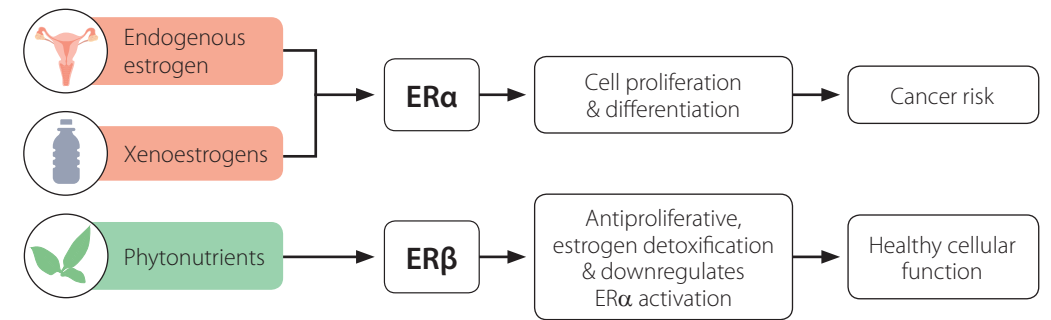


Estrogen metabolism and nutritional influences

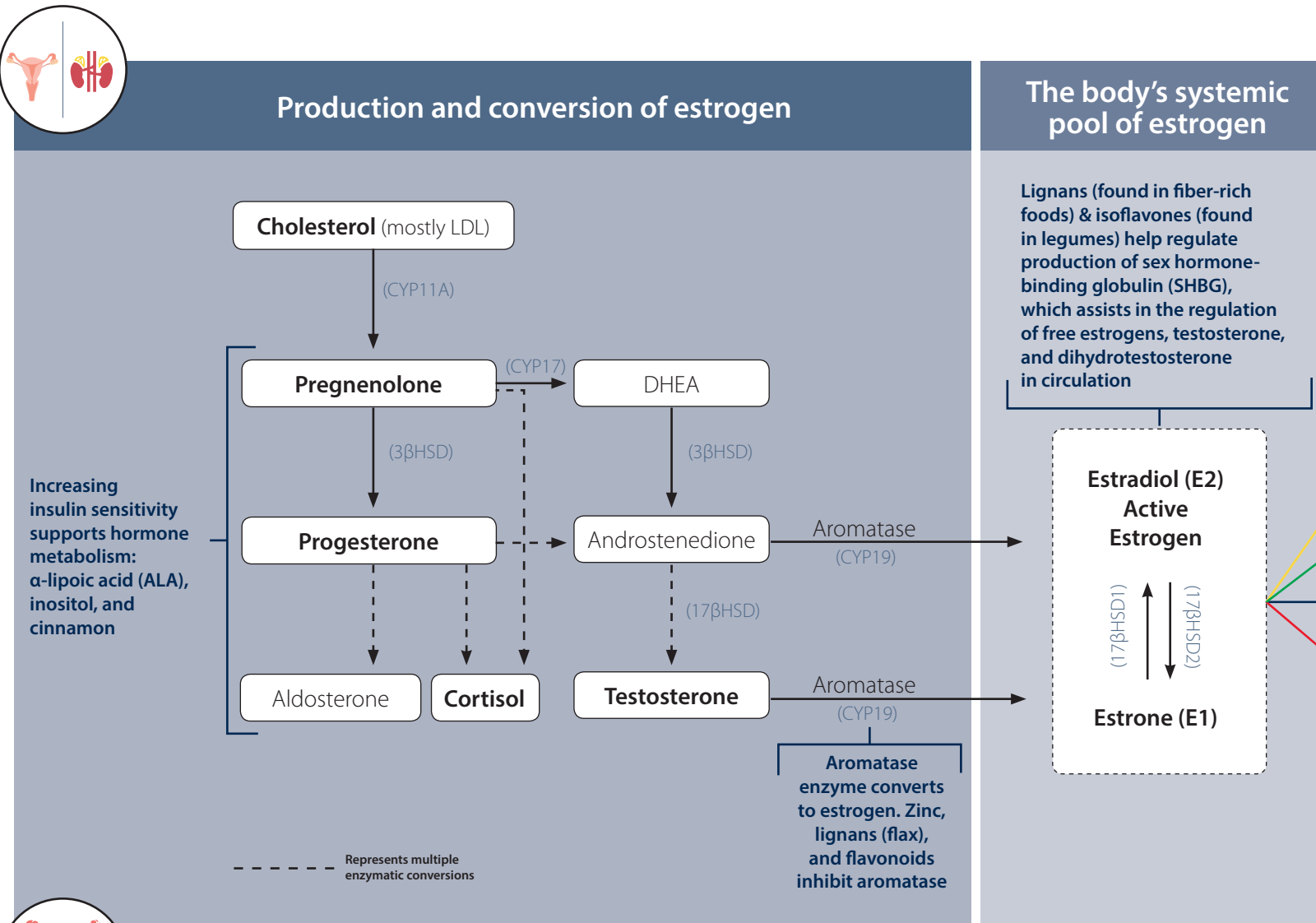
Estrogen is the primary hormone responsible for sexual and reproductive development in women. Once puberty begins, the body uses estrogen to regulate the first half of the menstrual cycle and then metabolizes the hormone for elimination via urination and defecation. Dietary and lifestyle modifications that support a healthy weight, like consuming a nutrient-dense dietary pattern (e.g., increasing intake of fiber and phytoestrogens) and being physically active, have been linked to the modulation of estrogen metabolism. In addition, many nutrients and nutritional bioactives have been studied for their influence on pathways of estrogen metabolism and detoxification, including but not limited to isoflavones, indole-3-carbinol, B vitamins, magnesium, limonene, calcium D-glucarate, and antioxidants.

Estrogens & estrogen receptor sensitivity

Estrogen receptors (ER) are present in both men and women. Endogenous estrogens, environmental xenoestrogens, and their metabolites selectively bind to estrogen receptors. Various phytonutrients, such as phytoestrogens, may moderate their binding, modulating cell signaling to support hormone balance.



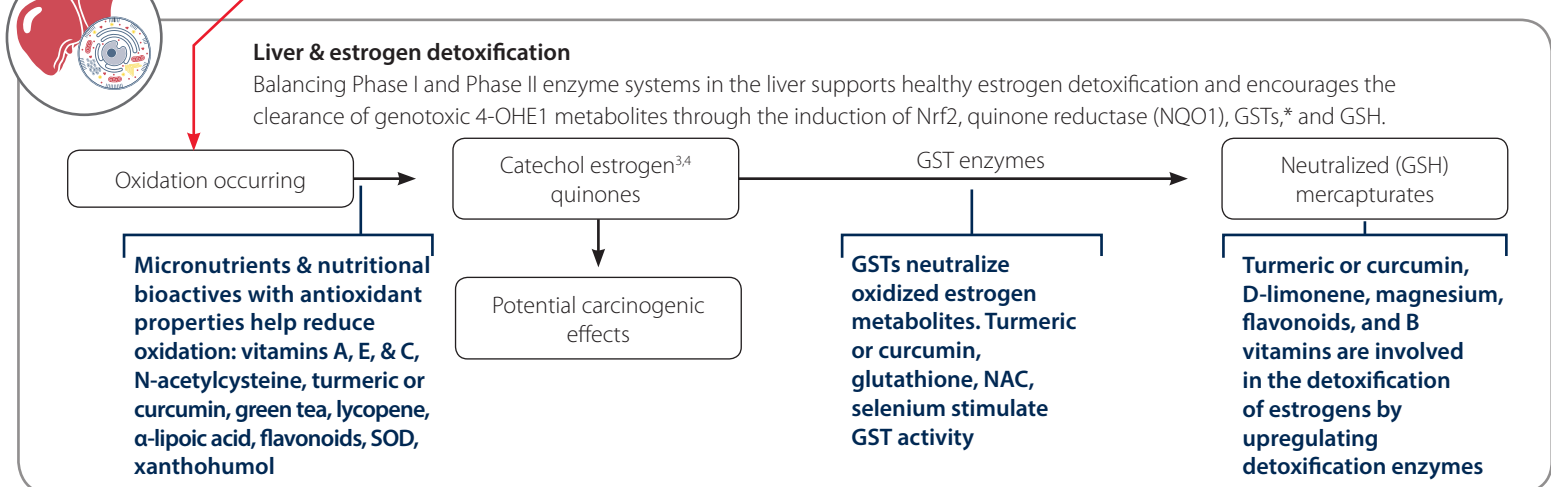
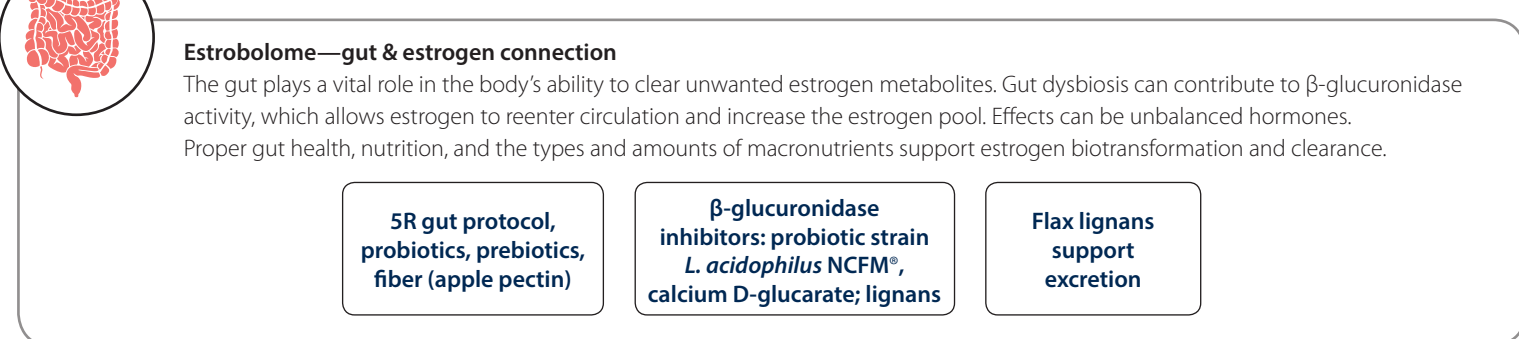
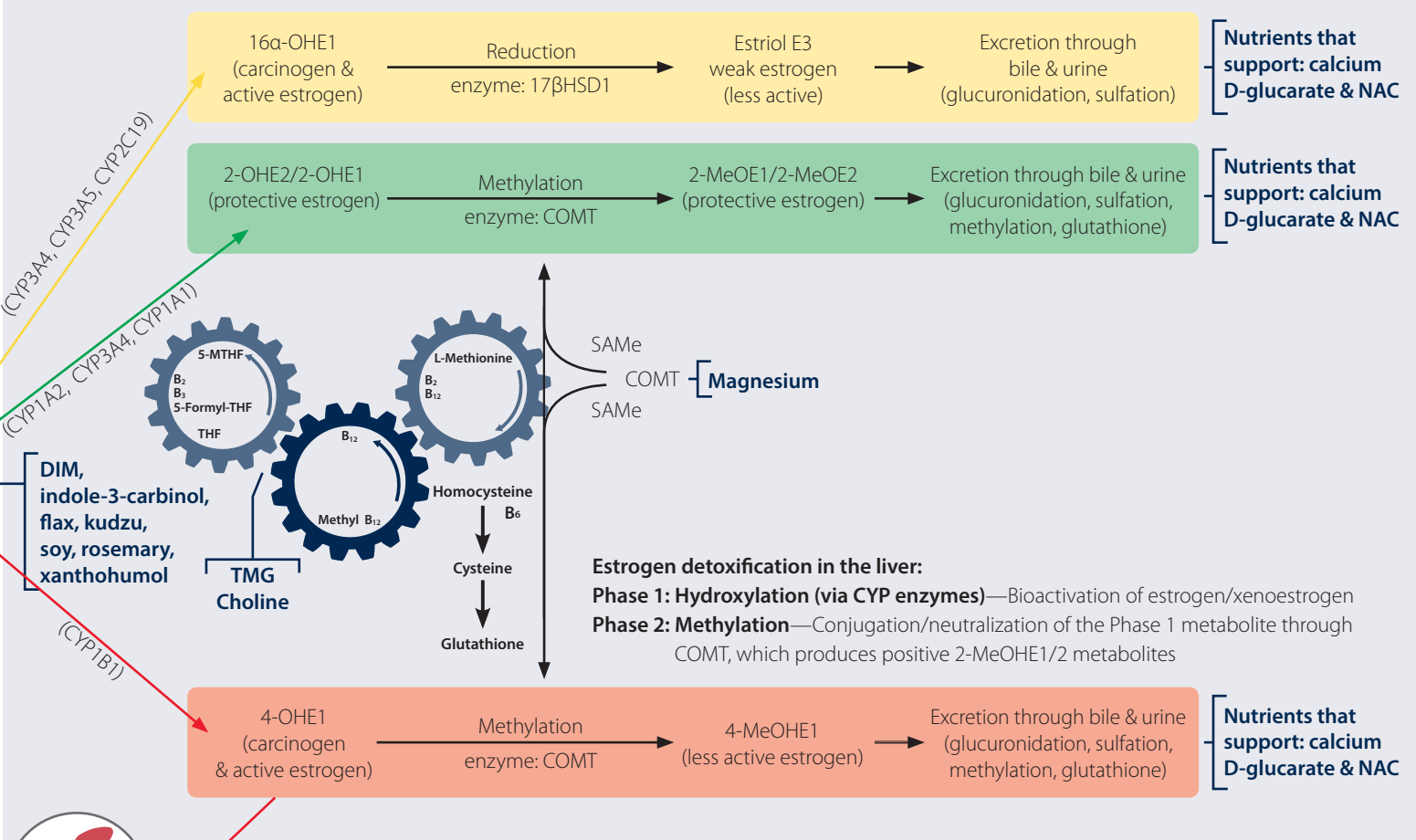
Phytoestrogen (plant-derived estrogens) examples include lignans, isoflavones (genistein, daidzein), and resveratrol. Vitamin B₆ helps modulate tissue response.



The body's systemic pool of estrogen

Lignans (found in fiber-rich foods) & isoflavones (found in legumes) help regulate production of sex hormone-binding globulin (SHBG), which assists in the regulation of free estrogens, testosterone, and dihydrotestosterone in circulation

Estrogen detoxification: bioactivation, conjugation, and elimination



KEY: CLA: conjugated linoleic acid; COMT: catechol-O-methyltransferase; DHEA: dehydroepiandrosterone; 5-formyl-THF: 5-formyltetrahydrofolate; HRT: hormone replacement therapy; 5-MTHF: 5-methyltetrahydrofolate; NAC: N-acetylcysteine; SAME: S-adenosylmethionine; SAH: S-adenosylhomocysteine; SHBG: sex hormone-binding globulin; THF: tetrahydrofolate; TMG: trimethylglycine; Nrf2: nuclear factor erythroid 2 (NF-E2) p45-related factor 2; NQO1: NAD(P)H:quinone oxidoreductase 1; GST: glutathione S-transferase; GSH: reduced glutathione; 2-OHE1: 2-hydroxyestrone; 2-OHE2: 2-hydroxyestradiol; 2-MeOHE1: 2-methoxyestrone; 2-MeOHE2: 2-methoxyestradiol; 4-OHE1: 4-hydroxyestrone; 4-MeOHE1: 4-methoxyestrone; 16α-OHE1: 16α-hydroxyestrone

*GSTs: glutathione S-transferases are important enzymes of detoxification and intra-cellular binding proteins