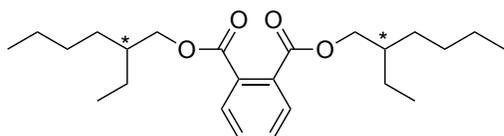
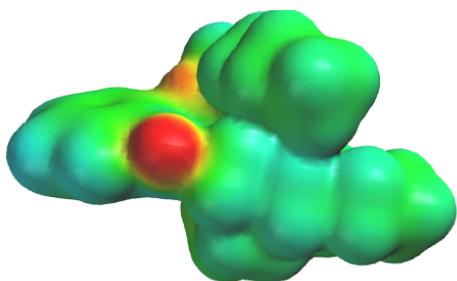
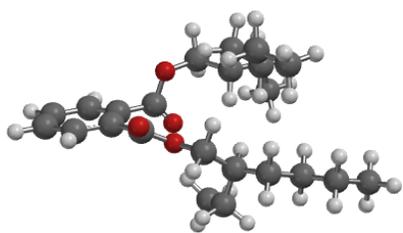


Phthalate esters are effective plasticizers because their flexible, bulky alkyl chains intercalate between polymer chains and weaken intermolecular interactions, thereby lowering the glass transition temperature and increasing flexibility and softness.

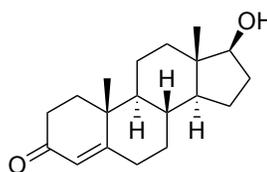
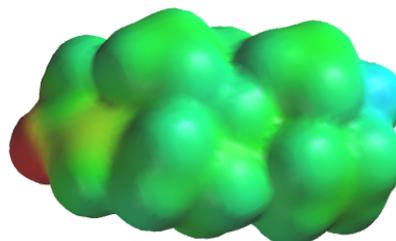
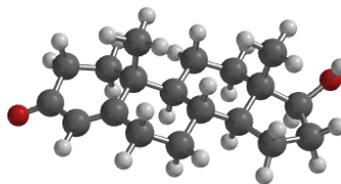
People are exposed to phthalate esters from flexible PVC flooring and vinyl products (e.g., Armstrongvinyl flooring), food-contact materials and cling wraps (generic PVC wraps), personal care products such as fragrances, nail polishes, hair sprays, and lotions (e.g., some formulations of Calvin Klein Eternity perfume, OPI nail polishes, and Pantene hair sprays historically contained DEP/DBP), children's toys and inflatable products made of soft vinyl (e.g., older Mattel and Fisher-Price toys before phthalate restrictions), synthetic leather and faux leather goods, car interiors, and various consumer electronics cables and coatings.

Sex hormones such as estrogens, androgens, and progesterone diffuse into cells and bind to their cognate nuclear receptors, which are ligand-activated transcription factors that translocate to the nucleus, dimerize, and bind specific hormone-response elements in DNA. By recruiting co-activators and co-repressors at these sites, each hormone–receptor complex can coordinately regulate the transcription of hundreds of target genes simultaneously, thereby orchestrating broad programs in reproduction, metabolism, development, and behavior.

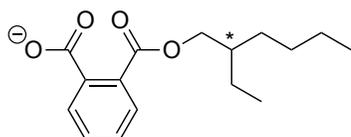
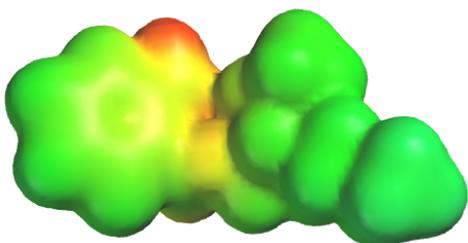
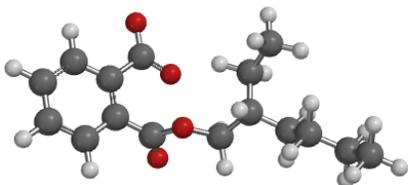
Hormone disruptors such as di(2-ethylhexyl) phthalate (DEHP) are thought to cause problems because, after metabolic conversion to monoesters like mono(2-ethylhexyl) phthalate (MEHP), they interfere with endocrine signaling (e.g., steroidogenesis and nuclear hormone receptor pathways), dysregulating the coordinated expression of many hormone-responsive genes that govern reproductive and developmental processes.



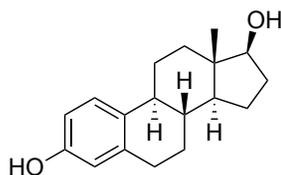
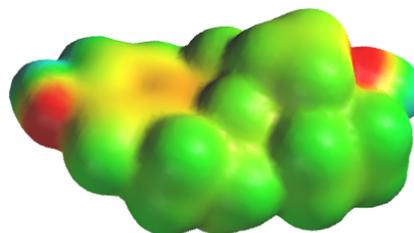
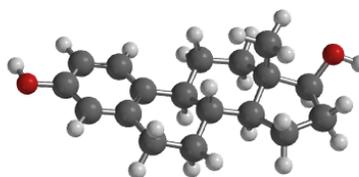
bis(2-Ethylhexyl) phthalate
DEHP



Testosterone



2-Ethylhexyl phthalate
MEHP



Estrogen (Estradiol)

References

1. Foundational human epidemiology – male developmental effects:

Swan SH, Main KM, Liu F, Stewart SL, Kruse RL, Calafat AM, et al. Decrease in anogenital distance among male infants with prenatal phthalate exposure. *Environmental Health Perspectives*. 2005;113(8):1056–1061.

2. Broad human-health review of phthalates with strong focus on DEHP:

Chang W-H, Herianto S, Lee C-C, Hung H, Chen H-L. The effects of phthalate ester exposure on human health: A review. *Science of the Total Environment*. 2021;786:147371.

3. Mechanistic reproductive toxicology in males (animal model, but DEHP-centric):

Gray LE Jr, Ostby J, Furr J, Price M, Veeramachaneni DN, Parks L. Perinatal exposure to the phthalates DEHP, BBP, and DINP, but not DEP, DMP, or DOTP, alters sexual differentiation of the male rat. *Toxicological Sciences*. 2000;58(2):350–365.

4. Updated mechanistic review on DEHP as an endocrine disruptor in reproduction:

Mesquita I, Lorigo M, Cairrão E. Update about the disrupting-effects of phthalates on the human reproductive system. *Molecular Reproduction and Development*. 2021;88(7):650–672.

5. Recent systematic review of reproductive toxicology of phthalates with detailed DEHP coverage:

Nobles CJ, Mesquita I, Sun J, Gan L, Dai C. Reproductive toxicological effects of phthalates: an updated systematic review (2020–2024). *Toxics*. 2025;13(1):xx–xx. (In press; pagination pending, but cite as 13(1):Article e000xxx once assigned.)