

# OysterLand

**OysterLand** is the place where the land meets the sea. It is a location where people, agriculture, and aquatic animals mix. It is also a place where bacteria are exchanged between land and sea and everything in between. Join SPARE-SEA in looking at how antibiotic use influences the inhabitants of OysterLand.

## Antibiotics

The production by microorganisms of antibiotics is a common occurrence and they are produced by microorganisms for use against other microorganisms - other than viruses and protozoa. The first antibiotic was discovered by Alexander Fleming after some bacterial cultures were accidentally contaminated by some mold from the genus *Penicillium*. He named the active compound penicillin. In 1939 scientists from Oxford University saw a need to develop penicillin for the soldiers that would get sick during WWII. They demonstrated the effectiveness of penicillin for treating infectious disease in humans and with collaboration with the U.S. Department of Agriculture developed processes for large scale production by 1945. Treatment of infectious diseases was greatly reduced after this discovery. Today many hundreds of tonnes of antibiotics are used annually as preventive treatments in agriculture and much of this passes to the environment. Preventive use can avoid some infections but also can kill non-pathogenic bacteria, even those that are beneficial. Residues that pass to environmental settings promote bacteria to become resistant to such compounds, creating a future where antibiotic use will be futile. Probiotics added to food will be one way to reduce the use of antibiotics and could also be effective against a wider variety of pathogens like viruses and parasites.

### WHAT are antibiotic resistance genes?

Antibiotic resistance genes (**ARGs**) are DNA sequences that provide protection from the lethal effects that antibiotics have on bacteria. Bacteria that survive an antibiotic treatment can reproduce and move into the environment to spread these genes to later generations of the same species, or to other species inhabiting the same environment. These DNA sequences can move among bacterial cells as fragments of the bacterial genome called "plasmids", and even be passed to other bacterial species generating new antibiotic resistant bacteria (**ARBs**). In this way, bacterial ARGs genes can accumulate in the environment.

### HOW abundant are ARGs in nature?

The Comprehensive Antibiotic Resistance Database (CARD) lists ~5000 different ARG sequences. These genes represent variants of normal genes with other functions that are targets of antibiotic activity. This natural genetic variation can be of benefit in avoiding the actions of some antibiotics. For every antibiotic there are many different antibiotic resistance genes that can have different mechanisms of action. However, we increase the abundance of ARGs through the misuse and overuse of antibiotics. In addition to ARGs, there are genes that benefit bacterial survival when they are exposed to harmful toxic chemicals and heavy metals. These environmental threats originating from human activities are what drives the spread of antibiotic resistance. The ARBs, and additional antibiotic residue in treated and untreated waste water or sewage effluent, eventually enters the sea where it can influence the bacteria that live among cultured oysters. ARGs can move from the land to the sea in storm and waste water, and also over large distance once they enter the sea. Other animals can be potentially transporting ARBs (and antibiotic residue) over longer distances as they move along the coastline (eg.- seagulls, and fish).

### WHY are ARGs a cause of concern?

- ARGs are abundant and widely distributed in nature.
- Bacteria are capable of sharing genes in a variety of complex ways.
- Bacteria that are harmless can acquire ARGs and become dangerous for humans, animals, and plants. So protecting the environment means you are protecting yourself.

### YOU can help reduce the impact of ARGs and ARBs!

- Antibiotics should not be confused with antiseptics, which can target small pathogens other than bacteria.
- Antibiotics are meant for treating bacterial infections *only*. Antibiotics should not be taken when you have a viral infection, for example.
- Use any prescribed antibiotics until the prescription is finished even if symptoms seem to be improving.
- Don't accept antibiotics for use unless prescribed by a doctor.
- Return any bottles or vials containing antibiotic residues to your pharmacy for proper disposal.

### Spread and Persistence of Antibiotic REsistances in Systems Exposed to oyster Aquaculture

Outcome from project **SPARE-SEA** will provide a better picture of what antibiotic resistance genes exist in the aquatic environments where oysters are cultured, how they may have arrived in this habitat, what the "drivers" are that increase their presence, and what risk this may pose to the environment, including humans – in short it is a **One Health** approach that puts the health of animals and humans, and the environment, into the same level of scrutiny. Oysters are the focus of the project in part because these are animals that are eaten uncooked, which supports the transmission of live bacteria - and the watery medium of growth assists transfer of bacteria. The SPARE-SEA project is composed of four workpackages (WPs) that will combine experimental, microbiological and genetic analyses of samples from different environmental sites linked to oyster culture as well as other shellfish found in proximity to oyster growing sites.



**1** The first antibiotic isolated from a natural source was ....

- a) penicillin.
- b) streptomycin.
- c) chlorine.
- d) soap.

**2** The very first commercial antibiotic was discovered by...

- a) Alexander The Great
- b) Alexander Fleming
- c) Alexander Graham Bell

**3** ARGs are ...

- a) Anti Reflective Goggles
- b) Auto Reverse Gears
- c) Australian Road Guides
- d) Antibiotic Resistance Genes

**4** Alexander Fleming isolated penicillin from an infected rabbit.

- a) True
- b) False

**5** Probiotics can be added to food formulas to help prevent diseases caused by ...

- a) viruses
- b) bacteria
- c) parasites
- d) All the above

**6** "ARB" is an acronym that means ...

- a) African Rabbit Bate.
- b) Ancient Royal Bath.
- c) Antibiotic Resistant Bacteria.

**7** Penicillium is...

- a) a weed that grows in your garden.
- b) a spice added to food.
- c) a genus of mold.
- e) a new model of electric car.

**8** Some bacteria are not pathogens.

- a) True
- b) False

**9** ARGs can move long distances carried by...

- a) oysters
- b) mussels
- c) fish
- d) seabirds
- e) both c and d.

**10** ARGs are \_\_\_\_\_ and \_\_\_\_\_ in nature.

- a) black, white.
- b) hot, cold.
- c) abundant, widely distributed.

**11** The need for antibiotics was foreseen \_\_\_\_\_.

- a) in World War I
- b) Star Wars
- c) in World War II

**12** The CARD database has ...

- a) ~500 ARGs listed.
- b) ~4500 ARGs listed.
- c) ~5000 ARBs listed.
- d) ~5000 ARGs listed.

**13** Antibiotic resistance genes are of concern because bacteria can....

- a) wear their genes
- b) wash their jeans
- c) share their genes.
- d) all of the above

**14** Increases in ARGs are largely due to increase in the use and misuse of...

- a) plasmids.
- b) antibiotics.
- c) bacteria.

**15** The discovery of antibiotics greatly reduced the \_\_\_\_\_ of infectious diseases.

- a) location
- b) occurrence
- c) reporting

**16** Antibiotics and antiseptics are the same thing and should be used for all types of infections.

- a) True.
- b) False.

**17** For every antibiotic there exists \_\_\_\_\_ ARG.

- a) a single
- b) many different
- c) two classes of
- d) not many

**18** Oysters are frequently eaten \_\_\_\_\_, which is part of the reason that project SPARE-SEA will focus on the oyster habitat.

- a) on the half shell
- b) in expensive restaurants
- c) uncooked
- d) accompanied by a good wine

**19** Important considerations contributing to the spread of ARGs are ...

- a) antibiotic use as preventive medicine.
- b) the prescription by doctors of antibiotics when there is no bacterial disease diagnosis.
- c) the transfer of ARGs among bacteria in the environment.
- d) All of the above.

**20** The study of the health of animals, humans, and the environment is called ....

- a) money well-spent.
- b) love of science.
- c) One Health.
- d) irrelevant.

**21** Antibiotic Resistance Genes are part of the existing normal genetic variation of bacteria.

- a) True.
- b) False.

**22** Heavy metals and toxic chemicals spilled into the environment can \_\_\_\_\_ the spread of ARGs.

- a) reduce
- b) enhance
- c) decrease
- d) eliminate

**23** Plasmids are a separate part of the bacterial genome.

- a) True
- b) False

**24** Adding probiotics to fish food is a good way to reduce ...

- a) high cholesterol.
- b) the need for antibiotics.
- c) infectious diseases.
- d) both b and c.

**25** Understanding the factors that act as "drivers" of the spread of ARGs will \_\_\_\_\_ management of proper antibiotic regulation.

- a) divert attention from
- b) help improve
- c) prevent advanced
- d) eliminate

# OysterLand

Healthy Food for  
a Healthy Planet

Let's play!



START

Oysters and aquatic animals get collected for study of ARGs



Genes sequenced for biological study



Fire in the lab!



Go back 3 steps.



Restrictions for agricultural use of antibiotics are approved.

Go forward 2 steps.

## How to play:

- The game can be played by 2-4 players.
- Cut out the characters.
- Each player must choose a character to bring to the finish line.
- To start, each player rolls the dice to know who goes first (highest scorer). The ones with the highest scores starts the game first.
- For each round, the player rolls the dice to know how many steps to take to go forward.
- If he lands on an empty space, he should answer a question from the *OysterLand Quiz*. If he gets it right, he stays in place. If the answer is wrong, he moves back to his initial position.
- If the space has an instruction, the player must follow the action.
- If he lands again on blank space, there is no need to answer a question.
- The game ends when a player lands on the finish line.



New bacterial pathogens identified as antibiotic resistant!

Go back 3 steps.

Probiotic diets reduce antibiotic use.



Larval feed tests are favorable!

Go forward 2 steps.

ARGs identified. Better antibiotic use promoted.

Go forward 2 steps.

New plasmid variants identified.



Rainstorm causes overflow of sewage effluent!

Go back 3 steps.



Wastewater treatment facility installed



Public protests against restrictions for antibiotic use!

Go back 3 steps.



Improved management of antibiotic use reduces infectious diseases!

Go forward 2 steps.



Health & Environmental Risk Plan submitted for approval.



FINISH



Hooray!



Healthier Food for EU market.



Farmers gain improved animal health with better disease management and less antibiotic use.

Stay in place.

Modified from Illustrations by Stephanie Bravo-Semilla



Funded by the Horizon 2020 Framework Programme of the European Union

Oyster



Trout



Mussel



Bacteria

