UMassAmherst | Environmental Health & Safety

Reproductive Toxicity Fact Sheet

OSHA defines reproductive toxins as "Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis)". Reproductive toxins may lead to adverse effects on sexual function and fertility in adult humans and/or on the development of offspring produced by exposure to a particular chemical. Reproductive toxicity may happen in both men and women.

GHS pictograms and hazard statements for reproductive toxins

(This information may be found in the SDS of the material):

1. H340 - May cause genetic effects
2. H341 - Suspected of causing genetic effects
3. H360 - May damage fertility or the unborn child
4. H361 - Suspected of damaging fertility or the unborn child
5. H362 - May cause harm to breast-fed children

Exposure Routes

The four main routes of exposure are inhalation, ingestion, injection, and absorption through the skin and eyes. Inhalation and absorption are considered as the two major occupational exposure routes.

Acute toxicity describes the adverse effects of a substance that result either from a single exposure or from multiple exposures in a short period of time, while chronic toxicity describes the adverse health effects from repeated exposures, often at lower levels, to a substance over a longer time period (months or years, even decades). Adverse reproductive effects are usually a result of chronic toxicity, while reproductive toxins may also cause acute toxicity effects, such as irritation to skin or eye, headache, nausea, etc.

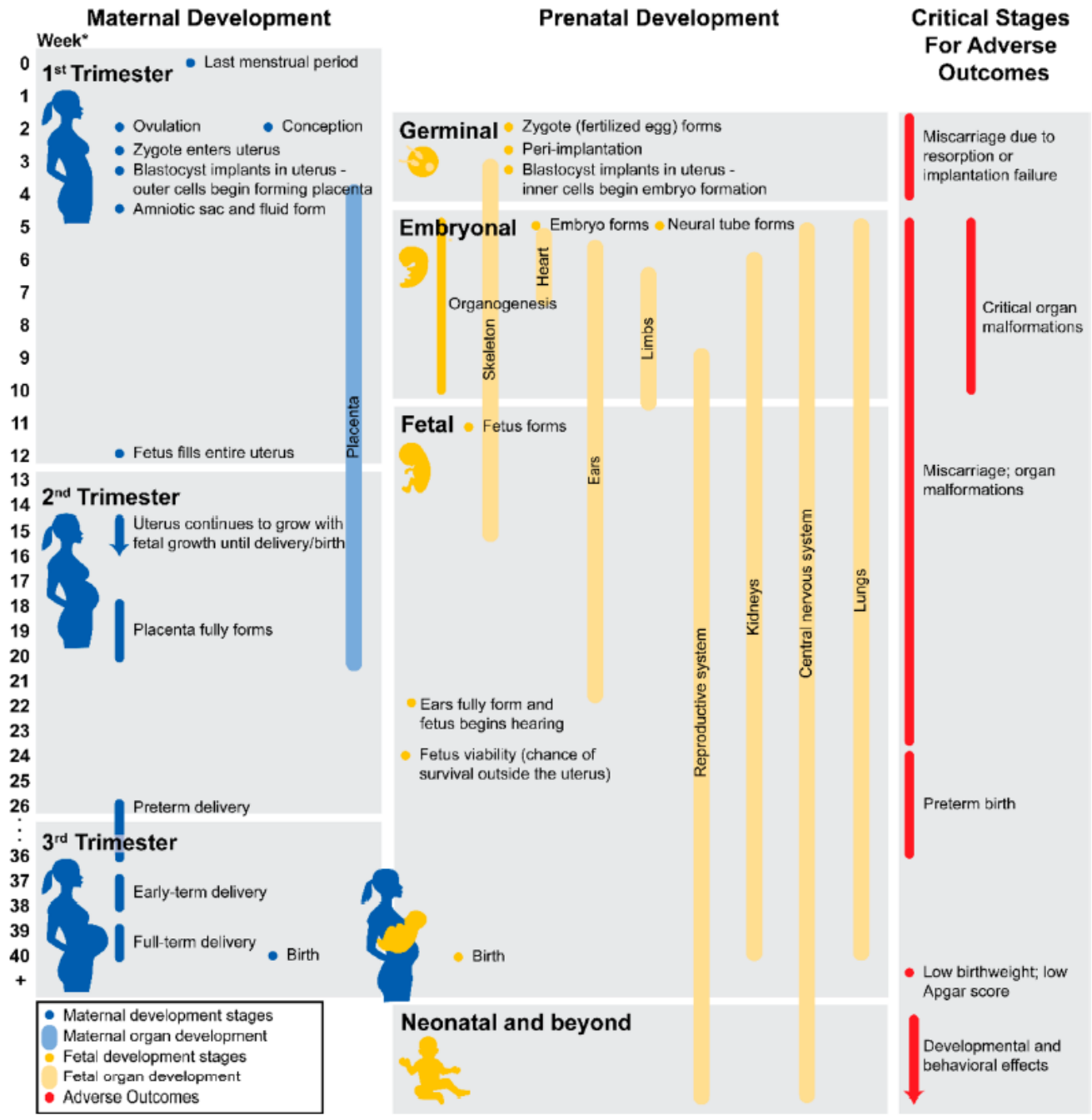
Female Reproductive Hazards:

1. Menstrual cycle effects: High levels of physical or emotional stress or exposure to chemicals such as carbon disulfide may disrupt the balance between the brain, pituitary, and ovaries. This disruption can result in an imbalance of estrogen and progesterone, and lead to changes in menstrual cycle length and regularity and ovulation. Benzene, mercury compounds, polychlorinated biphenols (PCBs) and ionizing radiation are examples that may cause these defects.
2. Infertility and subfertility: Damage to the eggs or a change in the hormones needed to regulate the normal menstrual cycle are just a few things that can cause problems with fertility. Fluorouracil (5-FU), mercury compounds, hexafluoroacetone, 2,4-dichlorophenoxyacetic acid and ionizing radiation are examples may cause the defects.
3. Miscarriage and stillbirths: Miscarriages and stillbirths occur for many reasons, such as the following: 1) The egg or sperm may be damaged so that the egg cannot be fertilized or cannot survive after fertilization; 2) A problem may exist in the hormone system needed to maintain the pregnancy; 3) The fetus may not have developed normally; 4) Physical problems may exist with the uterus or cervix. What causes most of these problems is still unknown. Examples of chemicals include arsenic and mercury compounds, etc.

4. Birth defects: A birth defect is a physical abnormality present at birth, though it may not be detected until later. In most cases, the cause of the birth defect is unknown. The first 3 months of the pregnancy is a very sensitive time of development because the internal organs and limbs are formed during this period. Examples of chemicals include 1,3 – Butadiene, ethylene thiourea, fluorouracil (5-FU), urethane, toluene, 2,4-dichlorophenoxyacetic acid, hexafluoroacetone, N-nitroso-dimethylamine, etc.
5. Low birth weight and premature birth: About 7% of babies born in the United States are born underweight or prematurely. Although better medical care has helped many underweight or premature babies to develop and grow normally, they are more likely than other babies to become ill or even die during their first year of life. Examples of chemicals include benzene, N-butanol, dimethoxymethane, dimethyl sulfoxide (DMSO), methanol, anisole, arsenic, methyl tert-butyl ether, tetrahydrofuran, xylene, and toluene, etc.
6. Developmental disorders: Sometimes the brain of the fetus does not develop normally, which leads to developmental delays or learning disabilities later in life. Such problems are often not noticeable at birth. They can be difficult to measure, may be temporary or permanent, and range from mild to severe. Developmental problems may appear as hyperactivity, short attention span, reduced learning ability, or (in severe cases) mental retardation. Examples of chemicals include tamoxifen, polychlorinated biphenols (PCBs), and toluene, etc.
7. Childhood cancer: Ionizing radiation has caused cancer in some children whose mothers were exposed during pregnancy.
8. Nursing: Some types of chemicals can get into breast milk and can harm a baby. A few examples of chemicals that can get into breast milk include lead, mercury and other heavy metals, dioxane, perchloroethylene, and bromochloroethane, etc.

Risks stemming from various hazards also may change over the course of a pregnancy, resulting in varying windows of vulnerability for pregnant researchers. The rapid changes occurring in both maternal and fetal organs over the course of a pregnancy from conception to birth alter the susceptibility to certain hazards and the severity of negative outcomes (Figure 1).

Figure 1. Important phases of maternal and prenatal development along with critical stages for when selected adverse outcomes can occur.



Male Reproductive Hazards:

1. Low Hormone Levels: This could affect how sperm are made or the man's sexual performance. Examples of chemicals include, but are not limited to: insecticides, lead, cadmium, organophosphates, DDE, manganese, phthalates.
2. Low Number of Sperm: There will be fewer sperm present to fertilize an egg; if no sperm are produced, the man is sterile. Examples of chemicals that can cause this effect include: lead, diesel exhaust, pesticide, bisphenol A, organophosphate, chromium, paraquat/malathion and diethyl ether.
3. Irregular Sperm Shape: These sperm often have trouble swimming or are unable to fertilize the egg. Examples of chemicals that can cause this effect include: insecticides, lead, carbon disulfide, pesticides, bisphenol A, petrochemical, carbofuran, nickel and chloroform.

4. Irregular Sperm Genetics: Radiation or chemicals may cause changes or breaks in the DNA. If a sperm's DNA is damaged, it may not be able to fertilize an egg; or if it does fertilize an egg, it may affect the development of the unborn baby. Examples of chemicals that can cause this effect include: phthalates, styrene, organophosphate, carbaryl, fenvalerate, lead, benzene.
5. Chemicals in Semen: These chemicals may kill the sperm, change the way in which they swim, or attach to the sperm and be carried to the egg. Examples of chemicals include, lead, trichloroethylene, boron, cadmium.
6. Low Amount of Semen: Some exposures may reduce this to less than 1/2 teaspoon, compared to average amount about 3/4 of a teaspoon. This may result in the fluid not transporting the sperm to the cervix (opening to the womb). Examples of chemicals include lead, organophosphates, paraquat/malathion.
7. Low Number of Swimming Sperm: Slow or not swimming sperm reduces the number of sperm available for fertilization. Examples of chemicals include insecticides, diesel exhaust, lead, cadmium, carbon disulfide, phthalates, pesticides, bisphenol A, fenvalerate, petrochemicals, welding fumes, N, N-dimethylformamide, abamectin, paraquat/malathion.
8. Lower Sex Drive: Some exposures may reduce the sex drive or libido. Examples of chemicals include carbon disulfide, bisphenol A.
9. Erectile Dysfunction (ED): Some exposures to some chemicals may cause erectile dysfunction, such as bisphenol A.
10. Lower Penis Sensitivity: If an exposure reduces the feeling in the penis the man may not be stimulated enough to ejaculate.
11. Lower Ejaculation Quality: If an exposure limits the ejaculation process sperm cannot reach the cervix (womb opening) and cannot get to the egg, such as bisphenol A.

How to Prevent Hazards?

Following all lab safety procedures included in the university's chemical hygiene plan usually will provide appropriate protection while working in the labs. The hierarchy of controls, from the most effective to least effective, include elimination/substitution (such as using lower hazard materials when possible), engineering controls (such as using local exhaust ventilation, including fume hoods), administrative controls (such as following safety SOPs), and PPE (including safety glasses, lab coats, gloves, face shields, etc.). It is always best to avoid all exposure in so far as possible. Individuals who are pregnant, trying to conceive, or nursing a child while working in a lab and have concerns about safety and exposures to hazardous materials or processes should contact EH&S (askehs@umass.edu or 413-545-2682) for a confidential consultation.

References and Resources:

1. Reproductive Health and the Workplace-NIOSH: https://www.cdc.gov/niosh/topics/repro/default.html
2. Reproductive Hazards-OSHA: https://www.osha.gov/SLTC/reproductivehazards/hazards.html
3. Lane, M. K. M., Garedew, M., Deary, E. C., Coleman, C. N., Ahrens-Víquez, M. M., Erythropel, H. C., ... & Anastas, P. T. (2022). What to Expect When Expecting in Lab: A Review of Unique Risks and Resources for Pregnant Researchers in the Chemical Laboratory. Chemical research in toxicology, 35(2), 163-198.
4. McGeough, C. P., Mear, S. J., & Jamison, T. F. (2021). A Call for Increased Focus on Reproductive Health within Lab Safety Culture. Journal of the American Chemical Society, 143(32), 12422-12427.