EOH3101
PRINCIPLES OF ENVIRONMENTAL HEALTH

ENVIRONMENTAL HEALTH ISSUES: ENVIRONMENTAL HORMONES
INTRODUCTION

• Endocrine disruptors are chemicals that may interfere with the body’s endocrine system and produce adverse developmental, reproductive, neurological and immune effects in both humans and wildlife.

• A wide range of substances, both natural and man-made, are thought to cause endocrine disruption, including pharmaceuticals, dioxin and dioxin-like compounds, polychlorinated biphenyls, DDT and other pesticides, and plasticizers such as bisphenol A.
Endocrine disruptors may be found in many everyday products—including plastic bottles, metal food cans, detergents, flame retardants, food, toys, cosmetics, and pesticides.
The endocrine system in the human body
• Hormones go to their intended destination through the bloodstream, where they find cells with molecular receptors suitable for them.

• After binding and “locking” themselves into place, the hormones will then be able to instruct the cells to divide or produce protein or instruct the cell to stop dividing or produce protein.

• Estrogen is produced by the ovaries and placenta in females, while in males, it is produced in the testis.
This is how hormones and endocrine disruptors work
Endocrine Disruptors

• Scientists have found out about a few substances which can disturb the functions of the endocrine system.

• A substance which can disturb normal communications between the transporter and cell receptor, where the chemical information is not well understood.

• Even a small effect on the endocrine system may cause a change on the growth, reproduction or behaviour which can influence the organism or later generations.
• These type of chemicals can mimic sex hormones such as estrogen or androgen or even prevent activities of both hormones.

• PCB (polychlorinated biphenyls) is a very popular hormone. Other examples include dioxin and furan.

• DDT, a type of pesticide, is also a hormone mimic which can shorten a mother’s lactating time to her child.
Drugs

Diethylstilbestrol

Ethynyl Estradiol

17β-Estradiol
Industrial Chemicals

Bisphenol A

p-Nonylphenol

17β-Estradiol

Butylbenzyl Phthalate Ester

Atrazine
Substances can interact with the endocrine system and will result in disruption in the normal functions of the system in different ways:

1. It can act as normal hormones and bind to receptors. This results in similar response for cells, and this is called **agonistic response**.

2. It can bind to receptors and prevent a normal response, and this is called **antagonistic response**.
3. Hormone disruptors may disrupt normal hormone and receptor production or control.

- The public is interested to know the substances responsible for the similarities or prevention of the “female” of female sex hormones, for instance 17-β estradiol. For males, it influences growth, development and behaviour.
Environmental Pollutants

Benzo[a]pyrene

2,3,7,8-Tetrachlorodibenzop-\( \beta \)-dioxin

Polychlorinated Biphenyls

17\( \beta \)-Estradiol
Substances which disturb the endocrine system

• Substances which disrupt the endocrine system are many and plentiful, include natural and man-made.

• Industrial, agricultural and urban wastes may expose organisms in the environment to high levels of sex hormones or phytoestrogen.

• Chemicals produced may be released inadvertently, including pesticides, industrial by-products and solid wastes (dioxin or PCB) or industrial wastes or municipal processes (alkylphenol).
Sources of environmental hormones

1. In foodstuff including soy beans, apples, wheat, cherries and legumes.

2. Environmental pollutants
Effects to the environment

To wildlife:

1. Deformed and death of bird embryo exposed to industrial chemicals or organochlorine pesticides.
2. Stunted reproduction and development of fish exposed to effluent from paper and pulp mill.
3. Abnormal reproduction of snails exposed to anti-decomposing substances.
4. Suppressed thyroid function and immune system in fish-eating birds.
5. Sex-change of fish (from male to female) for fish living near effluent discharge pipes.
LEFT: male  CENTER: female  RIGHT: imposex-exhibiting female, which has male sexual organs, such as penis and vas deferens

Rock shell (*Thais clavigera*)
Frogs are one of the most vulnerable creatures to hormone disruptors
Examples of Environmental Hormones

**Diethylstilbestrol, or DES**, a kind of man-made estrogen, was used extensively to prevent miscarriage and other pregnancy complications for millions of females, but now exist the risk for cervical cancer for their child/children and abnormal reproduction. For male babies, the sex organs are disfigured or smaller than normal.

![Chemical structure of DES]
From about 1940 to 1970, DES was given to pregnant women in the mistaken belief it would reduce the risk of pregnancy complications and losses. In 1971, DES was shown to cause a rare vaginal tumor in girls and women who had been exposed to this drug in utero.
“Really?”

Yes...

desPLEX®
to prevent ABORTION, MISCARRIAGE and
PREMATURE LABOR

recommended for routine prophylaxis
in ALL pregnancies...

96 per cent live delivery with desPLEX
in one series of 1200 patients—
—bigger and stronger babies, too. 2, 3
No gastric or other side effects with desPLEX
—or either high or low dosage. 6, 7, 8
1. Decrease in the number of sperm produced and absence of one or both testis in the scrotum (“Cryptorchidism”)
2. Increase in the number of breast, prostate and testicular cancer cases
3. Exposed males have been suggested to be more likely to be left-handed than unexposed males
4. Confirmed or strongly suspected prenatal DES exposure who self-identify as male-to-female transsexual, transgender, and intersexed, and many individuals who have reported experiencing difficulties with gender disphoria.

In animals:

Animals that exhibited structural neurological changes are shown to demonstrate various gender-related behavioral changes (so called "feminisation of males")
Dioxin may cause cancer on a large number of organs in the body. The safe limit for dioxin in foodstuff is 0.4 picograms for each kilogram of weight. In America, the average weight of dioxin in foodstuff is between 5 – 40 picogram, which is 120 times higher than is recommended by USEPA.

Chemical structure of Polychlorinated dibenzo-\(p\)-dioxins (PCDDs); simply known as dioxin.
The most important source of human exposure to dioxin is fatty food of animal origin. There is quite a lot of variation between different countries as to the most important items. In U.S. and Central Europe milk and dairy products and meat have been by far the most important sources.

Dioxins are formed as important toxic side products in the production of PCBs, chlorophenols, chlorophenoxy, acid herbicides and other chlorinated organic chemicals. This caused very high exposures to workers in poorly controlled hygienic conditions.
Other types of hormone mimics and their target hormones

<table>
<thead>
<tr>
<th>Chemical/Element</th>
<th>Common Usage</th>
<th>Example Hormone Target</th>
<th>Organism Type Impacted</th>
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</thead>
<tbody>
<tr>
<td>Polybrominated Diphenyl Ethers (PBDEs)</td>
<td>Flame retardants</td>
<td>Thyroid</td>
<td>Mammals, Birds, Reptiles, Fish</td>
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<td>DDT</td>
<td>Insecticide</td>
<td>Estrogen</td>
<td>Mammals, Birds, Reptiles, Amphibians, Fish, Invertebrates</td>
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<tr>
<td>PCBs</td>
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<td>Cadmium</td>
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<td>Fenoxycarb</td>
<td>Insecticide</td>
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<td>Bisphenol A</td>
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<td>Nonylphenol</td>
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<td>Estrogen</td>
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</tbody>
</table>
GENDER-BENDING CHEMICALS

PHTHALATES: Found in vinyl flooring, shower curtains, solvents, plastics, PVC. Banned in cosmetics made in EU.

PARABENS: Preservatives used in cosmetics, creams, lotions and deodorants.

TRICLOSAN: Antibacterial chemical used in soaps, toothpaste and chopping boards.

PCBs: Found in electrical circuits, paints, brake linings and flame retardants. Banned in EU.


LINURON/DIURON: Herbicides used to control weeds on roads, forests and farms. Traces found on food.

VINCLOZOLIN: Fungicide banned in EU, but found on imported fruit and vegetables.

PENTA-BDE: Flame retardants, now banned in EU, found in old foam mattresses and car seats.

PROCHLORAZ: Fungicide used on fruits and vegetables.

PROCYMIDONE: Fungicide banned in EU last year, traces found in UK beans, fruit smoothies and breakfast cereal.

Source: CHEM TRUST
Thank you for your attention!!