

Endocrine Disruptors in Wastewater

Can They Hurt Our POTWs?

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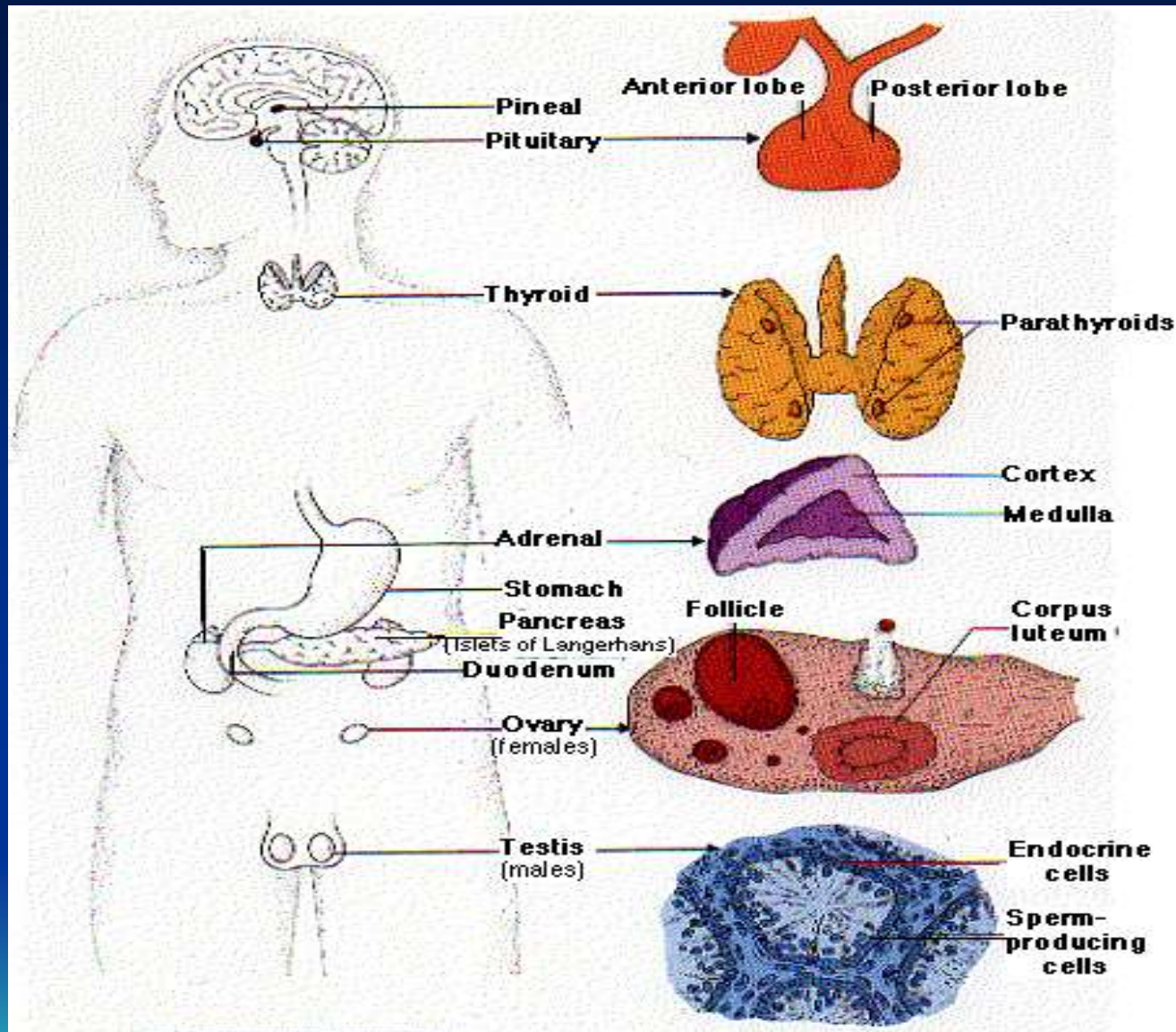


What are Endocrine Disruptors?

Chemicals or natural by-products in the environment that mimic hormones in the body and can have potential impact on wildlife and humans



Hormone	Structure ⁽¹⁾	Principal Source Link to diagram showing locations of the endocrine glands
Thyroid-stimulating hormone (TSH)	protein (201)	Anterior lobe of pituitary
Follicle-stimulating hormone (FSH)	protein (204)	
Luteinizing hormone (LH)	protein (204)	
Prolactin (PRL)	protein (198)	
Growth hormone (GH)	protein (191)	
Adrenocorticotrophic hormone (ACTH)	peptide (39)	Posterior lobe of pituitary
Antidiuretic hormone (ADH)(vasopressin)	peptide (9)	
Oxytocin	peptide (9)	
Thyrotropin-releasing hormone (TRH)	peptide (3)	
Gonadotropin-releasing hormone (GnRH)	peptide (10)	
Growth hormone-releasing hormone (GHRH)	peptides (40)	Hypothalamus
Corticotropin-releasing hormone (CRH)	peptide (41)	
Somatostatin	peptides (14, 28)	
Dopamine	Tyrosine derivative	
Melatonin	Tryptophan derivative	
Thyroxine (T ₄)	Tyrosine derivative	Thyroid Gland
Calcitonin	peptide (32)	Parathyroid glands
Parathyroid hormone (PTH)	protein (84)	
Glucocorticoids (e.g., cortisol)	steroids	
Mineralocorticoids (e.g., aldosterone)	steroids	Adrenal cortex
Androgens (e.g., testosterone)	steroids	



Studies, Roundtables and Discussions

EPA has sponsored and funded various studies and workshops to address the toxics and endocrine disruptor issues.

It has been verified that certain chemicals will cause endocrine disruption problems.



Current List of Identified Endocrine Disrupting Chemicals

17 B-estradiol

E2 (normal female hormone)

Ethinylestradiol (birth control pills)

Surfactants such as pnonylphenol and
nonylphenol ethoxylates



EPA Milestone Plan

EPA under NRDC law suit so they are
crunched to do the following:

- Release of list of research priority chemicals
- Develop test methods
- Establish regulations and guidelines
- Reveal their approach to establishing the “hit” list—
time lines, etc. (planned for June 2004)



EPA Final Report Peer Review

EPA sponsored the National Toxicology Program and the National Institute of Environmental Health Sciences to peer review reported low-dose reproductive and developmental effects and dose-response relations for endocrine disrupting chemicals report. The final report was released on August 20, 2001. (EPA document 625R00015)



EPA Must Develop Laboratory Analytical Methods

Lab Testing—levels of a specific compound

VS.

Biomarkers—molecules, biochemical pathways or cellular processes in experimental animals that change in response to contaminated habitats and are indicative of the exposure



Laboratory Analyses

- Bioassay-screening will help the wastewater industry determine the endocrine-disrupting potency of effluents. It will assess the cumulative effects of these compounds without having to quantify unknown chemicals individually—
- Of course these tests methods are still to be developed



Stream Contamination

In 1999 and 2000 USGS collected and analyzed samples from 139 streams in 30 states

They developed analytical protocols and sample collection methods

They analyzed for 95 different toxic chemicals

Trying to determine the extent of toxic chemicals that are in the environment and then to determine the impact to humans and wild life

Their results showed: 1 or more chemicals in 80% of the streams, more than 2 in 75%, 50% had 7 or more and 34% had 10 or more usually in very low concentrations (<1ppb)



Stream Contamination con't.

Most commonly detected “chemical groups”-

steroids, nonprescription drugs, insect repellent

within these groups detergents, steroids and plasticizers had the highest concentrations

most frequently detected chemicals were coprostanol (fecal steroid); cholesterol (plant and animal steroid);

N-N-diethyltoluamide (insect repellent); caffeine (stimulant), triclosan (antimicrobial retardant); 4-nonylphenol (nonionic detergent metabolite)



Tadpole Development

Two tadpoles after 57 days of development in the lab. The one on the right, which has yet to sprout limbs, was exposed to (at unknown levels) fluoxetine, also known as Prozac.



Treatability Study

Nonylphenol ethoxylate surfactants

Widely used in variety of ways

End up in WWTPs

Effluent from two Canadian WWTPs

Plant A has activated sludge, nitrification,
tertiary treatment and UV disinfectant

Plant B has non-nitrifying activated sludge
and chlorine disinfection

Plant A removed 97% Plant B removed 86%



Potential Effects on WWTPs

Removals of Estrogens in Treatment Plans

Country, Process	Estone	17-Beta Estradiol	Ethinylestradiol
Brazil, trickling filter	67%	92%	64%
Brazil, Activated Sludge	83%	99.9%	78%
Germany, Activated Sludge	0%	64%	0%
Italy, Activated Sludge	85%	87%	61%
Italy and Denmark, activated sludge	74%	88%	No data

Removals of Antibiotic Drugs in the Ohio River

Column	Filter Media	Percent Reductions
A	Sand	No removals
B	Sand and Brewer's Yeast	17%, 20%, 33%
C	Sand and Activated Charcoal	77%, 96%, 93%

Treatment of Choice

Activated carbon—methoxychlor,
endosulfan, DDT, Diethyl Phthalate, Di-
(2ethylhexyl) Phthalate, PCBs,
Alkylphenols and Alkylphenol Ethoxylates

Coagulation/sedimentation—Dioxin



What's on the Horizon?

- Possibility of new regs to control the discharge of endocrine disruptors
- Possibility of regulations for water treatment plants
- 10-20 year planning for new WWTP
- Many of the possible compounds are already listed on the EPA's National Toxic Rule



Planning for the Future

- More emphasis on source control which will fall on Pretreatment's shoulders
- Closer look at TTO list; incorporating into permits for non-categoricals
- From a holistic approach should we be working with drinking water plants?
- Theoretically water treatment plants are sources of problem



Industrial Pretreatment Purpose

- Prevent Pass Through (water quality and Biosolids)
- Protect Worker Health and Safety (collection systems and POTW)
- Protect Plant Operations
- Ensure NPDES Compliance

