**Lipids in the PDB**

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**ASBMB Learning Objectives**

(<https://www.asbmb.org/education/core-concept-teaching-strategies/foundational-concepts/structure-function>)

1. Biological macromolecules are large and complex

* Students should be able to **describe the basic units of the macromolecules** and the types of linkages between them *(Introductory)*.

4. Macromolecular interactions

* Students should be able to discuss the **interactions between a variety of biological molecules** (including proteins, nucleic acids, lipids, carbohydrates and small organics, etc.) and describe how these interactions impact specificity or affinity leading to changes in biological function *(Intermediate)*.

### Lipids:

Unlike protein, nucleic acids, and carbohydrates, lipids are a collection of molecules that are hydrophobic in nature. This means that they are insoluble in water but soluble in organic solvents, such as benzene, toluene, and methanol.

There are several types of lipids:

* fatty acids have an acidic group on one end and an aliphatic tail
* oils and waxes are esters of fatty acids and alcohols
* phospholipids are esters of fatty acids and alcohols (usually glycerol) along with a phosphate group attached to the alcohol.
* steroids have a 4-ring structure with various groups attached to them.

Instead of forming polymers through covalent linkages, lipids interact with each other and with other molecules through non-covalent interactions to perform key functions in biology.

Note: In the PDB most lipid molecules are treated as small molecules or ligands.

#### Role in biology:

* Lipids such as phospholipids and cholesterol form important parts of membranes.
* Lipids like fats and oils help store energy in cells.
* While some lipids function as key messengers in signaling pathways, others (various steroids) act as hormones that regulate specific functions in plants and animals.
* Waxes play important structural and protective roles in various organisms.

#### Chemical structure of Lipids:

* All lipids have a significant portion of the molecule that is hydrophobic (i.e., made of carbons and hydrogens only). This is the part of the molecule that makes it insoluble in water.
* Fatty acids have hydrocarbon chains with twelve or more carbon atoms. The carbons may be linked together through single covalent bonds (saturated) or double/triple bonds (unsaturated).
* Alcohols can form esters with one or more fatty acids to form fats, oils, waxes, and phospholipids.
* Steroids have cores that include four linked rings that may be decorated with one or more groups.

A few examples of lipids are included below:

|  |  |
| --- | --- |
| DAO: Lauric Acid | CLR: Cholesterol |

Did you know that the definitions, chemical formulae, and representative coordinates for all amino acids are available in the Chemical Component Dictionary (maintained by the [worldwide PDB](https://www.wwpdb.org/) (wwPDB)? You can search for these components or ligands using the [Ligand Expo](http://ligand-expo.rcsb.org/index.html) tool or directly from the [RCSB PDB](https://www.rcsb.org/) website.

### Explore:

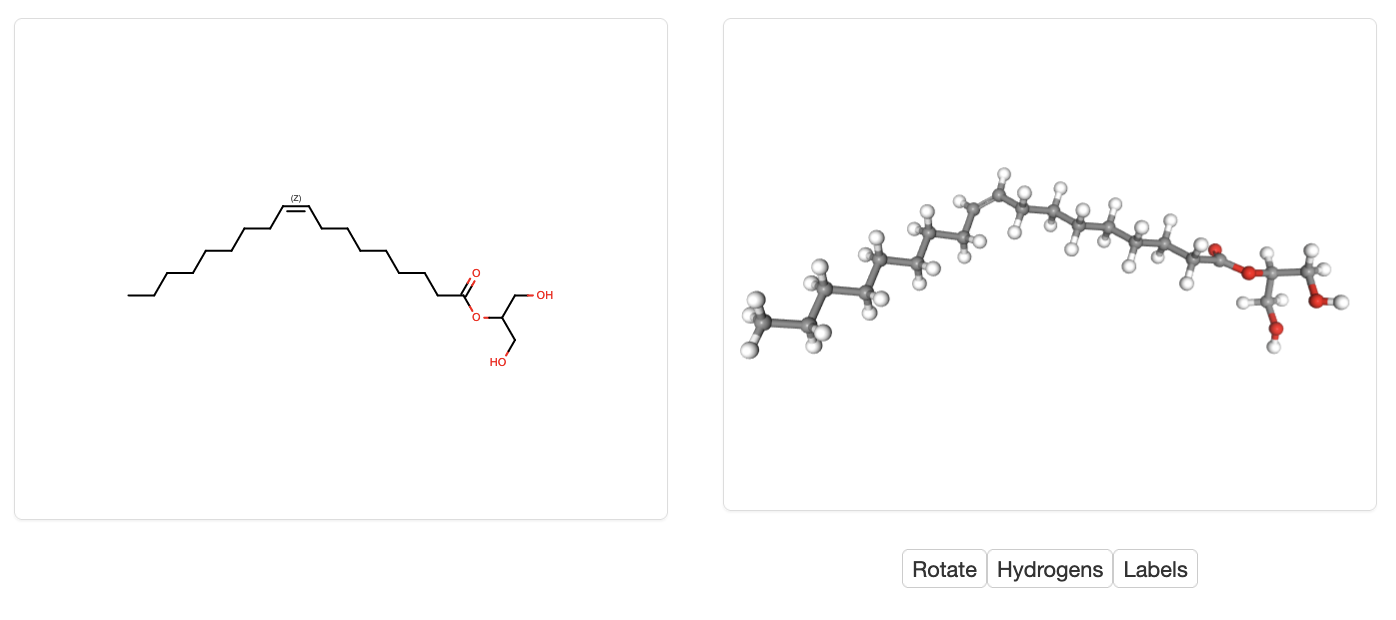
* Lipids include a broad range of molecules. Explore small molecules in the PDB’s Chemical Component Dictionary that are [non-polymers and have a molecular weight that is greater than 300 Da](https://www.rcsb.org/search?request=%7B%22query%22%3A%7B%22type%22%3A%22group%22%2C%22logical_operator%22%3A%22and%22%2C%22nodes%22%3A%5B%7B%22type%22%3A%22group%22%2C%22logical_operator%22%3A%22and%22%2C%22nodes%22%3A%5B%7B%22type%22%3A%22group%22%2C%22nodes%22%3A%5B%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.type%22%2C%22operator%22%3A%22exact_match%22%2C%22negation%22%3Afalse%2C%22value%22%3A%22non-polymer%22%7D%7D%5D%2C%22logical_operator%22%3A%22and%22%7D%2C%7B%22type%22%3A%22group%22%2C%22nodes%22%3A%5B%7B%22type%22%3A%22group%22%2C%22nodes%22%3A%5B%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.formula_weight%22%2C%22value%22%3A%7B%22from%22%3A300%2C%22to%22%3A400%2C%22include_lower%22%3Atrue%2C%22include_upper%22%3Afalse%7D%2C%22operator%22%3A%22range%22%7D%7D%2C%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.formula_weight%22%2C%22value%22%3A%7B%22from%22%3A400%2C%22to%22%3A500%2C%22include_lower%22%3Atrue%2C%22include_upper%22%3Afalse%7D%2C%22operator%22%3A%22range%22%7D%7D%2C%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.formula_weight%22%2C%22value%22%3A%7B%22from%22%3A500%2C%22to%22%3A600%2C%22include_lower%22%3Atrue%2C%22include_upper%22%3Afalse%7D%2C%22operator%22%3A%22range%22%7D%7D%2C%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.formula_weight%22%2C%22value%22%3A%7B%22from%22%3A600%2C%22to%22%3A700%2C%22include_lower%22%3Atrue%2C%22include_upper%22%3Afalse%7D%2C%22operator%22%3A%22range%22%7D%7D%2C%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.formula_weight%22%2C%22value%22%3A%7B%22from%22%3A700%2C%22to%22%3A800%2C%22include_lower%22%3Atrue%2C%22include_upper%22%3Afalse%7D%2C%22operator%22%3A%22range%22%7D%7D%2C%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.formula_weight%22%2C%22value%22%3A%7B%22from%22%3A800%2C%22to%22%3A900%2C%22include_lower%22%3Atrue%2C%22include_upper%22%3Afalse%7D%2C%22operator%22%3A%22range%22%7D%7D%2C%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.formula_weight%22%2C%22value%22%3A%7B%22from%22%3A900%2C%22to%22%3A1000%2C%22include_lower%22%3Atrue%2C%22include_upper%22%3Afalse%7D%2C%22operator%22%3A%22range%22%7D%7D%2C%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22text_chem%22%2C%22parameters%22%3A%7B%22attribute%22%3A%22chem_comp.formula_weight%22%2C%22value%22%3A1000%2C%22operator%22%3A%22greater_or_equal%22%7D%7D%5D%2C%22logical_operator%22%3A%22or%22%2C%22label%22%3A%22chem_comp.formula_weight%22%7D%5D%2C%22logical_operator%22%3A%22and%22%7D%5D%2C%22label%22%3A%22text_chem%22%7D%2C%7B%22type%22%3A%22group%22%2C%22logical_operator%22%3A%22and%22%2C%22nodes%22%3A%5B%7B%22type%22%3A%22group%22%2C%22nodes%22%3A%5B%7B%22type%22%3A%22terminal%22%2C%22service%22%3A%22full_text%22%2C%22parameters%22%3A%7B%22value%22%3A%22lipid%22%7D%7D%5D%2C%22logical_operator%22%3A%22and%22%7D%5D%2C%22label%22%3A%22full_text%22%7D%5D%7D%2C%22return_type%22%3A%22mol_definition%22%2C%22request_options%22%3A%7B%22paginate%22%3A%7B%22start%22%3A0%2C%22rows%22%3A25%7D%2C%22results_content_type%22%3A%5B%22experimental%22%5D%2C%22sort%22%3A%5B%7B%22sort_by%22%3A%22score%22%2C%22direction%22%3A%22desc%22%7D%5D%2C%22scoring_strategy%22%3A%22combined%22%7D%2C%22request_info%22%3A%7B%22query_id%22%3A%22c918408af83e059cd5349fd807727d29%22%7D%7D). Note that while this is not a complete list of lipids, many of them are lipids or lipid-like molecules. Make a gallery of these molecules by clicking on the  icon at the top of the list of amino acids listed on the page to explore these molecules.

### Examine:

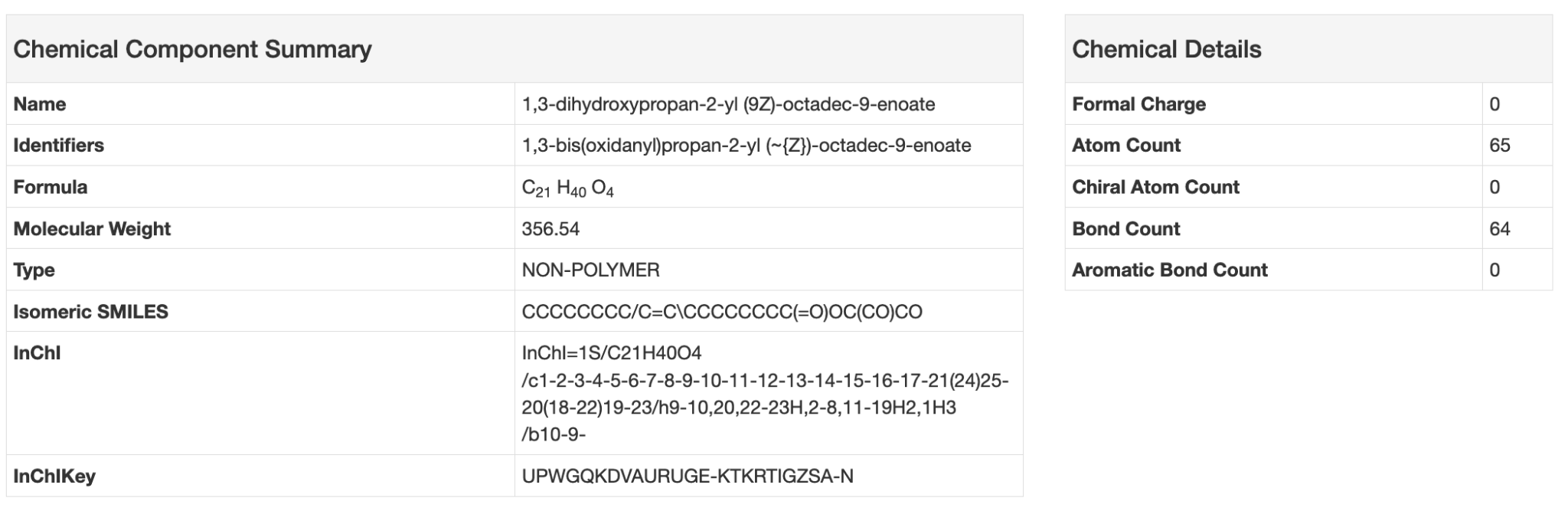
To learn more about each amino acid you can examine its ligand summary page.

For example for [YOG](https://www.rcsb.org/ligand/YOG), you can

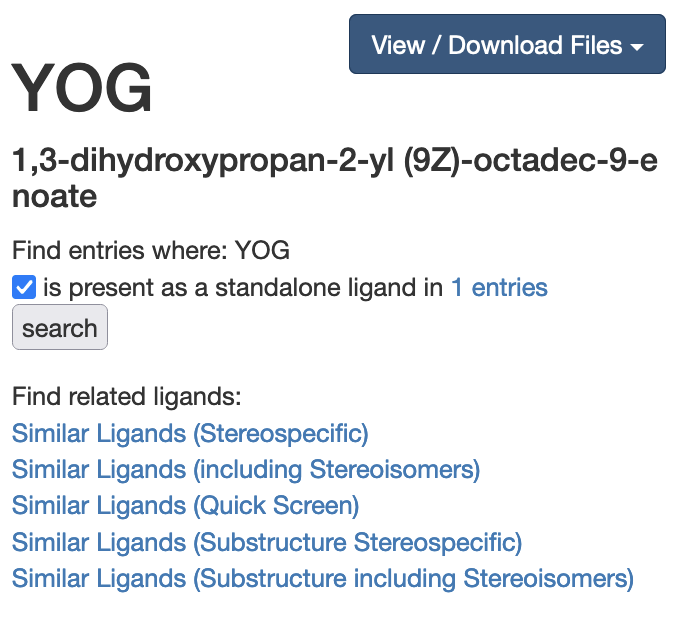
* Examine the 2D and 3D structures of the molecule



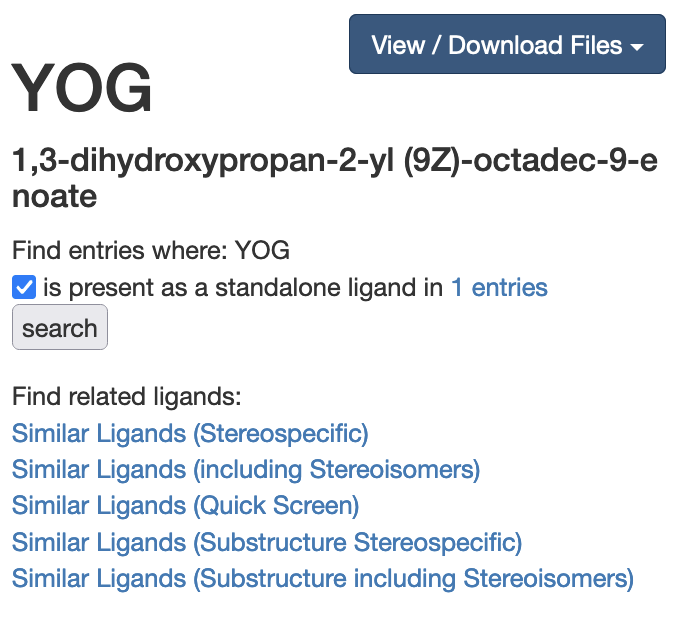
* Access the complete chemical name, formula, and other chemical identifiers



* Download files, identify PDB entries where the molecule is present as part of a polymer, covalently bound, or interacting through non-covalent interactions.



* Find other ligands in the dictionary with the same or similar chemical properties.



* Where available, information about the molecule being a drug or nutraceutical, and links to DrugBank, PubChem etc. to access additional information.

