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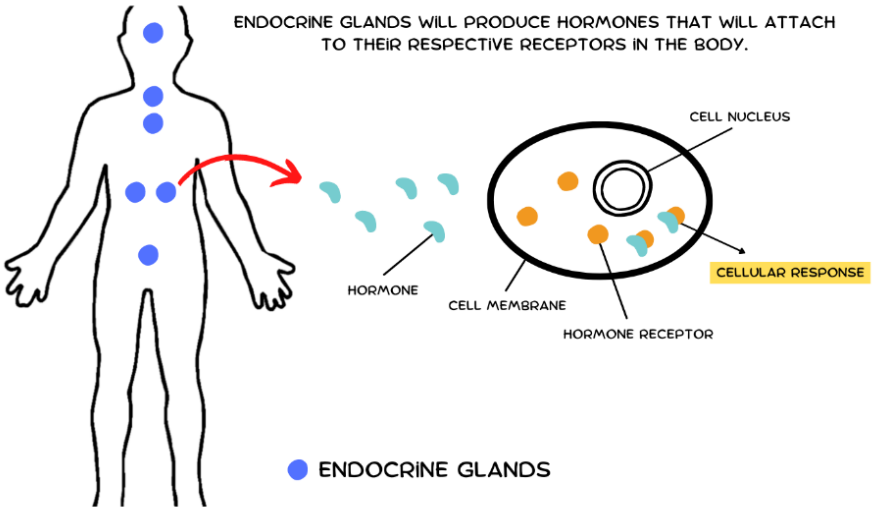
The Effects of Endocrine Disruptors on Expecting Mothers, Their Fetus, and Later Childhood Development – Part 1

A Brief Introduction to the Endocrine System

Hormones are molecules that travel through the body of living organisms to fulfill various functions, and for this reason, they are often called "chemical messengers". Many important processes from birth to death are dictated by hormones, including growth, development, metabolism, sexual maturity, sleep, and emotions (*Hormones and the Endocrine System*, n.d.). Together, hormones make up the endocrine system, which is dispersed throughout the body in the form of glands. These glands produce hormones, which then travel through the bloodstream to reach their appropriate sites, i.e., receptors.



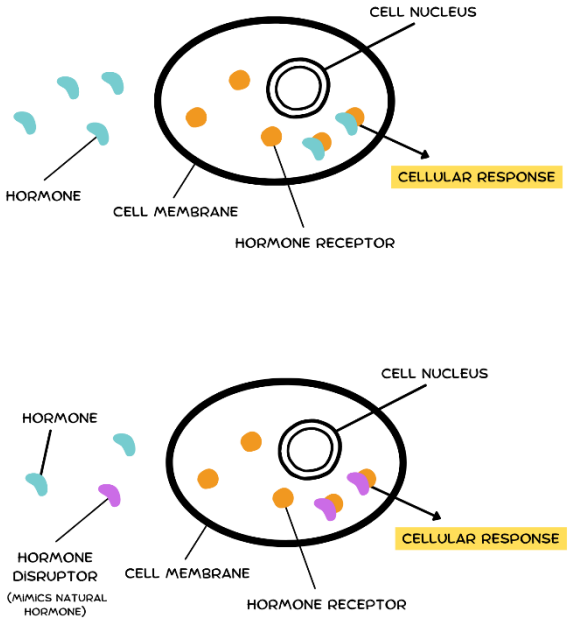
To draw a simple picture of the hormonal process, try to think of hormones as keys whose goal is to find its suitable lock (receptor) in the body. This lock may be situated at a faraway location or at a closer location, but regardless of the distance, once the hormone meets its receptor, it can unlock a wide range of chemical reactions that instruct cells to carry out specific roles. Thanks to years of evolution, the body has evolved internal clocks that dictate when a specific hormone needs to be released. One example of this is the

gonadotropin-releasing hormone (GnRH) that is released around puberty to trigger the development of sexual maturity (Fernald & White, 1999).

Endocrine Disruptors

Endocrine disruptors are molecules that resemble the hormones in our body. This means that they can attach to the receptors in the body and trigger reactions that often hinder the body's functioning. Unfortunately, endocrine disruptors are ubiquitous in our modern-day environment as they are found in virtually every item that we use, from personal products to other commonly used items like containers, food, toys, and more (*Endocrine Disruptors*, n.d.).

Endocrine disruptors can have many negative effects on the body, and multiple researchers have already demonstrated their consequences in both human and animal studies. To understand the extent of their damage, the rest of this article series will discuss how endocrine disruptors affect individuals in different phases of life, starting with expecting mothers and fetuses.



Endocrine Disruptors and Pregnancy

Embryo Implantation. Embryo implantation is a process during which the developing embryo will latch on to the uterine wall to embed itself within it and trigger the start of maternal-fetal exchanges. This is an important phase that follows conception and

precedes placental and fetal development. A few animal studies have shown that endocrine disruptors often disrupt this process, making miscarriages more likely (Midic et al., 2018; Taylor, 2008).

Placental Development. In the early stage of pregnancy, endocrine disruptors such as phthalates and bisphenol A (BPA) have been found to impact the quality and success of gestation (Rolfo et al., 2020). Namely, using animal studies and epidemiological data, researchers have found that endocrine disruptors often disrupt placental development which leads to serious complications like fetal growth restriction (FGR), preeclampsia (PE), and gestational diabetes. Furthermore, disruptions in hormones have been found to heighten the risk for obesity, cardiovascular disease, and other chronic illnesses not only in expecting mothers, but in all women of reproductive age (Ehrlich et al., 2016).

Embryonic Development. In 2019, a study using livestock as animal models found that endocrine disruptors exerted their effects primarily by acting on trophoblast cells (Yang et al., 2019). Trophoblast cells make up the outer layer of the blastocyst which is a structure whose inner cell mass will transform into the embryo. When endocrine disruptors interact with trophoblast cells, they cause changes in the signalling pathways for genetic expression. Many more studies (Gingrich et al., 2018; Gu et al., 2012; Midic et al., 2018) have confirmed this mechanism while one of them also added to the findings by demonstrating how endocrine disruptors inhibited cell proliferation (required for fetal growth) and induced apoptosis (i.e., cell death) in human trophoblast cells (Derfoul et al., 2003).

Direct Transmission of Toxins. Numerous studies have also demonstrated the transmission of endocrine disruptors from mother to fetus. As an example, in 2018, one team of researchers evaluated umbilical cord and blood samples from 29 mother-newborn pairs to identify a relationship between the concentrations of endocrine disruptors and newborn health variables (Caserta et al., 2018). Their findings suggested that mothers who had high levels of perfluorooctanoic acid (PFOA) gave birth to infants with lower birth weights.

The Effects on Fetal Development

It is common knowledge that what the mother is exposed to is also what will be spread to her fetus. As described above, endocrine disruptors have been found to affect birth weight, but the effects are not limited to that. In 2020, a scientific investigation revealed that endocrine disruptors often crossed the blood-fetal barrier and disrupted the development of numerous systems in the fetus such as the central nervous system, the endocrine system, the liver, and reproductive systems (Tang et al., 2020). The endocrine

disruptors in this specific study involved bisphenol A (BPA), organochlorine pesticides (OCPs), diethylstilbestrol (DES), and phthalates (PAEs).
The list of consequences of endocrine disruptors on fetal development is lengthy, but below are some major findings in human studies that serve as evidence. Note: The abbreviation "EDCs" is used as a short form to describe endocrine disrupting chemicals.

- EDCs prevent calcium from reaching the fetus and aiding bone growth (Derfoul et al., 2003).
- EDCs are likely to cause delays in brain developments and affect locomotion, learning/memory, stress regulation, and other important cognitive capacities in the fetus (Masuo & Ishido, 2011).
- EDCs impair the development of the brain, immune, and endocrine systems (Tang et al., 2020; Ünüvar & Büyükgebiz, 2012).

Important Implications

There are two main issues with the fetal-maternal transfer of endocrine disruptors: (1) life-long impacts that extend into and affect health outcomes in adulthood, and (2) trans-generational inheritance. The next parts of this article series will discuss these along with the effects of continuous exposure in teenagers, adults, and the elderly.

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