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Endocrine Disrupting Compounds: Problems and Solutions

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Opinion Piece

What are Endocrine Disrupting Compounds?

Figure 1:http://www.sciencesource.com/archive/-ss2313191.html, accessed November 11/2018

Endocrine Disrupting Compounds are defined by the World Health Organization as an exogenous substance that alters the function of the endocrine system, causing adverse health effects in the organism, offspring, or subpopulations [1]. A majority of EDC's originate from anthropogenic activities. Hormones occur in humans at specific times and concentrations to regulate functions such as growth, metabolism, and reproduction. Endocrine disruptors alter natural hormone systems. Exposure to EDC's can cause effects for the duration of an organism's life. EDC's can also impact an organism's offspring. EDC's are suspected to have various effects on human health including altered reproductive processes in males and females, delayed neurodevelopment in children, abnormal growth patterns, and an increased likelihood of developing breast cancer [2].

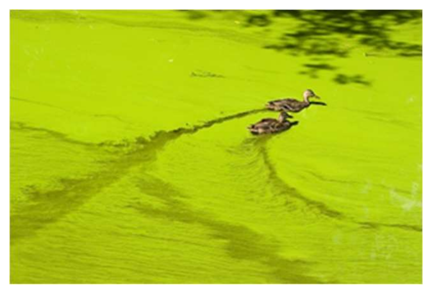

Figure 2: http://daily.jstor.org/the-problem-with-algae-bloom/, accessed November 11, 2018

Where are Endocrine Disrupting Compounds?

Endocrine disrupting compounds are found in pesticides and herbicides, flame retardants, and some plastics. As a result, they are detectible in soils, air, and water [2, 3]. In Antarctica, the level of EDC's has been increasing. The first detections of EDC's

Figure 3: https://www.oregonmetro.gov/tools-living/garbage-and-recycling/recycling-home/plastic-recycling, accessed November 11, 2018

occurred in the aquatic life. The origin of the chemicals was in DDT and other pesticides that had never been used on the continent. The travel span of these chemicals in ocean waters shows the persistence of EDC's in the environment. The rise in EDC's in the Antarctic has been a consequence of the fact that two thirds of the summer stations lack wastewater treatment capabilities. The effluent discharged from these facilities have EDC's from steroid hormones [4]. The steroid hormones in wastewater originate as pharmaceuticals. The pharmaceutical industry was looking for synthetic estrogenic compounds that could be produced instead of the expensive, naturally occurring estrogen material currently used. The research lead to the creation of BPA, which causes severe cornification of vaginal tissues. Although BPA could not be used in pharmaceuticals, it did take on roles in several other common day products, while BPA was substituted with DES as an estrogenic [5]. As different uses were found for different endocrine disrupting compounds, their use became common. The pesticides that washed away during rain, along with the excess estrogen in human waste from pharmaceuticals, both collect in waterways.

Figure 4: http://www.financialexpress.com/industry/why-2018-will-be-a-challenging-year-for-pharmaceuticals/1110705, accessed November 11, 2018

The effects of EDC's concentration and duration have been tested on zebrafish. The tests were conducted with M. aeruginosa, a specific EDC that occurs from algae blooms. M. aeruginosa has caused toxicity in fish populations and problems for water treatment facilities. The female zebrafish eggs that were exposed to EDC's for various durations and concentrations, while not statistically different from each other, resulted in ten percent less eggs hatching. The zebrafish that were exposed developed histological lesions in the liver and experienced reproductive impairment with transgenerational effects [6].

Figure 6: http://www.dailymail.co.uk/sciencetech/article-4278116/Beautiful-images-Antarctic-research-station-journey.html, accessed November 11, 2018

Figure 5: https://www.researchgate.net/figure/Adult-zebrafish-Danio-rerio-females-upper-individual-can-easily-be-differentiated fig29 304791642, accessed November 11, 2018

As a result of the increasing amount of exposure to EDC's in western countries, there is evidence to suggest that EDC exposure is resulting in a higher incidence of male reproductive disorders, increasing infertility rates and various other testicular complications. The reproductive complications have been repeated in animal trials with varying doses and durations of EDC's, and a similar correlation exists within human populations [7]. The estimated cost of health complications associated with endocrine disrupting compounds in the United States, as of 2016, was 340 billion USD, and in the European Union the estimate was 209 billion USD [8].

Potential Solutions

There are several paths that have been explored to minimize the effects of EDC's by regulating certain chemicals that are known to have endocrine disrupting potential, as done with BPA. The most prevalent options are detection and treatment. A Rapid Adaptable Portable In-vitro Detection biosensor (RAPID) would benefit both the science and healthcare fields with a faster and less expensive test for EDC that targets estrogen receptors found in soy plants and BPA. This biosensor has been successful in detecting EDCs in human blood and urine [8]. The other solutions are focused on remediation in wastewater, because all EDC's are either carried into the water system or originate there due to other pollutants causing eutrophication. The EDCs from surfactants, pesticides and plastic reinforcements can be degraded at a faster rate with the use of anaerobic membrane bioreactors (AnMBR) and microalgae with oxygen and light [9]. Other methods for degrading EDCs include photocatalytic degradation with immobilization and modification of the photocatalyst. When either of these photocatalytic degradations is performed, the overall purification process is simplified, because the photocatalyst slurry no longer needs to be removed from the purified water. This is a more efficient process compared with photochemical oxidation, which requires the addition of oxidizers such as ozone or hydrogen peroxide. Although the photocatalyst process is more efficient at degrading the EDCs, the photochemical oxidation process is more cost effective [10]. Another option for water treatment of EDCs is the use of the white rot fungus Pleurotus ostreatus HK 35, which is a common industrial

Figure 7: http://www.youtube.com/watch?v=R2-w4cvi bM, accessed November 11, 2018

cooking mushroom. Pleuroutus osteatus successfully performed in the lab to eliminate 94% of EDCs in the sample. It was used for ten days in a trickle bed wastewater treatment plant where it was successful in removing 74% of the EDCs without any interruption of the typical microbiota used in the process. This makes this treatment process the most promising, moving forward [3].

Figure 8: http://www.mushrooms.com/pearl-oyster-mushrooms, accessed November 11, 2018

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