# miniPCR™ Protein Folding LARP (Live Action Role Play)

## Summary

In this activity, students will role play to make a folded protein from a polypeptide chain. Students will represent individual amino acids. Based on the chemical properties of the amino acids, the group must arrange themselves in a stable tertiary structure. Here we list directions to follow, but we encourage teachers to experiment with this activity and to modify it to their needs and class.

## Materials

### Instructions

Step by step instructions to follow while directing your students.

### Teacher Questions

Use these questions throughout the activity to challenge students and to assess their understanding. The questions are meant as suggestions to expand upon.

### Formative Assessment/Exit ticket

At the end of the activity or class, use to assess student understanding.

### Amino Acid Cards

Printed two per page. Cut pages in half prior to use. Print at least one card per student. The number of positively charged and negatively charged amino acid cards that are handed out should be equal. The number of hydrophobic and hydrophilic amino acids cards should be close to equal.

# Directions

## Overview

This activity can be used for a wide range of groups sizes, but we recommend a minimum of about 16 students. Students will be given *Amino Acid Cards* identifying them as one of the twenty amino acids coded for by the universal genetic code. Students will form a primary structure by linking arms in a line. Depending on the chemical properties of each student's amino acid, students will need to bond with another amino acid, be shielded from the surrounding aqueous environment, or be in contact with the surrounding aqueous environment all while remaining linked to their neighbors in a primary structure. By arranging themselves as described above, students will form a tertiary structure.

### Round 1: Primary Structure

- Hand out amino acid cards randomly.
- Tell students to form a line, shoulder to shoulder and link arms at the elbows. This is order represents the protein primary structure.
- Ask students to form a new primary structure. Students should reorder themselves in line.

### Round 2: Tertiary Structure

- Inform students that they are in the cytoplasm of the cell, an aqueous environment.
- To form a tertiary structure, students must follow the following three rules.
  1. If the student is an amino acid with a positive charge, they must physically touch their card to an amino acid card with a negative charge, and vice versa.
  2. If the student is an amino acid that is hydrophobic, they must end up on the inside of the protein tertiary structure shielded from the surrounding water.
  3. If the student is an amino acid that is hydrophilic, they must end up on the outside of the protein tertiary structure in contact with the surrounding water.
- Tell the group to "go", and all students must accomplish the above tasks simultaneously. Remind students that under no circumstances can they break their link with the amino acid next to them.
- When students seem to have settled on a tertiary structure, inspect their arrangement. Check that all charged amino acids are in contact with an amino acid of opposite charge, and that no hydrophobic amino acids are on the outside of the group.
- Have students make adjustments to their structure if necessary.

## Notes on implementing.

- As a general rule, we recommend having students link elbows instead of holding hands. It tends to be less awkward for students, and students also tend to let go less often during the LARP.
- Handing out an excess of hydrophobic amino acid cards will make it very difficult for students to reach a stable tertiary structure.
- Secondary structure is extremely difficult to model to students in this or other simple modeling exercises. We recommend acknowledging that secondary structures are important, but that for the purposes of this activity we will be overlooking them.
- We recommend running this LARP several times with the same group. The first run can be heavy on instruction. In subsequent runs, students can trade amino acid cards and run the LARP on their own, seeing how changes in primary structure will affect tertiary structure.
- To add complexity to the LARP, try putting lines of tape on the ground to represent a cell membrane. Regions of the protein inside the cell membrane must have hydrophobic amino acids on the exterior of the protein. Challenge the group to make a primary structure that will fully or only partially span the membrane when a tertiary structure is formed.
- We recommend laminating cards and adding string to make them hang on students' necks like a necklace.

## Example Questions

### Round 1: Primary Structure

What do you call the structure that you are in now?

- *The basic order of amino acids in a polypeptide chain is referred to as primary structure.*

What do you call the bond that links you to the person next to you?

- *The bond between amino acids is a peptide bond.*

What is the least amount of rearranging you could do to make a new primary structure?

- *The least amount of rearrangement resulting in a new primary structure would be one student changing places.*

In the cell, what would determine your primary structure?

- *Primary structure is determined by the amino acid sequence which is directly determined by the nucleotide sequence of the DNA/RNA.*

### Round 2: Tertiary Structure

What made you end up where you are in the tertiary structure? Did anyone have to direct you?

- *Tertiary structure is determined by the chemical properties of the individual amino acids.*

Now that you have reached your tertiary structure, how easy would it be for you to move around in relation to each other? In other words, how stable are you?

- *It should be difficult for students to move much within the protein. Protein tertiary structure is the thermodynamically most stable structure a polypeptide can form.*

If I wanted to break up this structure in the cell. What could I do?

- *Heat or change in pH could denature the protein in the cell.*

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If there were a mutation in the DNA that coded for this cell causing the replacement of a single amino acid, what types of changes would have a big effect on your structure? What types of changes would be less likely to have an effect.

- *Changing charged amino acids for uncharged amino acids or amino acids of the opposite charge would likely have a large effect. Changing a hydrophobic for a hydrophilic amino acid and vice versa could also have a significant effect.* Changing one amino acid for another amino acid with similar chemical properties would be less likely to affect the tertiary structure of the protein.

Exit Ticket Name:_____

In your own words, describe how the chemical properties of amino acids affect the tertiary structure of a protein.

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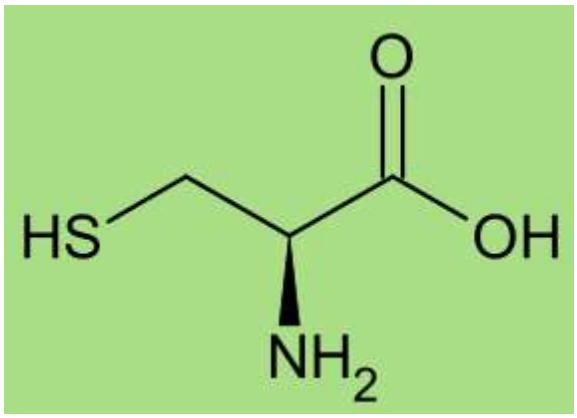
# Cysteine

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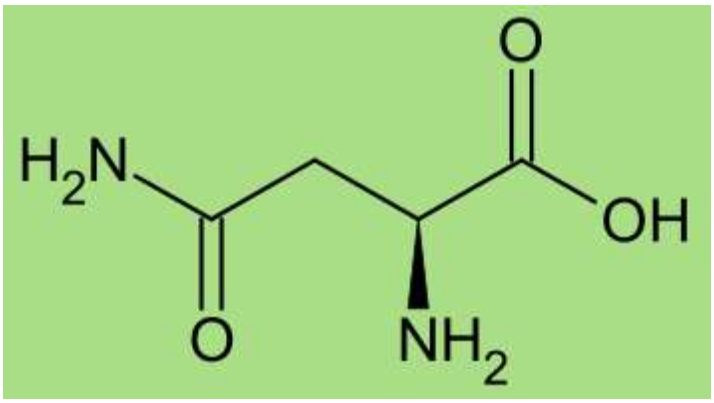
# Asparagine

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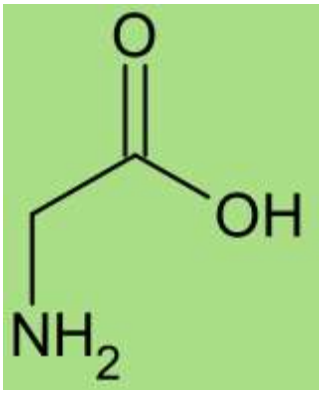
# Glycine

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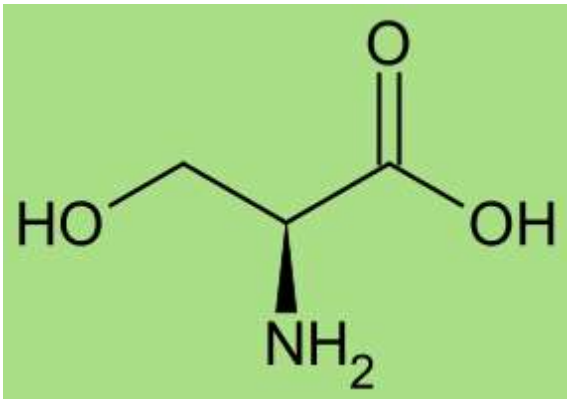
# Serine

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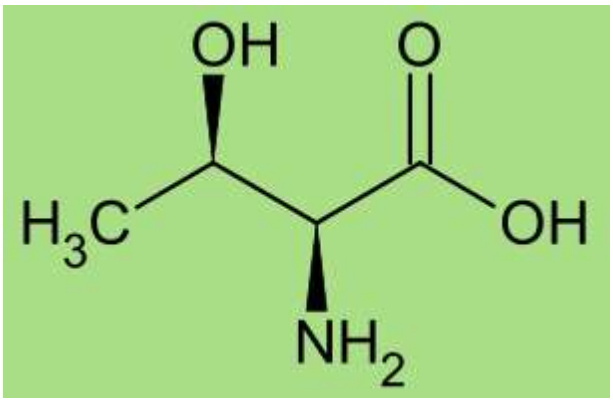
# Threonine

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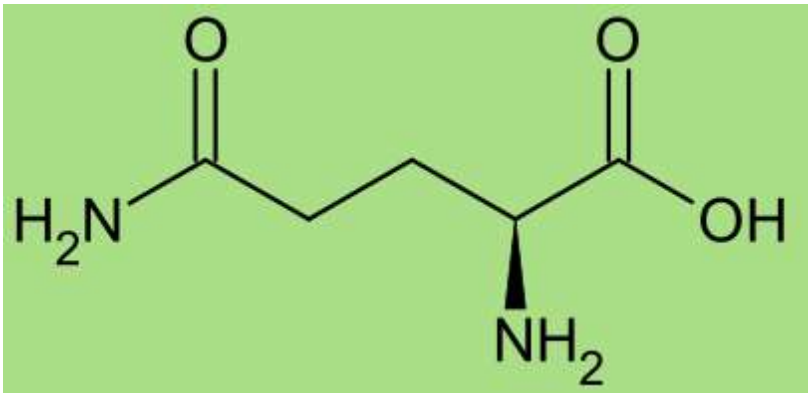
# Glutamine

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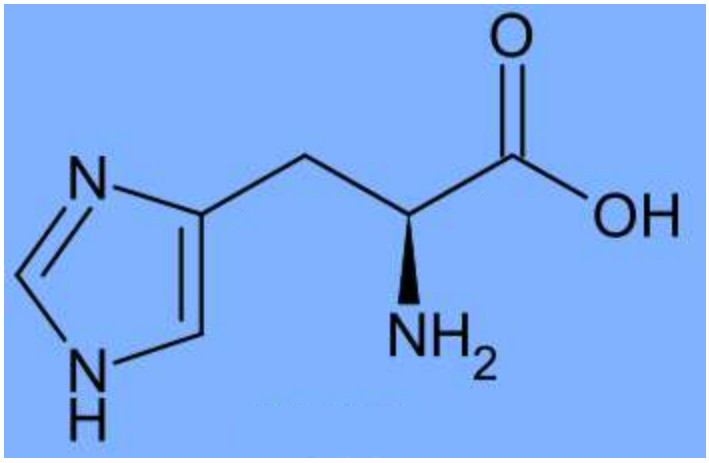
# Histidine




Positive Charge

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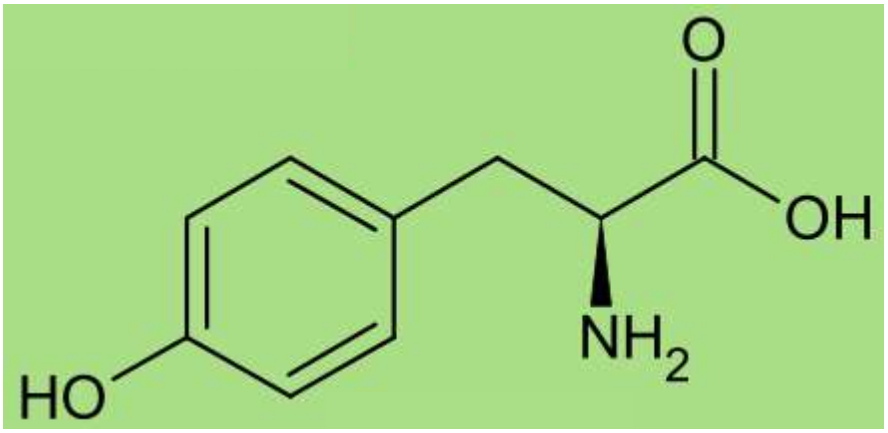
# Tyrosine

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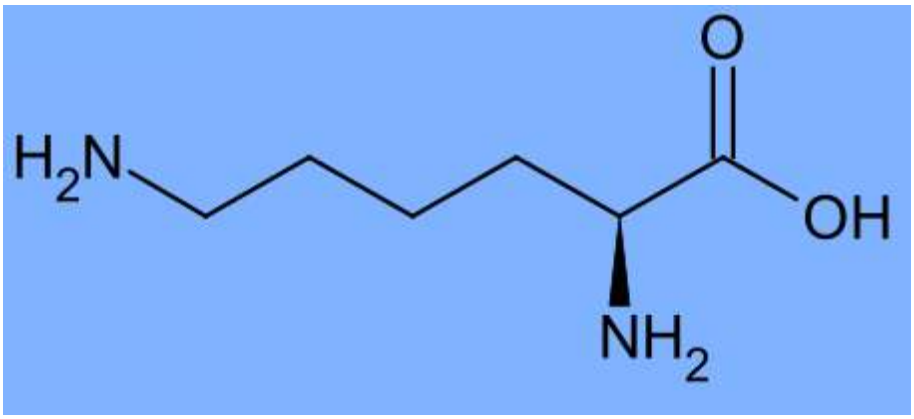
# Lysine




Positive Charge

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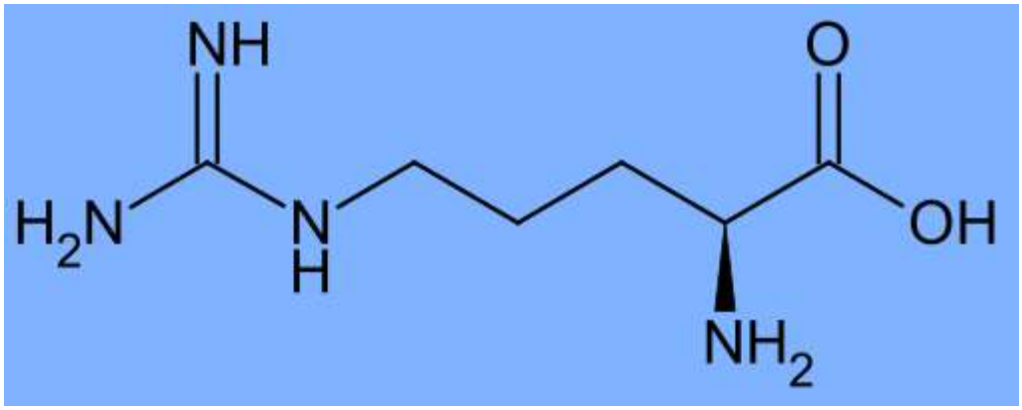
# Arginine




Positive Charge

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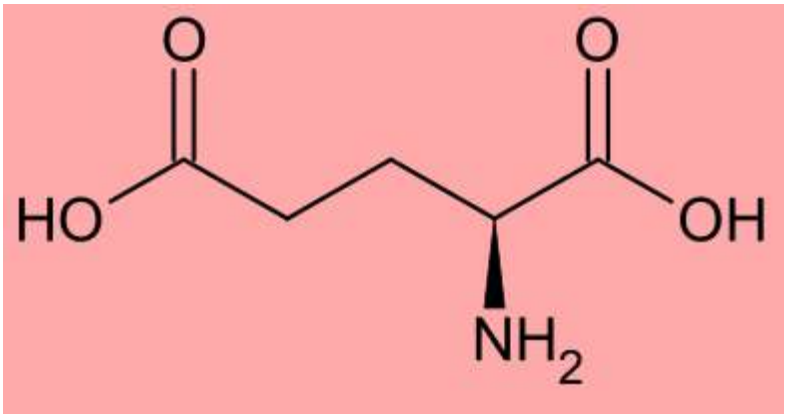
# Glutamic Acid




Negative Charge

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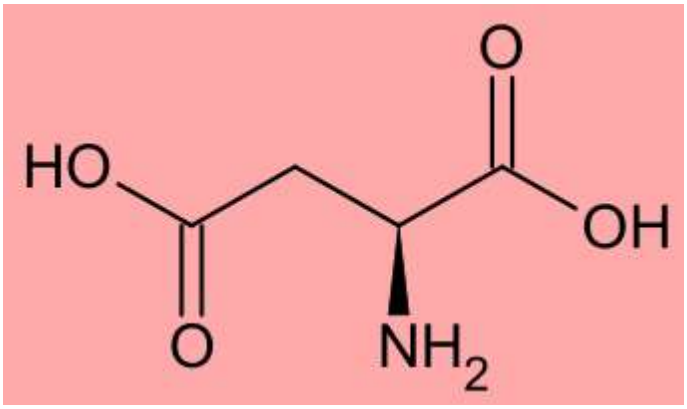
# Aspartic Acid




Negative Charge

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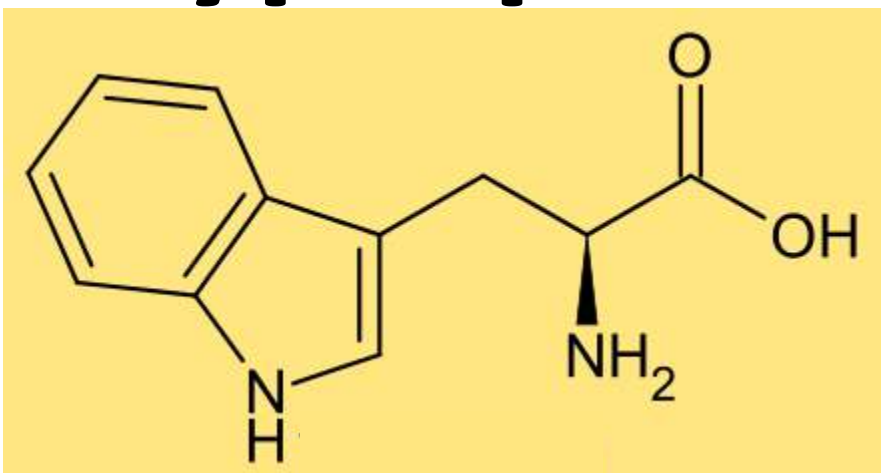
# Tryptophan

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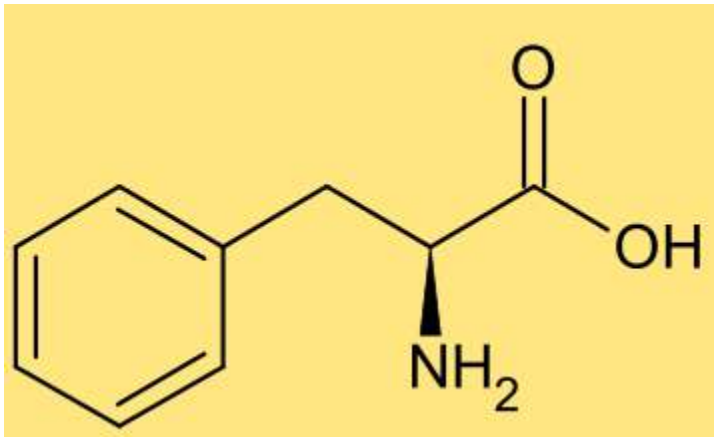
# Phenylalanine

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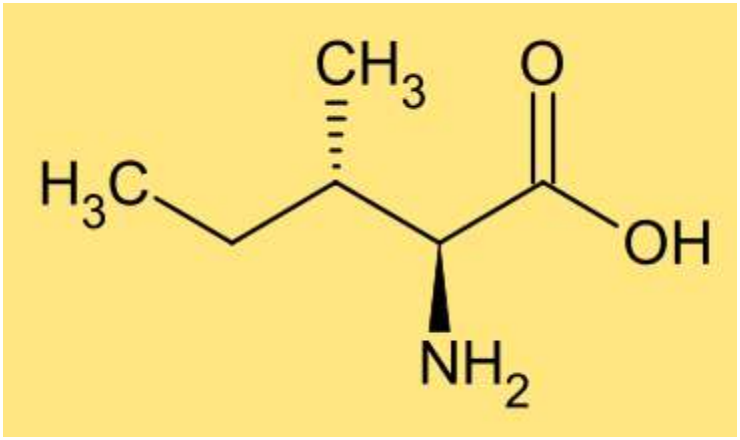
# Isoleucine

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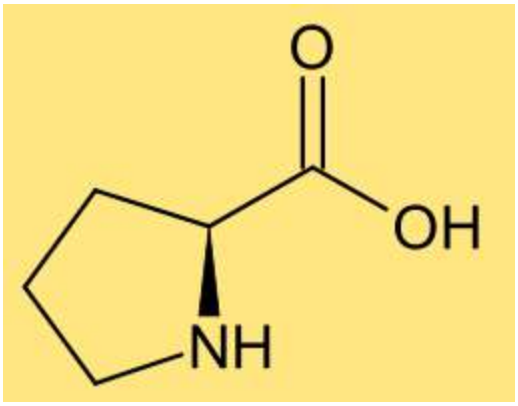
# Proline

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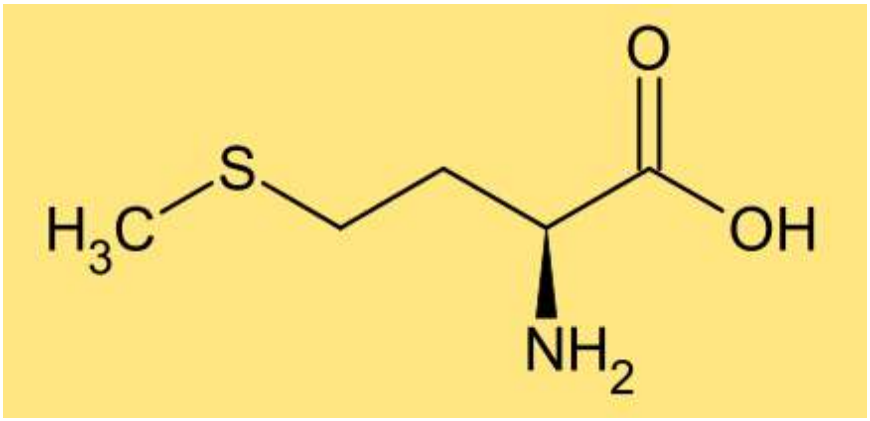
# Methionine

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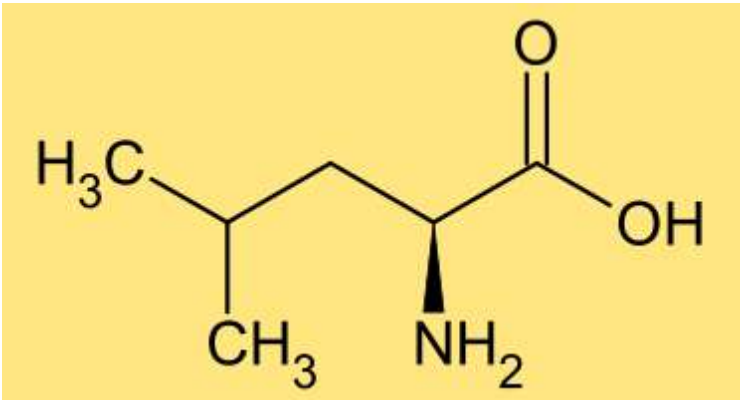
# Leucine

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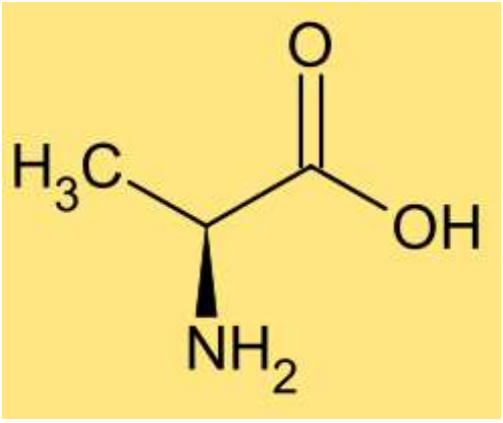
# Alanine

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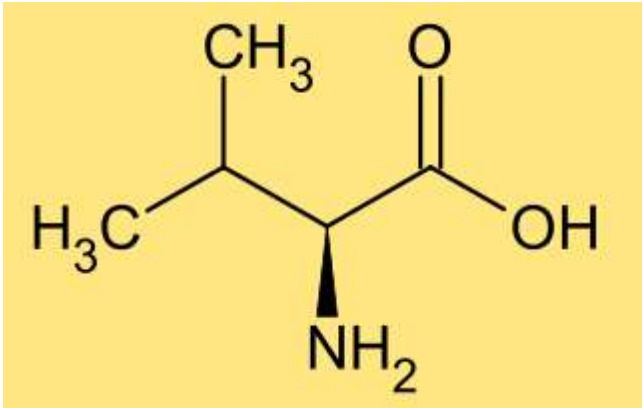
# Valine

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