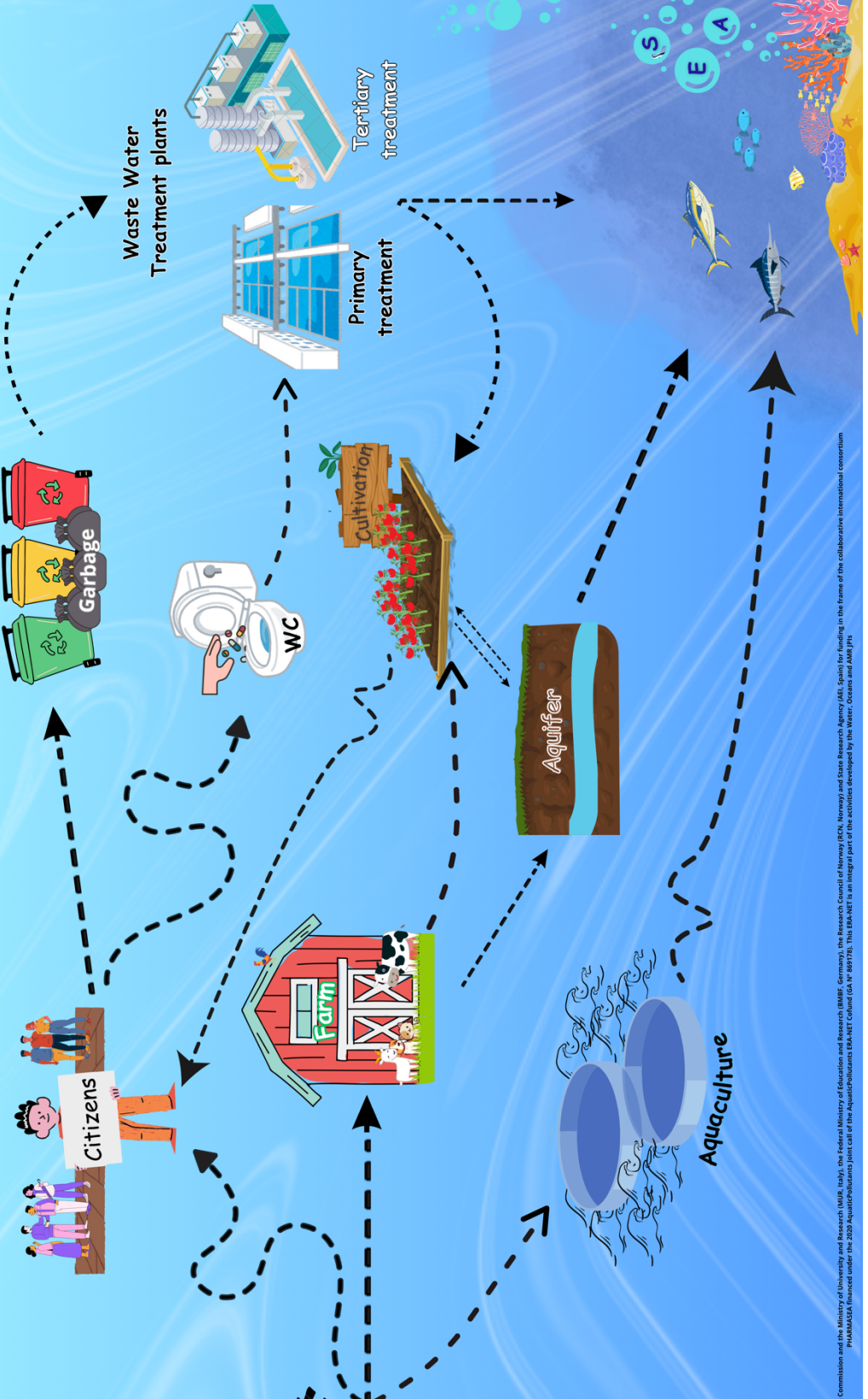


The Pharma's Adventure

THE PHARMA'S ADVENTURE



STARF

SCAN ME!



The authors would like to thank the European Commission and the Ministry of University and Research (MUR, Italy), the Federal Ministry of Education and Research (BMBF, Germany), the Research Council of Norway (RCN, Norway) and State Research Agency (AEI, Spain) for funding in the frame of this collaborative international consortium PHARMASEA financed under the 2020 AquaticPollutants joint call of the AquaticPollutants ERA-NET Colour (GA N° 893778). This ERA-NET is an integral part of the activities developed by the Water, Oceans and AOM JPI.

THE PHARMA'S ADVENTURE

An interactive journey to discover the environmental impact of pharmaceutical compounds.

Objective of the Game

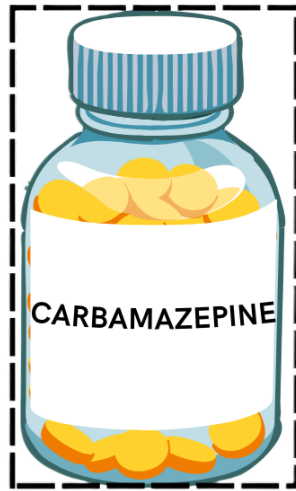
The goal of "THE PHARMA'S ADVENTURE" is to explore the journey that pharmaceutical compounds take after their use, eventually reaching the marine environment, understanding their role as emerging environmental contaminants. Players will learn how drugs can become pollutants and how to adopt good practices to reduce their environmental footprint.

Three game pieces, representing different pharmaceutical active principles (for human, veterinary, and aquaculture use*), will be provided.

These pieces must be placed by the players on the "Start" square of the game board.

Each active principle will follow a different path until it reaches the "sea" square.

An expert, guiding the player step-by-step through the journey, will help the player to choose the correct direction at each stop, providing scientific explanations that help a better understand of drug life cycle. Additionally, throughout the game, information will be provided about good practices to adopt or bad habits to correct for reducing the environmental impact caused by pharmaceuticals.



***PHARMACEUTICAL ACTIVE PRINCIPLES**

- 1) **Carbamazepine:** Carbamazepine is an anticonvulsant drug primarily used in human therapy to treat epilepsy, bipolar disorder, and neuropathic pain. It helps to prevent and control seizures, stabilizes mood, and reduces nerve pain by regulating electrical activity in the brain.
- 2) **Amoxicillin:** Amoxicillin is a broad-spectrum antibiotic commonly used in humans to treat infections such as respiratory, urinary, and skin infections. In aquaculture, it is used to prevent and treat bacterial diseases in fish, helping to maintain healthy stock and reduce losses due to infections.
- 3) **Fipronil:** Fipronil is an insecticide commonly used in veterinary medicine to treat fleas, ticks, and mites in pets like dogs and cats. In aquaculture, it is used to control parasites in fish farms, ensuring healthier aquatic species and reducing the spread of disease among stock.

Game Resolution – Pharma’s route

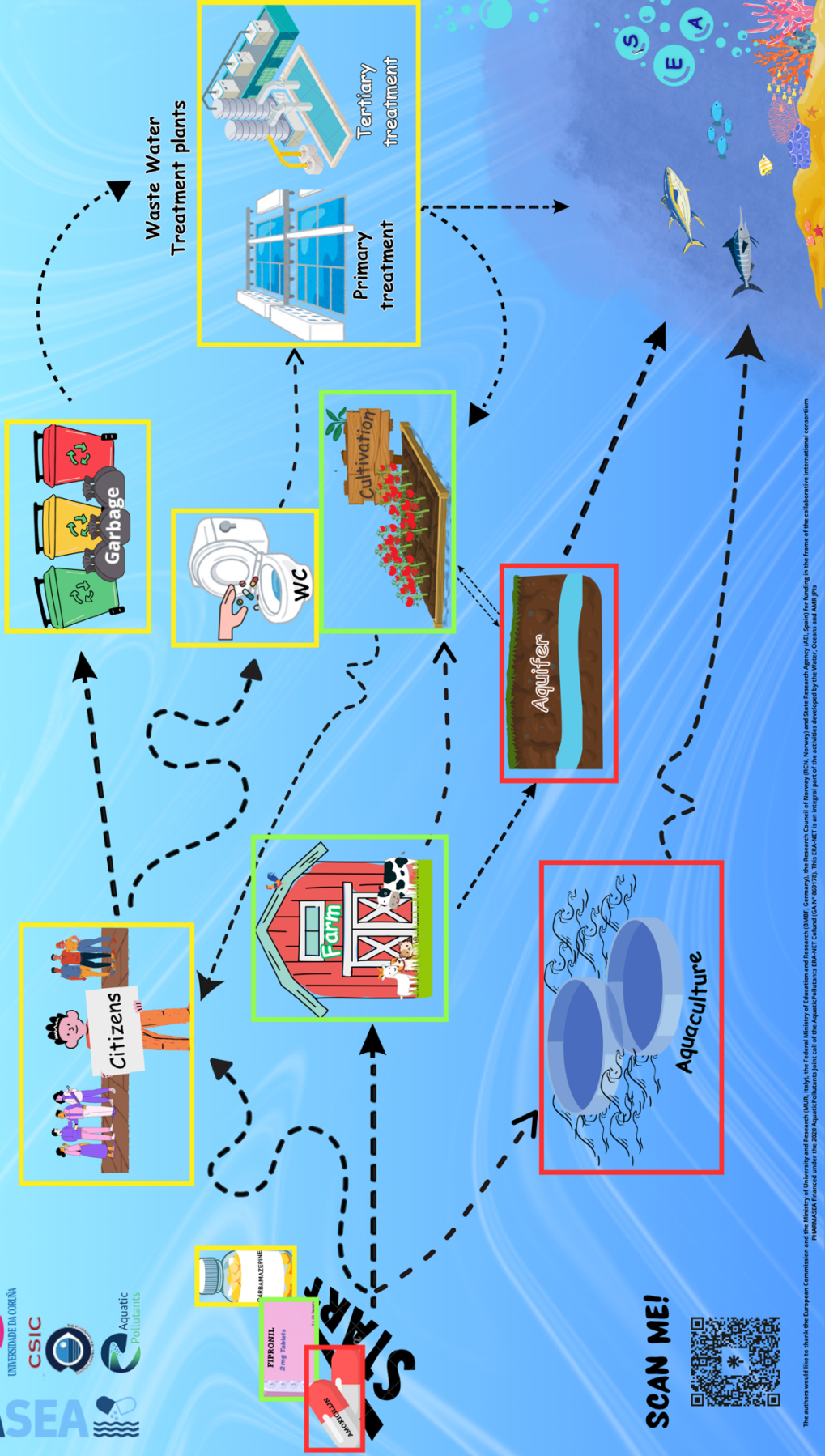
Actually, each drug can follow multiple pathways to the sea, but for an easier game-flow, also avoiding creating confusion to the players, only one route has been assumed as the right one. However, at the end of the game, the expert will provide the comprehensive overview by explaining all the alternative ways from users to the environment.

In the next page, edge images highlighted with the same color, suggest the correct path for each drug.

THE PHARMA'S ADVENTURE



PHARMASEA



SCAN ME!



The authors would like to thank the European Commission and the Ministry of University and Research, MIUR, Italy, the Federal Ministry of Education and Research, BMBWF, Germany, the Research Council of Norway, RCN, Norway and State Research Agency (AEI, Spain) for funding in the frame of the collaborative international consortium PHARMASEA, financed under the 2020 Aquatic-Pollutants ERA-NET Call and the Aquatic-Pollutants ERA-NET Colvet (GA PY 897175). This ERA-NET is an integral part of the activities developed by the Water, Oceans and AMR JPI.

Carbamazepine

PATHWAY:

Start → Citizens → Garbage or WC → Waste Water Treatment plants → Cultivations / Sea

Carbamazepine is an antiepileptic drug; therefore it is a medication for human use. The pathways this drug can take if not correctly disposed of properly are two: a) disposed through **garbage**, b) or through the toilet (**wc**). The latter pathway can be taken either intentionally (inappropriate disposal) or "physiologically," through human urine/feces containing the active ingredient not fully metabolized. Both options (a and b) will lead carbamazepine to **wastewater treatment plants**. Depending on the type of plant selected (**primary** or **tertiary**), the drug will be more or less removed by the system. The treated water can then be used a) for irrigating crops (**cultivations**), thus returning to humans through the consumption of the harvest; or b) it can reach the **sea**, where carbamazepine interacts with marine ecosystems, including some species that are part of the human food chain.

Fipronil

PATHWAY

Start → Farm → Aquifer/ Cultivation → Waste Water Treatment plants → Cultivations / Sea

Fipronil is a parasitic drug used in both veterinary medicine and agriculture. For this game, the drug will be considered for its use in veterinary medicine (**farm**). Animal feces and urine released into the soil contain the active ingredient not fully metabolized, which can a) be transported through precipitation (leaching) to groundwater (**aquifer**), or b) reach crops when animal waste is used as fertilizer (**cultivation**). Both options (a and b) will lead fipronil to **wastewater treatment plants**. Depending on the type of plant selected (**primary** or **tertiary**), the drug will be more or less removed by the system. The treated water can then be used a) for irrigating crops, thus returning to humans through the consumption of the harvest; or b) it can reach the **sea**, where fipronil interacts with marine ecosystems, including some species that are part of the human food chain.

Amoxicillin

PATHWAY

Start → Aquaculture → Sea

Amoxicillin is an antibiotic that can be used by humans, in aquaculture, and by pets/livestock. Therefore, it could follow any of these three pathways. For this game, the drug is considered for its use in **aquaculture**. Once used in marine aquaculture facilities, amoxicillin can easily disperse into the surrounding marine environment, interacting with species that are part of the human food chain (including both farmed and **wild species**).