



ARE ZEBRAFISH AFFECTED BY TINY PLASTICS IN OUR ENVIRONMENT?

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YOUNG REVIEWERS:



AARAV
AGE: 11



MAYESHA
AGE: 14



SULIAMAN
AGE: 10

Zebrafish get their name from the black lines along their bodies. These fish have many similarities with humans and help scientists investigate diseases. Sometimes diseases can be linked to our environment. Since humans started using plastic materials in the last century, we have been filling our soil and water with plastic garbage. With time, plastics break down and become so tiny that they can enter the bodies of many animals, including us. Scientists added one type of these tiny nanoplastics, called polystyrene, into the water where zebrafish eggs were developing. Scientists found that nanoplastics could enter many zebrafish organs and cause the fish to swim differently. Nanoplastics even affected how zebrafish use their genes. Lessons learned from these experiments will help teach

people to use fewer plastic products, to be more careful with the way they use plastics, and to come together to find ways to reduce plastic waste.

EMBRYOS

The name for a baby fish when it is just starting to grow inside an egg. Embryos become little fish that hatch out of the egg, ready to swim.

GENES

Tiny instruction manuals inside every living thing. They are part of the DNA found within the cells of all living organisms.

Figure 1

(A) Adult zebrafish living in the laboratory. (B) Zebrafish lay eggs, which grow into embryos. (C) A 5-day-old embryo, with all its organs already developed.

WHAT ARE ZEBRAFISH?

Zebrafish (Figure 1) are super special animals because they help scientists learn about how our bodies work. They come from rivers in Asia but are now grown in laboratories all over the world. As you can imagine, they got their name because they have black lines along their bodies, like zebras! But when they are babies (also called **embryos**) their bodies are transparent so you can see right through them, like having x-ray vision. Scientists also love to work with zebrafish because they grow quickly, and they lay hundreds of eggs that can be used for experiments. Zebrafish are like us in many ways because they have many of the same **genes** and organs that we do. So, when we study how zebrafish get sick, we can learn about human diseases, too [1].

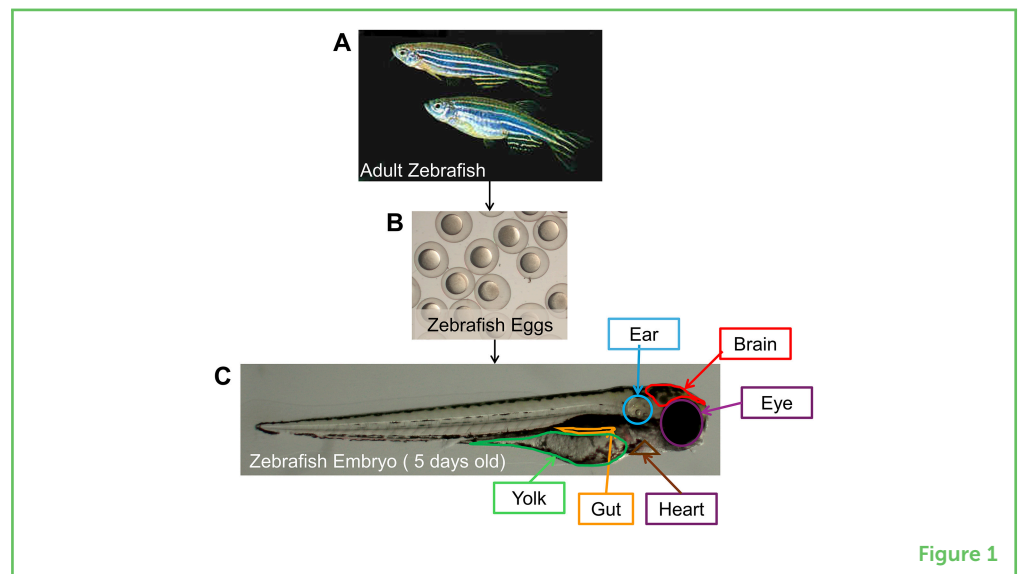


Figure 1

OUR ENVIRONMENT—THEIR ENVIRONMENT

The environment is everything around us. It is the land we walk on, the air we breathe, the water we drink, and all the animals and plants that live on Earth. We are always connected to our environments—in our houses, at school, at the playground, or on the beaches or in the forests we sometimes visit. But sometimes things in the environment are so tiny that we cannot see them. For example, the bacteria in the soil or the tiny sand particles floating in the air or the ocean. For zebrafish, their environment is the water they live in. In nature,

zebrafish live in rivers, but in the laboratory, they live in special water tanks. Scientists take good care of zebrafish and make sure their environment is always safe and clean.

Sometimes our environment can become dirty. Imagine that you go to your favorite playground, and someone has left a lot of trash lying around. Everything is filthy with cans, candy wrappers, empty plastic bottles, and even old clothes and toys. Children would not want to play in that playground anymore. Well, sometimes people do that to our environment—to our rivers, beaches, forests, and air. This is called pollution, and it makes our environment dirty and unhealthy [2]. Pollution can come from traffic and factories that make cars, toys, or computers, but sometimes it comes from people throwing garbage where it does not belong, like into a lake, river, or the ocean.

NANOPLASTICS

Plastics are not made by nature. They are materials made from oil that humans invented in the middle of the 20th century. Since then, we have used plastics for everything. Plastic is the material most of your toys are made of. Bottles of water and many grocery bags are made of plastic, too. Nowadays, even some clothes are made of plastic threads! When people throw away things made of plastic, they do not break down in the environment like autumn leaves that disappear after a few months. Plastic things never disappear, they just become smaller and smaller until they are so tiny that we cannot see them anymore, even with a microscope (Figure 2)! These tiny bits of plastic are called **microplastics**. But it does not stop there. Microplastics can be further broken down into particles called **nanoplastics**—“nano” means really, really small [3]. Nanoplastics are smaller than bacteria and may even be smaller than viruses. Scientists have discovered that nanoplastics are everywhere on Earth, in the soil, in the air, in the water of our rivers and oceans, and even in the tap water that we drink! They come from all our plastic garbage that is not properly thrown away or recycled and ends up in the environment.

ARE NANOPLASTICS DANGEROUS FOR ZEBRAFISH?

Nanoplastics can be in the water where zebrafish live. Animals and people could breathe air, drink water, or eat food that is contaminated with these tiny nanoplastics [4]. That is why it is important to find out if nanoplastics can be dangerous to zebrafish or people and if they can make animals sick. Scientists have designed experiments to find out if nanoplastics can harm zebrafish. We do this by adding a specific type of nanoplastics, called **polystyrene** (made in a laboratory) to the water where zebrafish eggs are growing (Figure 3). These

MICROPLASTICS

Tiny pieces of plastic, smaller than a grain of rice, that can come from broken-down plastic trash.

NANOPLASTICS

Super tiny pieces of plastic that are so small you can not see them, even with a regular microscope.

POLYSTYRENE

A type of plastic that is widely used in many consumer products such as styrofoam, food packaging, lids, bottles, and disposable cutlery.

Figure 2

Particle size comparison. A human hair is around 100 micrometers (μm) in diameter. Nanoplastics are between 100 and 100,000 times smaller than a human hair. They have a size between 1 and 1,000 nanometers (nm).

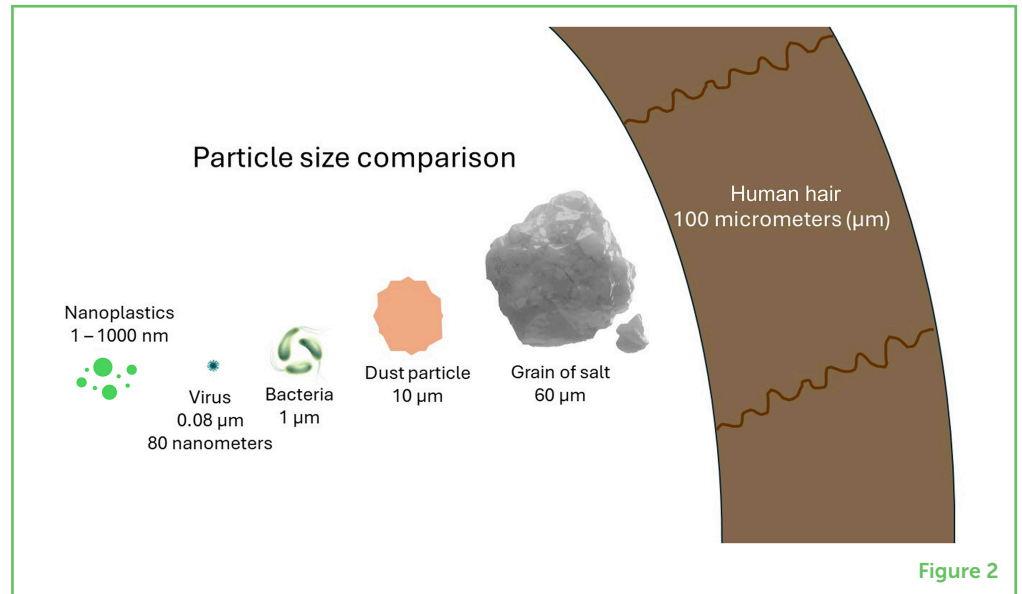


Figure 2

nanoplastics are dyed with a green color so scientists can see them under a microscope.

Figure 3

(A) Zebrafish eggs were exposed to green nanoplastics, (B) Scientists observed that the nanoplastics accumulated in many fish organs. (C) Nanoplastics increased the hyperactivity and anxiety of zebrafish and (D) changed the activity of genes that help make hormones.

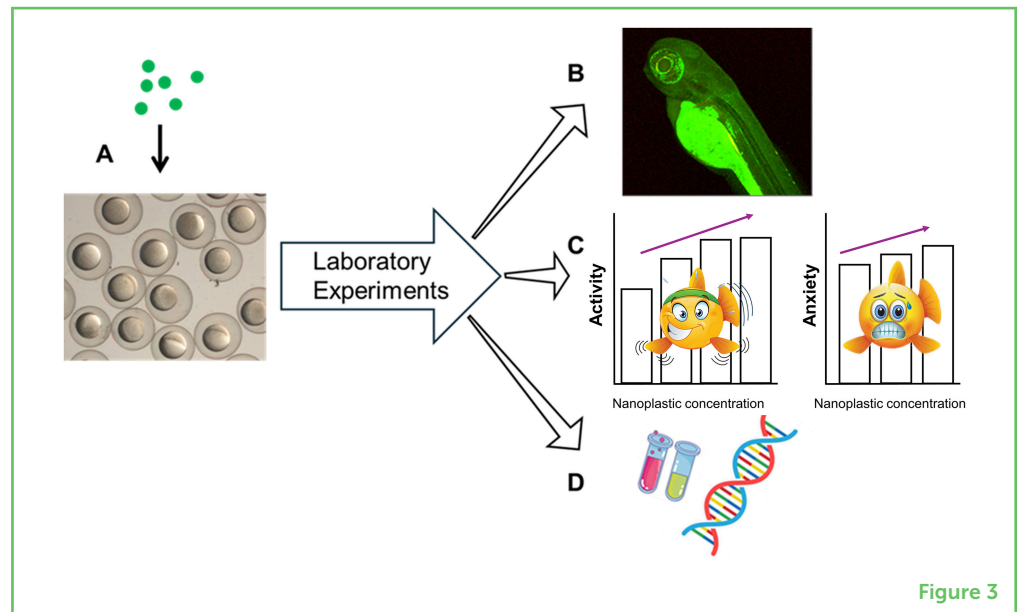


Figure 3

Scientists found that these nanoplastics can go inside the zebrafish and travel all over their bodies, even to their brains. Nanoplastics also cause the zebrafish's eyes and head to become a little bit smaller than normal. In the laboratory, with very powerful cameras, scientists can see and track how these baby zebrafish swim. Polystyrene nanoplastics caused zebrafish to swim faster, meaning they became hyperactive—they could not stop moving! Nanoplastics also made the zebrafish more nervous, and they preferred to stay close to the walls,

HORMONES

Special chemicals made by your body that work as messengers to help it work properly. They tell our bodies how to grow, feel, and do things like sleep and eat.

to feel safer, instead of swimming freely around the space available to them. This means that zebrafish were more fearful or anxious.

Scientists also measured if nanoplastics caused problems in the zebrafish's genes. Genes are the instructions to make the body of the zebrafish. They are part of the DNA found inside the cells of all living things. Some genes can be activated (turned on) or not depending on the normal function of the specific cells. Some zebrafish genes are similar to human genes. In particular, scientists looked at genes that affect **hormones**, which are similar in humans and in zebrafish. Hormones are messengers that travel through the body and help cells and organs communicate. They are very important for growth, reproduction, and almost all body functions. Scientists found that nanoplastics could change the activation of some of the genes that contain the instructions to make hormones. This is very important because it could mean that exposure to nanoplastics could make zebrafish and people sick.

LESSONS LEARNED

Zebrafish are of great importance to scientists who want to learn about how plastics, microplastics, and nanoplastics can be dangerous to people and to other animals [5]. Plastics are everywhere, but we can help the environment if we try to use less of them. For example, we can help by using cloth bags instead of plastic bags, or glass bottles instead of plastic bottles. We can also help the environment if we properly reuse and recycle plastic things. For example, we can try to reuse a plastic bottle to make a toy or an ornament instead of simply throwing it away. We can also help by throwing plastic garbage into the appropriate recycling containers and by picking up plastic garbage that we find on walks in a forest or on a beach. Together, we can help to make the environment safe, cleaner, and healthier!

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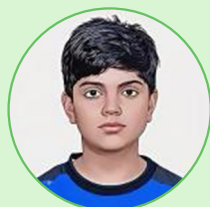
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YOUNG REVIEWERS

AARAV, AGE: 11

Hi, I am Aarav and I am 11 years old. I like playing games, watching TV, and reading. I also play with my friends in the park near my house.



**MAYESHA, AGE: 14**

Hi! I am Mayesha, and I am currently in 9th grade at 14 years old. I have a strong passion for exploring science, particularly in the field of biomedical sciences. My favorite subjects are math and science, and I am proud to say that I excel in both! I have one sister who is also dedicated to her studies, and we often motivate each other to do our best. When I am not studying, I love spending time outdoors, whether it is playing sports or simply enjoying nature. I also enjoy playing Roblox, where I can connect with friends and unleash my creativity. I am excited about the future and look forward to discovering more about science and technology!

**SULIAMAN, AGE: 10**

I like football, playing games, and reading. I also like to understand complex scientific ideas.

AUTHORS**MONICA TORRES-RUIZ**

Dr. Torres-Ruiz is a toxicologist. She works with other scientists at the National Center for Environmental Health in Spain. She did her Ph.D. at Fordham University (NY) studying the biology of invertebrate animals that live in rivers. This is why she now uses the zebrafish and other aquatic animals to study how toxic chemicals in the water can make the animals and people sick. Besides doing experiments in the lab, she is also passionate about communicating science to the public and especially to children. *mtorres@isciii.es

**ANTONIO DE LA VIEJA**

Dr. De la Vieja is a professor at the Instituto de Salud Carlos III in Spain. His research aims to discover how hormones work in the body, to find new treatments for diseases and to cure certain types of cancer. Dr. De la Vieja obtained his Ph.D. in biochemistry at the Universidad Autónoma de Madrid in Spain and has also conducted some of his research in the USA as a postdoc. He is fascinated by how life works and discovering the mysteries that help improve human health and the environment.

**PATRICIA IGLESIAS-HERNANDEZ**

I am a Ph.D. student at the Instituto de Salud Carlos III in Spain. My research focuses on studying various effects of chemicals present in the environment, such as nanoplastics. I want to know about their effects on human health, specifically examining how they could affect hormones. For my research, I am using zebrafish, mice, and cell cultures as models.

**MARÍA MUÑOZ-PALENCIA**

I am a biologist and a lab technician, and since I was a child, I always wanted to work in natural sciences. Over my years of experience, I have worked in many laboratories, helping scientists in their research and data analysis. I really enjoy learning new things and being like a detective, finding new clues to solve scientific problems.



ANA L. CAÑAS-PORTILLA

I am the director of the National Center for Environmental Health (CNSA) Spain, where we investigate the impact of the environment on our health, including pollutants, air quality, chemicals, and radiation. My research over the past 17 years has been focused on environmental toxicology, trying to determine the quantity of pollutants in people's bodies and to understand the relationship between pollutants and certain diseases.