

How are chemicals impacting our reproductive health?



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Abstract

You might have heard of a chemical called **BPA**. Maybe you have seen a “BPA Free” label on a reusable water bottle. But did you know that BPA is just one chemical that is part of a much larger group known as endocrine-disrupting chemicals, or EDCs? EDCs are everywhere. They are in most food packaging, cosmetics, shampoo, and even in antibacterial soap! But now scientists are starting to understand that these chemicals could be the cause of many health problems, including reproductive problems.

In this study we reviewed the scientific research looking at EDCs and reproduction in both fish and mammals. We

wanted to understand what the research said about how these chemicals impact reproductive systems. The studies we reviewed used laboratory animals to better understand reproduction in fish and mammals. What we found was quite worrying. There is lots of evidence to show that EDCs can cause changes in how the reproductive system develops and grows. There is also evidence that EDCs have long-term impacts including fertility problems and reduced reproductive success.

Introduction

The **endocrine system** regulates many functions throughout the body. It has three main parts: glands, hormones, and receptors. Glands produce the hormones, which then travel around the body in the blood. Once they reach the cell, they bind to hormone receptors. This controls different processes within the cells. So basically, they are like messengers that tell your body what to do. Hormones control many important functions, such as growth, sexual maturity, and sleep. **Endocrine disrupting chemicals, or EDCs, can interfere with this messaging system.** But how? EDCs have a similar chemical structure to hormones (Fig. 1). This means they can mimic hormones or block hormone receptors. That affects the way the endocrine system works.

EDCs are in many products, such as electronic equipment, building material, cosmetics, and food packaging. Scientists have found a link between the rise in their production and a worldwide increase in reproductive problems. **Exposure to EDCs can cause long-term and short-term effects.** For example, EDCs can affect how the reproductive system

grows during development. These changes can then cause long-term effects such as reducing **reproductive success.**

In this study we reviewed what scientists have learned about the impact of EDCs on reproduction. We focused on the key development stages in both fish and mammals and how EDCs impact them.

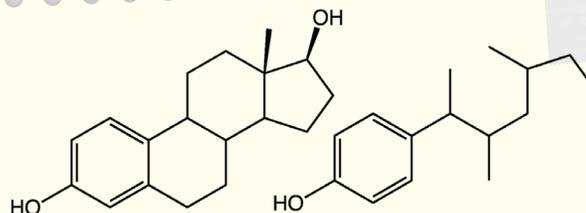


Figure 1:

A comparison of the structures of a natural reproductive hormone and a man-made EDC. On the left is estradiol (an estrogen hormone), and on the right is a nonylphenol (often found in detergents).

Methods

First of all, we decided which key development stages to focus on. In fish we focused on **sex ratio** regulation, gonad growth, and puberty. In mammals we focused on the development of male and female reproductive organs. We then looked for research that focused on the impact of EDCs on these key developmental processes. Finally, we reviewed those research papers to get an overall picture of the effects of EDCs on reproduction.

To help us look for trends in the data, we created a table that showed all the different impacts of EDCs on the key

development stages. **As we were reviewing the research, we tallied up how many times each impact appeared in the experiential research.** This allowed us to see which effects were most common.

Sex ratios in fish?

We might expect that when fish lay hundreds of eggs, the balance of male and female would be about 50/50. But actually, genetic and environmental factors (such as temperature, pH, and oxygen levels) can change the ratio. Some fish even change gender during their lifetime!

Results

The studies we looked at presented a lot of evidence about EDCs affecting reproduction (Table 1).

→ Fish

- EDCs impact the sex ratio of fish spawn. EDCs that mimic **estrogens** result in a higher number of females being born.
- EDCs reduced the size of testes and ovaries, lowered the sperm count, and reduced reproductive success. These impacts were short lived or permanent, depending on the chemical, the concentration, and the time and the length of exposure.
- EDCs also affected the timing of puberty. Some caused early puberty and others delayed puberty.

→ Mammals

- Several studies showed that EDCs can affect testosterone levels in male rats.
- Early exposure to EDCs can cause underdeveloped testes as adults. This is because male gonad development depends on testosterone.
- In humans, there are links between EDC concentration in the umbilical cord or breast milk and lower fertility in adult men.
- Female rats exposed to EDCs as fetuses had abnormal ovary growth.
- **There was also evidence that the effects of EDCs could impact multiple generations.** If young rats were exposed to EDCs, then their offspring also showed effects in their reproductive organs.

Table 1: How many times we found different impacts of early EDC exposure in fish and mammals.

FISH		MAMMALS - MALE		MAMMALS - FEMALE	
Sex ratio regulation		Testes development		Ovarian development	
Higher male ratio	4	Abnormal growth observed	23	Abnormal growth	13
Higher female ratio	1	No clear results	9	No clear results	0
More intersex fish	2	Testes growth		Transgenerational effects	2
No clear results	2	Lower sperm count	5	Ovarian growth	
Gonad growth		Lower testosterone levels	15	Lower fetus survival	2
Reduced testicular development	2	Smaller testes	3	Reduced fertility	2
Reduced ovary development	2	Larger testes	1	Smaller ovaries	3
Reduced spawn or fertility success	3			Delayed puberty	2
No clear results	5				
Puberty					
Delayed puberty	14				
Accelerated puberty	8				

Discussion

We found a lot of evidence that exposure to EDCs early in life can cause changes in gonad development in both fish and mammals. This in turn can have long-term consequences on reproductive success.

We also learned that the impacts of EDCs are complicated. Each chemical has a different impact on the reproductive system depending on the message they interfere with. Even the same chemical can have multiple effects depending on when in life an animal is exposed to it. The concentration of the chemical and the length of the exposure also affect how the reproductive system is impacted.

There is scientific evidence that EDCs cause a negative impact on reproduction in wildlife and humans. Still, we really need more research to better understand how these chemicals disrupt the system. Hopefully then we will be able to better regulate their presence in our environment! Also, we need a better understanding of environmental EDC concentrations so we can understand our exposure to them. And we need to learn about the combined effects of multiple EDCs on reproduction.

Conclusion

EDCs are invisible chemicals that can be either natural or man-made, so it is impossible to avoid them completely. However, you can try to limit your exposure by thinking about what you eat, drink, and buy. Have a look at the list of common EDCs in Table 2 and try to avoid products that contain these

chemicals. Be mindful of both the ingredients in your food or toiletries, for example, but also the packaging they come in. Unfortunately a "BPA free" label doesn't mean EDC free. Always avoid microwaving food in plastic containers since this can cause EDCs to leak into your food.

EDC	Found in
Bisphenol A (BPA)	Plastics such as food storage material, DVDs, food cans, thermal paper (receipts)
Nonylphenols	Laundry and dish detergents, latex paints, lawn care products
Parabens	Food preservatives, shampoo, cosmetics (makeup, moisturizer)
Phthalates	Cosmetics, sunscreen, food packaging, drinking straws, insecticides
Perfluorochemicals	Clothing, non-stick food wrappers, popcorn bags
Triclosan	Antibacterial soap, toothpaste, mouthwash, deodorant
Polychlorinated biphenyls (PCBs)	Electronics and building materials, insulation, fiberglass, paint
Dioxins	Waste incineration, fires, volcanic eruptions

Table 2:

Common EDCs and their sources.

Adapted from work by [Endocrine.org](https://www.endocrine.org) and [Dr. Rahman](#).

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Glossary of Key Terms

BPA, Bisphenol A – a chemical used to make plastics. It is commonly found in food storage containers, refillable drinks bottles, and the lining of some drinks cans.

Endocrine-disrupting chemicals (EDCs) – natural and man-made chemicals found in many household and industrial products that can interfere with the endocrine system. They have similar chemical structure to hormones. For example, an EDC might block the message coming from testosterone and affect testis development or sperm production. Or your stomach might see an EDC and think it is a messenger that usually says “It’s time to eat again,” so you feel hungry even though you have already had enough to eat.

Endocrine system – a messaging system consisting of glands producing hormones and the hormones themselves. Hormones act as messengers to tell other organs in the body what to do. The endocrine system coordinates many different essential functions in the body, including growth, development, reproduction, sleep, and blood pressure.

Estrogens – a group of hormones that is important for the development of female body characteristics and the regulation of the female reproductive system. Some of them do also have important functions in the male body. Examples include estradiol and progesterone.

Exposure – coming into contact with something harmful, in this case EDCs.

Gonad – reproductive organ that produces hormones and gametes. In males, the gonads are called testes and produce sperm. In females, the gonads are called ovaries and produce eggs.

Reproductive success – an individual’s ability to produce offspring during their lifetime.

Sex ratio – the number of males compared to the number of females in a population.

Check your understanding

- 1 How do EDCs affect the reproductive system?
- 2 Can the effects of EDCs impact multiple generations?
- 3 Why do you think that having smaller ovaries or testes would negatively impact reproduction?
- 4 Looking at the list of common EDCs above, how many products do you think you have used today that *could* contain these chemicals?
- 5 How do you think we should handle the problems that EDCs cause?

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Endocrine Society: What you can do about EDCs

<https://www.endocrine.org/topics/edc/what-you-can-do>