

CONTAGIOUS CANCERS THAT CAN SPREAD BETWEEN OCEAN ORGANISMS

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ARIA

AGE: 11



SIA

AGE: 10

Cancer is a disease that occurs when cells multiply uncontrollably. It can affect species on land or in water. Normally, cancer is not contagious; it only affects the organism in which it originates. However, recently, a new type of contagious cancer was found in some ocean animals. Contagious cancers have been discovered in clams, cockles, and mussels around the world. These cancer cells leave the body of the organism where they originated, survive in seawater, and then infect other individuals. In this article, we will tell you what makes contagious cancers different from normal cancers, the species in which contagious cancers have been detected, and the great importance of studying these rare cancers.

CANCER: UNCONTROLLED CELL DIVISION

Pretty much everyone has heard of a terrible disease called cancer. In humans, specific types of cancer can affect organs like the brain,

MUTATION

Any change in the genetic material of an organism, specifically a modification of its DNA sequence.

CONTAGIOUS

Something can be passed from one person to another, like a cold or a flu when you're close to someone who's sick.

BIVALVES

Aquatic organisms with bodies that are enclosed by two "valves", which are commonly known as shells. Examples include clams and mussels.

HAEMOLYMPH

Fluid that circulates within the bodies of some invertebrates such as insects, arachnids, and mollusks. Its function is similar to blood.

MITOSIS

The process by which a single cell divides into two cells, which involves replicating and splitting up the DNA.

DNA

Deoxyribonucleic acid, the molecule that contains the genetic information of cells.

lungs, or skin. The body's normal, healthy cells only divide as much as necessary, but cancer results from a massive, out-of-control multiplication of cells. Typically, cancers are caused by **mutations** in the genes that regulate normal cell division.

Cancer does not only affect humans—it can affect other animals and even plants. All living organisms have cells, so they can all develop cancer, whether they live on land or in water. In fact, many marine (ocean) species develop cancers, such as whales, dolphins, sea lions, walrus, turtles, fish, sponges, and corals. In this article, we focus on a peculiar type of cancer that affects shellfish species.

CONTAGIOUS CANCERS?

Most cancers are not **contagious**, meaning they cannot spread from one person to another like the flu or COVID-19 can. This means that, when a person with cancer dies, the cancer also dies. However, researchers have recently found some types of cancer that can survive even after the organism dies. A type of cancer discovered in certain shellfish called **bivalves** can spread between individuals and is thus known as a contagious cancer. In contagious cancers, cancer cells leave the affected individual, survive in seawater, and infect another individual. These cancers have been found in many bivalve species, including cockles, clams, and mussels.

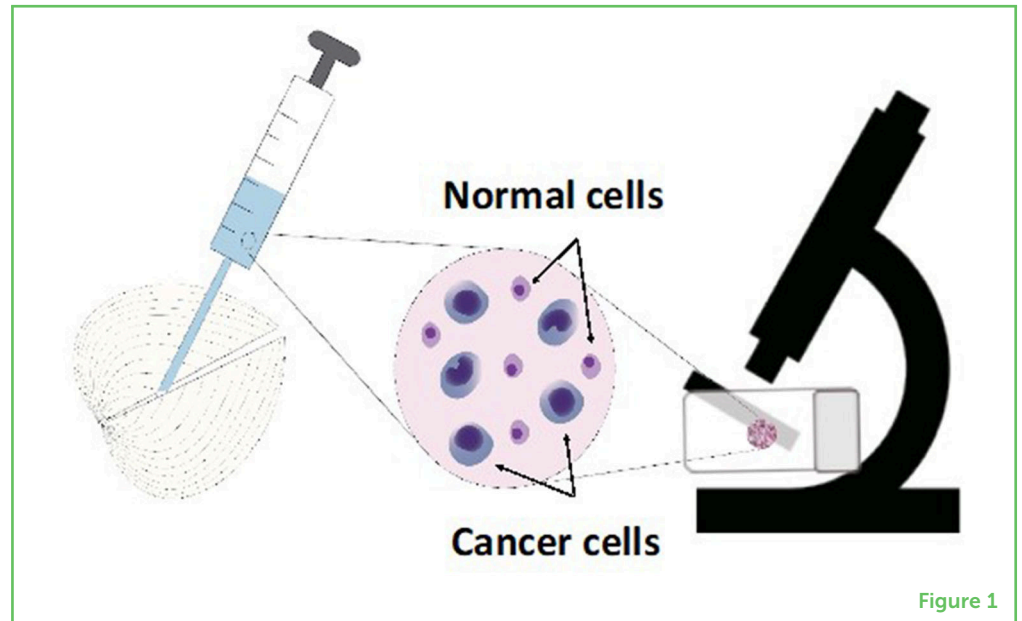
THE PECULIAR CASE OF CONTAGIOUS CANCER IN BIVALVES

The scientific term for contagious cancers affecting bivalves is disseminated neoplasia. "Neoplasia" means "new growth" and "disseminated" means that the cancer spreads through all organs. In bivalves, the cancer spreads through their **haemolymph**, which is their form of blood. Scientists can remove a drop of haemolymph using a syringe and observe it under a microscope. Cancer cells are easily identifiable because they are larger than healthy cells. Furthermore, as cancer is a disease in which cells divide uncontrollably, it is very common to find cancer cells in the midst of **mitosis** (Figure 1). The rapid division of cancer cells causes the bivalve's organs to deform, which prevents their proper functioning. For example, if the gills no longer have their normal structure, the bivalve will be unable to get oxygen from the water, which can ultimately lead to death.

DNA studies have been important in the discovery that these bivalve cancers are contagious. In an individual with a non-contagious cancer, the DNA of healthy cells is very similar to the DNA of cancer cells. However, in an individual with a contagious cancer, the DNA of cancer cells is quite different from the DNA of healthy cells because

Figure 1

Diagnosis diagram of bivalve cancer in the laboratory. Bivalves with cancer are diagnosed by observing a drop of the haemolymph under a microscope. Cancer cells are larger than healthy cells and are often in the process of mitosis.



those cancer cells originated in a different organism—the one that infected it.

WHICH BIVALVE SPECIES GET CONTAGIOUS CANCERS?

Several contagious cancers have been found in species of clams, cockles, and mussels all over the world (Figure 2). These shellfish live in coastal areas, so they can be easily caught when the tide goes out or by using small boats. The first contagious cancer in bivalves was diagnosed in softshell clams along the Atlantic coast of the United States and Canada [1, 2]. In Europe, contagious cancers have been found in clams from the Baltic Sea [3], and in common cockles from the Atlantic coast of Europe [1, 4]. Lastly, two mussel species found worldwide have also been found to be affected by contagious cancers. In fact, contagious cancers in mussels have been detected in locations that are very far from each other, such as the East and West coasts of the United States, Canada, Argentina, Peru, France, Russia, and Japan [5, 6].

SUPER-POWERFUL CONTAGIOUS CANCERS

On rare occasions, contagious cancers can spread to a different bivalve species. This is the case with two contagious cancers detected in clams off the Spanish coast. DNA studies of the contagious cancers detected in warty venus and golden venus clams revealed that these cancers originated in a different clam species [1, 7]. For example, a contagious cancer that originated in striped venus clams was found in warty venus clams (Figure 3). Although researchers have seen several cases of contagious cancers spreading to closely related species,

Figure 2

Species of bivalves that are known to be affected by contagious cancers.

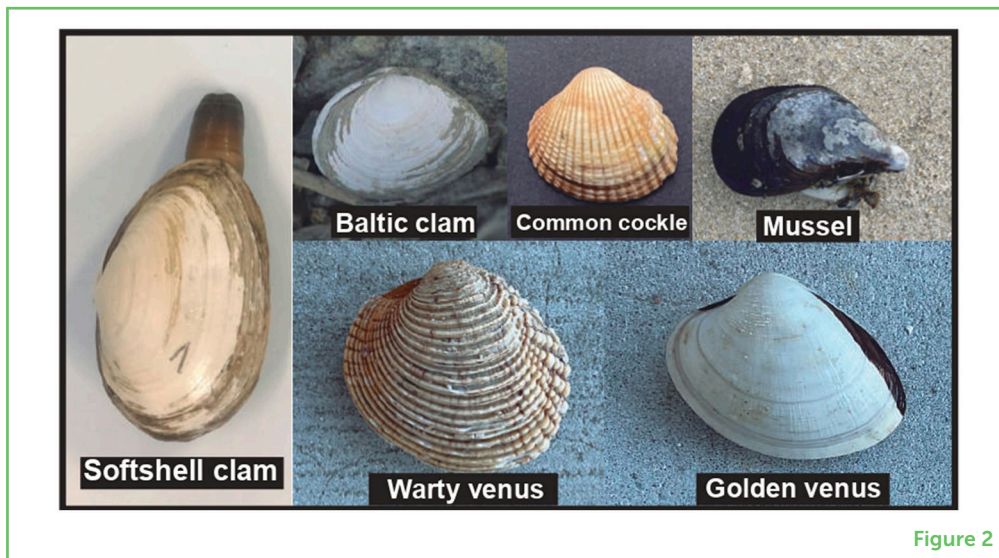


Figure 2

contagious cancers do not spread to all the bivalve species that are living close to the infected individuals.

Figure 3

(A) A contagious cancer arises in common cockles and spreads among the population of cockles (same species). (B) A contagious cancer arises in striped venus clams and spreads among warty venus clams (a different species). (C) Two contagious cancers arise in a mussel species and while one of them (orange) only infects the same species, the other cancer (pink) continues to spread in both that species and in other mussel species.

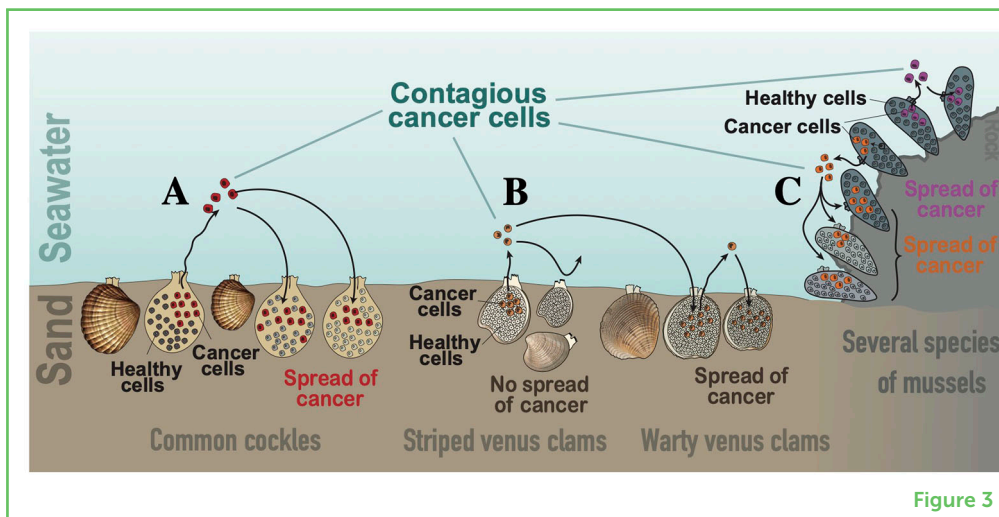


Figure 3

CAN HUMANS GET CANCER FROM EATING SHELLFISH?

Contagious cancers in bivalves are highly specific to those organisms and have only been found to infect closely related species. Not all bivalves living near affected individuals become infected [8]. Thus, it is unlikely that humans could ever become infected with cancer from eating shellfish. When we eat bivalves, our bodies break down the food to extract nutrients and energy—and a contagious cancer cell from a bivalve could not survive that process. Even if a contagious cancer cell could enter the human body, humans have an effective immune system that can defend against many diseases. In a nutshell, it is extremely unlikely that humans could become infected with cancer from shellfish.

WHY ARE MARINE CONTAGIOUS CANCERS IMPORTANT TO STUDY?

Studying marine contagious cancers is important for three main reasons. First, bivalve cancers can be fatal for the affected organisms because cancer cells reach all their organs, preventing them from carrying out their normal functions. Second, contagious cancers have revolutionized our understanding of cancer in marine organisms. We now know that each individual with cancer poses a threat to all healthy individuals, as they can release cancer cells that can survive in the marine environment for days, waiting to infect another organism. In other words, these cancers behave like infectious diseases, such as the flu or COVID-19. Third, understanding why contagious cancers affect many bivalve species could help scientists to understand what makes a cell become cancerous in the first place.

IMPACTS ON BIODIVERSITY

The discovery of contagious cancers puts a new twist on understanding a disease that kills many people each year. Contagious cancers have also been found in species that live on land, including dogs and Tasmanian devils. In the case of Tasmanian devils, contagious cancer is driving the species to extinction, decreasing Earth's **biodiversity**. However, the contagious cancer found in dogs does not kill the animals quickly, so the cancer can survive for years. Studies have found that this contagious dog cancer could be the oldest known cancer. Since it can remain alive after death of the original host, it has been able to survive for thousands of years [9].

In summary, we now know that, although it is rare, cancer can be contagious in some cases. Will we find more contagious cancers in nature? This is a question that researchers will try hard to answer in the years ahead.

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BIODIVERSITY

It refers to the rich variety of life on Earth, including different species of plants, animals, and living things in a place.

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YOUNG REVIEWERS



ARIA, AGE: 11

Aria loves playing with her two guinea pigs and feeding birds and squirrels in her backyard. She gave each squirrel a unique name and lots of peanuts. Aria is always curious about science, and she has a lot of questions about nature, animals, and the universe. She also likes singing and drawing in her spare time.



SIA, AGE: 10

Sia is a vivacious student of class six. She is a good storyteller and wants to be an author among many other things! She loves to read and swim. She engages easily with her peers and seniors and is a very keen observer of her surroundings (a scientist in the making!!).

AUTHORS



ALICIA L. BRUZOS

Alicia L. Bruzos is a cancer researcher at a precision medicine laboratory in London. She has studied human cancers and marine contagious cancers since 2016. Her favorite part of working in science is doing different things every day: traveling to the beach to collect cockles or clams, doing experiments while wearing a fancy lab coat, analyzing data on a supercomputer, teaching genetics to college students and, when she has time, sketching figures. She had already visited as many countries as years old she is (25) and that is why, when she is not working, Alicia is traveling.



SEILA DIAZ

Seila Diaz studied marine science in Vigo (Spain) and completed her doctorate at the University of Santiago de Compostela (Spain). She studies the diseases that affect shellfish, especially cancers. Nowadays she works at the University of Aveiro under a Marie Skłodowska-Curie contract. She loves to find herself in the thousand and one stories in adventure books. She practices marine sports, especially diving. Seila has managed to make her passion since she was a little girl—the sea—into the subject of her day-to-day work. *seila.diaz@ua.pt