Oblivion is Dangerous
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Picture this: You grab an apple in the morning for breakfast, say goodbye to your loved one, and jump into your car to drive to the gas station. Pretty harmless morning, right? Maybe, on the surface, but in reality the apple you ate for breakfast contains Thiabendazole, a common pesticide residue on apples known to cause cancer and reproductive toxicity (Pesticide Action Network, 2010). The gasoline used to fill up your car contains several hazardous chemicals known to cause cancer, such as benzene. At the gas station, diesel emissions bombarded your respiratory system increasing your susceptibility to cancer. In fact, the California Air Resources Board estimated that 70% of all cancer related illnesses in California arise from exposure to diesel emissions (California Air Resources Board, 2017).

We are exposed to a vast number of environmental toxicants everyday. In 2014 alone, 3.89 billion pounds of toxicants were released into air, water, and land sources. (Environmental Protection Agency, 2017). Globally, approximately 12.6 million deaths are attributed to environmental toxicant exposure each year (World Health Organization, 2016). Toxins are substances that are harmful to the human body. Environmental toxicants are toxic substances introduced into the environment. When toxins enter cells they can disrupt essential cellular processes, such as chemical reactions, cell division, and cell survival. This causes cellular dysfunction and can lead to organ toxicity and various diseases, including cancer. To prevent toxicant-associated disorders, we need efficient ways to test how chemicals might affect the human body before they are released into the environment.

Interestingly, researchers are now using stem cells to test the effects of environmental toxicants. Stem cells are naturally occurring cells that have the ability to divide and become different specialized cell types within the body. Specialized cell types are cells that perform a specific function. Stem cells have two important functions during adult life: 1) replenishing the stem cell population, and 2) replacing damaged, aging, or dead cells when necessary. For example, hepatocytes **detoxify** harmful substances in the liver. The process of a stem cell producing a specialized cell type is termed differentiation. There are several different stem cells used to research environmental toxicants; however, induced pluripotent stem cells (iPSCs) may offer the best approach to toxicological testing.

iPSCs are a great choice for toxicity testing because of their versatility and accessibility. For example, iPSCs have the ability to differentiate into all 200 specialized cell types in the body. Therefore, a researcher can study toxicity in several different cell types. Furthermore, iPSCs are easily created by taking skin cells from a human individual and converting them into stem cells in a petri dish! Most importantly, utilizing iPSCs allows researchers to observe potential toxic effects in human cells before examining toxicity at the organismal level.

There are several ways to test the effects of environmental toxicants in iPSCs. For example, stem cell populations may be examined for changes in metabolism, cellular toxicity, and appearance following exposure to environmental toxicants. Additionally, stem cell populations may be monitored for their differentiation potential in the presence of toxic substances. In fact, a study performed by Ceccatelli *et. al* 2013 found that, when exposed to the

neurotoxin methyl mercury, neural stem cells displayed decreased ability to divide and differentiate into neurons. Researchers may also examine toxin-mediated changes in gene expression and protein levels within a cell. Notably, scientists can also test multiple toxins at once, which is more reflective of a real world scenario; you are likely simultaneously exposed to a number of toxins on a daily basis (depending on where you live). It's also possible to test the effects of beneficial substances—like vitamins—to examine their ability to suppress or abolish symptoms associated with toxicity.

The use of stem cells for predictive toxicology has become more commonplace in the field of research, and their application for human toxicity modeling is limitless. Ultimately, iPSCs offer a promising solution to toxicity screening in several ways getting us one step closer to understanding the biological underpinnings of toxicity. As you can see, iPSCs pave the way for enhanced toxicological testing!

References

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