuticals and Personal Care Products (PPCPs)

Published as part of ACS ES&T Water special issue "Navigating Challenges and Charting Solutions of Water Issues in South East Asia".

Zhi Yuan Yong, Yen San Chong, Muhammad Arif Haikal Mohamad Hanafi, Mohd Firdaus Abdul Wahab, Hooi Ling Lee, Mohd Bakri Bakar, Zaiton Abdul Majid, Norazah Basar, Sheela Chandren, Hasrinah Hasbullah, Mohd Hafiz Dzarfan Othman, Wei Yee Chan, Siti Nur Tahirah Jaafar, and Ee Ling Yong[†]

Cite This: ACS EST Water 2024, 4, 4099–4109

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ABSTRACT: The presence of multidrug-resistant bacteria in Malaysian waters and farmed aquatic species in its estuarine environment suggests contamination due to pharmaceuticals and personal care products (PPCPs). However, this issue has lacked serious attention. This study performed suspect screening to identify tentative PPCPs in water and mussels located at the Melayu River during high and low tides, followed by a public awareness survey to understand the public behavior toward handling PPCPs. In total, 75 PPCPs were tentatively identified. Four and six compounds were found in surface water during low and high tides, respectively, while mussel samples showed 50 compounds during low tide and 35 compounds during high tide. Interestingly, 7 pharmaceuticals and 4 personal care products appeared in both tides in mussel samples. Survey findings revealed that while respondents understood PPCP pathways entering the environment and associated threats, they were unaware of relevant laws and proper disposal methods for unused pharmaceuticals, which are often discarded together with domestic wastes. The findings highlight the urgent need for detailed suspect screening with targeted analysis in order to establish relevant regulatory measures apart from providing public education on the proper disposal of PPCPs to mitigate contamination.

KEYWORDS: pharmaceuticals and personal care products, suspect screening, mussels, public perception and awareness, disposal practices

1. INTRODUCTION

Occurrences and environmental effects of emerging contaminants, especially pharmaceuticals and personal care products (PPCPs), are no longer a foreign research topic.^{1–5} The persistency and bioaccumulative characteristics of PPCPs as well as their concentrations in water matrices are already well-established.^{6–9} Nevertheless, the understanding of their presence in Southeast Asian countries is still fairly limited. A review conducted in year 2022 revealed that antibiotics and nonsteroidal anti-inflammatory drugs (NSAIDs) were the most frequently studied group.³ Great concerns have been raised regarding their potential adverse effects on the ecological safety and human health particularly on the development of multidrug-resistant bacteria in the environment.^{10–12} The ripple effect of the usage of PPCPs can substantially challenge risk assessors and regulators once they enter the environment, especially water bodies.¹³

PPCPs normally contaminate the aquatic environment via the discharge of municipal wastewater treatment plants (WWTPs).^{14,15} This is due to the fact that the current WWTP technology is still unable to achieve 100% removal of these contaminants.^{16,17} PPCPs can be detected in surface water at a concentration range from sub-ng L⁻¹ to µg L⁻¹ across the globe.^{18–22} Zooming into the studies related to PPCPs in the water aquatic environment within Malaysia for the past decade, only few could be found.^{15,23,24} Their

Received: April 30, 2024
Revised: August 5, 2024
Accepted: August 6, 2024
Published: August 14, 2024



TOTAL RESPONDENT
386 (54.4% female; 45.6% male)

AGE
21 to 35 years old (72%)

EDUCATIONAL BACKGROUND
Master (6.8%); Bachelor (74.4%);
Diploma (5.5%); < STPM (13.3%)

MARITAL STATUS
Single without kids (72.3%);
Married with kids (23.3%)

SURVEY ON PUBLIC AWARENESS AND PERCEPTION

Table 1. Percentage Distribution and Mean Score of Respondents' Perceived (a) PPCPs and (b) Sources of PPCPs (0 = Impossible; 1 = Very Unlikely; 2 = Unlikely; 3 = Maybe; 4 = Likely; 5 = Very Likely; 6 = Obviously)

(a)									
product category	percentage (%)							mean	SD
	0	1	2	3	4	5	6		
oral medication	1.0	5.2	10.6	32.6	24.1	19.4	7.0	3.60	1.30
topical medication	1.3	4.9	10.1	26.7	33.9	17.1	6.0	3.62	1.26
toiletries (e.g., shampoo, facial wash, shower gel, deodorant, sunscreen, cosmetics etc.)	0.8	2.1	4.7	11.7	27.2	38.6	15.0	4.38	1.20
detergent (e.g., laundry detergent, floor detergent, toilet detergent, etc.)	0.8	0.0	6.2	7.0	23.1	38.3	24.6	4.65	1.18
overall mean score								4.06	0.94
(b)									
sources of PPCPs	percentage (%)							mean	SD
	0	1	2	3	4	5	6		
residents at home	0.5	1.3	4.7	10.1	29.3	37.0	17.1	4.36	1.16
untreated domestic sewage	0.3	1.3	4.1	9.3	16.6	38.3	30.1	4.76	1.20
treated domestic sewage	1.0	5.4	13.0	22.3	24.1	22.5	11.7	3.77	1.43
hospital	0.5	0.8	5.4	19.9	29.5	31.6	12.2	4.21	1.16
industry	0	0.3	1.0	6.7	14.0	33.2	44.8	5.15	0.99
treated industrial wastewater	1.8	2.8	7.8	19.2	23.6	23.9	21.0	4.15	1.45
overall mean score								4.41	0.81

SURVEY ON PUBLIC AWARENESS AND PERCEPTION

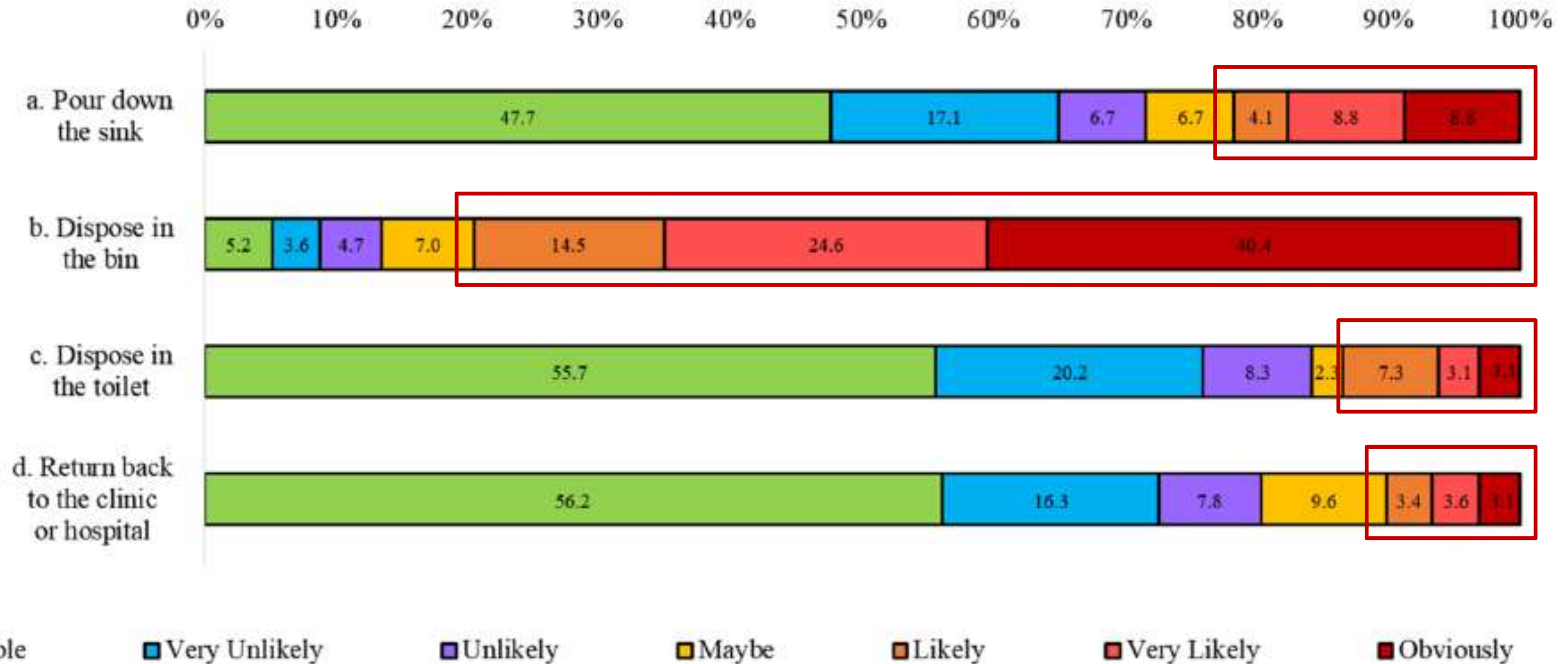
Table 2. Percentage Distribution and Mean Score of Respondent's Perceived (a) Effects of the Presence of PPCPs in the Environment and (b) Regulation of PPCPs^a

(a)										
effects	percentage (%)							mean	SD	
	0	1	2	3	4	5	6			
enter food source	1.0	1.3	5.2	21.2	26.7	26.7	17.9	4.23	1.28	
enter drinking water	1.3	3.1	8.3	19.7	24.1	25.4	18.1	4.11	1.41	
negatively affect aquatic animals if left unattended?		0.3	4.7	10.4	18.1	26.2	40.4	4.87	1.20	
negatively affect humans if left unattended?	0.8	0.8	3.1	11.4	14.8	30.8	38.3	4.84	1.25	
overall mean score								4.51	0.85	
(b)										
regulation	percentage (%)							mean	SD	
	0	1	2	3	4	5	6			
PPCPs are regulated in the Environmental Quality Act	4.1	3.9	6.7	28.8	33.7	16.6	6.2	3.59	1.348	
overall mean score								3.59	0.851	

^a(0 = impossible; 1 = very unlikely; 2 = unlikely; 3 = maybe; 4 = likely; 5 = very likely; 6 = obviously).

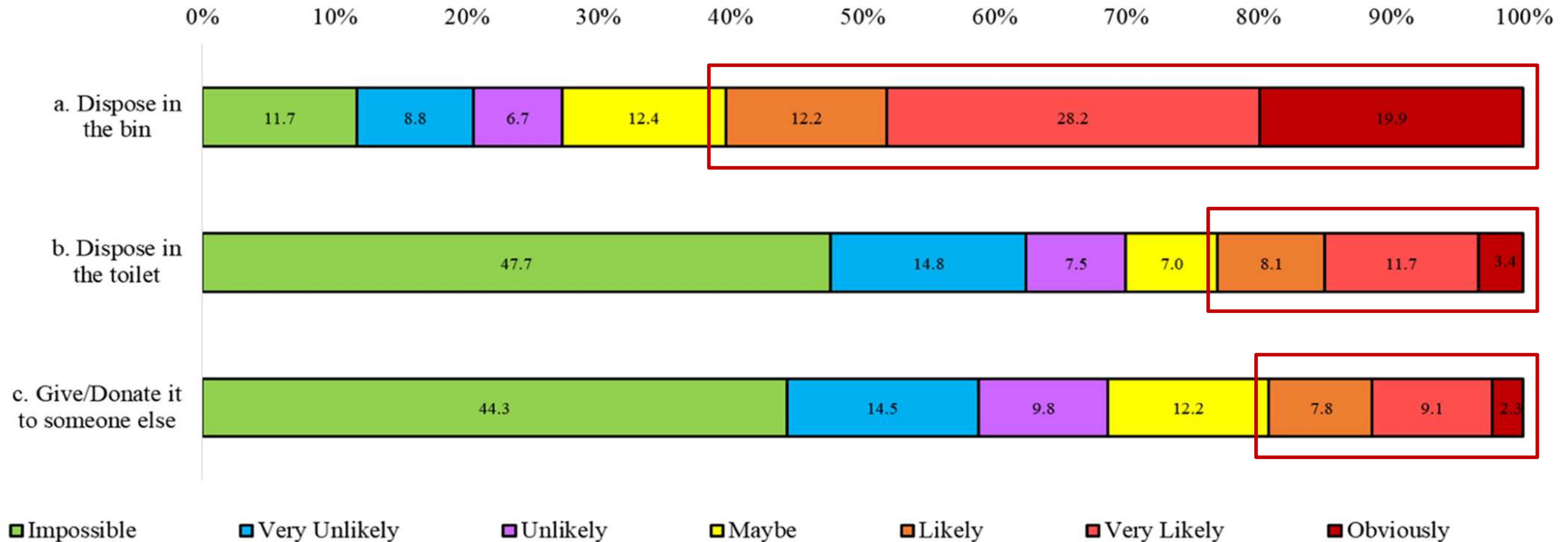
SURVEY ON PUBLIC AWARENESS AND PERCEPTION

Expired medicine disposal practice



SURVEY ON PUBLIC AWARENESS AND PERCEPTION

Leftover and/or unused toiletries disposal practice



<https://www.mymedisafe.org.my/>

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ACKNOWLEDGEMENT

- ACS Global Innovation Imperatives (Gii) • UTM Tier 1 Research University Grant •
- Muhammad Arif Haikal Muhammad Hanafi • Saffatul Husna Ismail •

THANK YOU NOW, WHAT'S NEXT?

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