## **Exploring Amino Acids**

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**Lesson Overview**:

This lesson reviews amino acids (the building blocks of proteins).

**ASBMB Learning Objectives**

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

2. Structure is determined by several factors

* Students should be able to **recognize the repeating units in biological macromolecules** and be able to discuss the structural impacts of the covalent and noncovalent interactions involved *(Introductory)*.

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As the name suggests, all amino acids have an amino (NH3+) and an acidic group (COO-). However, some amino acids have an acidic group in the side chains too.

1. Explore the [naturally occurring (standard) amino acids](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%22rcsb_chem_comp_container_identifiers.comp_id%22%2C%22operator%22%3A%22in%22%2C%22negation%22%3Afalse%2C%22value%22%3A%5B%22gly%22%2C%22ala%22%2C%22ser%22%2C%22thr%22%2C%22val%22%2C%22leu%22%2C%22ile%22%2C%22tyr%22%2C%22trp%22%2C%22phe%22%2C%22his%22%2C%22asp%22%2C%22asn%22%2C%22glu%22%2C%22gln%22%2C%22pro%22%2C%22arg%22%2C%22lys%22%2C%22met%22%2C%22cys%22%5D%7D%7D%5D%2C%22logical_operator%22%3A%22and%22%7D%5D%2C%22label%22%3A%22text_chem%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%22scoring_strategy%22%3A%22combined%22%2C%22sort%22%3A%5B%7B%22sort_by%22%3A%22score%22%2C%22direction%22%3A%22desc%22%7D%5D%7D%2C%22request_info%22%3A%7B%22query_id%22%3A%2222bbd5c22f2ad12a74a6e733045968ba%22%7D%7D) in the PDB. Make a gallery of these amino acids by clicking on the  icon at the top of the list of amino acids listed on the page for your reference. Note that the amino acids are shown in their uncharged states in the chemical component dictionary. Each amino acid has a unique identifier (or alphanumeric code) that is used to represent it in the coordinate file. For example the identifier for glycine is GLY.
   1. Which of these amino acids have negatively charged side chains (at physiological pH)? List their identifiers.

* 1. Save an image of the amino acid(s) listed above and point out with labels, where the charge would be located.

1. Explore the molecule [TYR](https://www.rcsb.org/ligand/TYR) and answer the following questions:
   1. What is the complete chemical name of this molecule?
   2. Which of the following describe the nature of the side chain of this amino acid? Select all options that are appropriate.
      * Polar
      * Apolar
      * Aromatic
      * Positively charged
      * Negatively charged
   3. If this amino acid were part of a protein, what types of non-covalent interactions can this amino acid sidechain form?

* 1. Is this molecule used as a drug or supplement? How did you figure this out?

1. Explore the [ligands in the Chemical Component Dictionary that are related to TYR](https://www.rcsb.org/search?request=%7B%22query%22%3A%7B%22type%22%3A%22group%22%2C%22nodes%22%3A%5B%7B%22service%22%3A%22chemical%22%2C%22parameters%22%3A%7B%22type%22%3A%22descriptor%22%2C%22descriptor_type%22%3A%22SMILES%22%2C%22value%22%3A%22c1cc(ccc1C%5BC%40%40H%5D(C(%3DO)O)N)O%22%2C%22match_type%22%3A%22fingerprint-similarity%22%7D%2C%22label%22%3A%22chemical%22%2C%22type%22%3A%22terminal%22%7D%5D%2C%22logical_operator%22%3A%22and%22%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%22scoring_strategy%22%3A%22combined%22%2C%22sort%22%3A%5B%7B%22sort_by%22%3A%22score%22%2C%22direction%22%3A%22desc%22%7D%5D%7D%2C%22request_info%22%3A%7B%22query_id%22%3A%22a8edeca926f7c45465289a8089f14d55%22%7D%7D) and answer the following questions:

Note that each ligand has a three alpha-numeric character code. This is used to identify the ligand in PDB structures. For example Tyrosine’s ligand code is TYR.

* 1. Did you find a ligand called Meta-Tyrosine in the list above? Write the ligand code for this molecule. Click on the code to view the details of this molecule. List at least one alternate chemical name (or identifier) for this molecule.

* 1. List at least one way in which this molecule is similar to TYR and one way it is different from TYR. Hint - you may wish to support your written answer by including an annotated/labeled image of the molecules you are comparing.

1. Explore the following molecules in PDB’s Chemical Component Dictionary by clicking on the link included in the first column in the following table. Complete the table by:
   1. Indicating the “Molecule Type” by selecting from the following terms: **L-amino acid, D- amino acid, not a chiral molecule**.
   2. Filling in the “Reason” and “Evidence” columns to include the reason for your classification in words and in a figure respectively. Follow the example shown for SER.

| Ligand ID | Chemical structure | Type of molecule (Claim) | Evidence | Reason |
| --- | --- | --- | --- | --- |
| [SER](https://www.rcsb.org/ligand/SER) |  | L- amino acid |  | The clockwise CO-R-N rule applies. Listed as L-peptide linking (see Ligand Summary page for SER). |
| [DSN](https://www.rcsb.org/ligand/DSN) |  |  |  |  |
| [FGL](https://www.rcsb.org/ligand/FGL) |  |  |  |  |
| [PRO](https://www.rcsb.org/ligand/PRO) |  |  |  |  |