# How Do Organisms Build Structures From Proteins?

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|  | Introduction and Part 1: Protein Structure |
| 0:00  Narrator appears, waves. | Hi.  In this video I’ll be talking about the basic structure and function of proteins. |
| Narrator walking | I invited my friend Marcy to help me explain what proteins are, how organisms use them to build useful structures, … |
| Cartoon of rhino appears. | …and how small changes in one region of one protein can produce BIIIIGG changes in organisms. |
| 0:15  Fly-in on rhino muscle  Papa Legba:Users:danjohnson:Downloads:2357291507_a15ca882a6_o.jpg | First, what IS a protein? ***Question: SUMMARIZE***  In everyday life, we think of protein as the stuff that muscles are made of. As you’ll soon see, … |
| Pepper with names and functions, arrows, ever faster | … cells and organisms contain several thousand different proteins that do all kinds of jobs. |
| Zoom in to a single microfilament  to 3D complex structure  Papa Legba:Users:danjohnson:Desktop:Space Structures:Small filament.png  Papa Legba:Users:danjohnson:Desktop:Space Structures:Lysozyme.png  to amino acids  Papa Legba:Users:danjohnson:Desktop:Stick strutures:Small alanine.png | What makes up a protein? ***Question: SUMMARIZE***  Proteins are **macromolecules**, which means they are large molecules made up of repeating subunits of small molecules.  In the case of proteins, the repeating subunits are **amino acids.**  ***(Display* BOLD UNDERLINED *words on-screen)*** |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:1 2000px-AminoAcidball.svg.png  Hi-lite each area | Amino acids are **organic molecules**. That means they are built mainly from carbon atoms.  (***HIGHLIGHT carbon atoms)***  Most amino acids have a central carbon atom with 4 side groups. (***NUMBER side groups)***  One side group is an **amine**. A second side group is a **carboxylic acid**.  (***HIGHLIGHT side groups)***  These two side groups are found in ALL amino acids, and are important for several reasons.  For one thing, they give amino acids their name. |
|  | They also are where amino acids form covalent bonds that join them together in long chains.  ***(HIGHLIGHTS AND ARROWS walk through image)*** |
| Papa Legba:Users:danjohnson:Desktop:Stick strutures:AlphaHelixProtein.jpg | The amino and carboxylic acid groups also form hydrogen bonds within proteins, helping them fold into complex shapes.  ***(HIGHLIGHTS AND ARROWS walk through image)*** |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:1 2000px-AminoAcidball.svg.png | The third side group usually is a hydrogen.  (***HIGHLIGHT side group)***  The fourth side group is different for each amino acid.  (***HIGHLIGHT side group)*** |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:2 Colored amino acids:Pro_miguelferig.jpg | One amino acid, proline, has a second covalent bond connecting its amine group to the side group. This creates a ring structure that will be important later when we look at how proteins fold. |
|  | ***Question: SUMMARIZE. Which part of amino acids are different?***  ***Which parts participate in hydrogen bonding?*** |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:3 2000px-Amino_Acids.svg.png | Living things use 22 different amino acids to make proteins. Most proteins are made using just 20 amino acids. The other two are only used by certain organisms or for certain proteins. |
| Image of archaebacteria | For instance, methane-producing archaebacteria use a particular amino acid called … |
| Add image of pyrrolysine | … pyrrolysine that mammals and vertebrates NEVER use in their proteins. So if you find a protein with pyrrolysine in it, you know it was made by bacteria. |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:2 Colored amino acids:Gly_miguelferig.jpg | The unique side groups can be as small as one hydrogen,  ***(ADD THIS AND NEXT FIVE AMINO ACIDS TO SAME PAGE)*** |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:2 Colored amino acids:His_miguelferig.jpg | or big, complex ring structures. |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:2 Colored amino acids:Lys_miguelferig.jpg | Under the conditions inside a cell, the side groups can be + charged, |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:2 Colored amino acids:Asp_miguelferig.jpg | - charged, |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:2 Colored amino acids:Ser_miguelferig.jpg | polar but uncharged, |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:2 Colored amino acids:Ala_miguelferig.jpg | or entirely non-polar. |
| Papa Legba:Users:danjohnson:Desktop:Schematics:Amino_Acids_Venn_Diagram.png | The relative charge (***HIGHLIGHT***), polarity (***HIGHLIGHT***), and size (***HIGHLIGHT***) of the side groups in the protein are what give proteins many of their important properties. |
| Plant making amino acids in leaves. | Where do amino acids come from? ***(QUESTION: SUMMARIZE)***  Plants make amino acids by combining sugars made by photosynthesis with nitrogen ions they take out of the soil.  That’s one reason why plant fertilizers contain nitrogen. |
| Rhino grazing. | Animals like us get part of our amino acids from our diet. Our cells make the rest of the amino acids by converting the backbone of one type of amino acid to another.  Just like cows, moose, and many animals, rhinos are vegetarians, or using the scientific term, **herbivores**. Marcy gets all the amino acids she need from plant matter. |
| Humans eating cheeseburger. | Humans are **omnivores**, meaning I can eat either plant or animal matter to get the amino acids I need. |
| Lions eating meat.  Papa Legba:Users:danjohnson:Downloads:6980791925_a1e85abf3c_o.jpg | Lions, wolves, and other hunters are **carnivores**, meaning they get amino acids mainly from eating other animals. |
| Montage of 3 prior images | Eating a normal, healthy diet containing a wide variety of foods gives us all the amino acids we need. |
| Papa Legba:Users:danjohnson:Desktop:Molecular Shapes:Amino_kiseline.jpg | Unless you have a specific disease or condition that affects protein metabolism, you do not need special protein supplements.  ***(Cover with red strike-out and sound rejection alarm.)*** |

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| Highlight muscle fiber  Papa Legba:Users:danjohnson:Desktop:Skeletal_muscle_-_longitudinal_section.jpg | Where are proteins found? (***QUESTION: RECALL***)  Muscles ARE mainly protein, but they definitely are NOT the only place we find proteins. |
| Illustration of a generalized cell.  Papa Legba:Users:danjohnson:Desktop:0312_Animal_Cell_and_Components.jpg | EVERY cell… |
| Highlight protein rich areas | …contains proteins… |
| Highlight lipid rich areas | …as well as lipids,… |
| Highlight CHO rich areas | …carbohydrates, and … |
| Highlight NA- rich areas | …nucleic acids. |
| Cross-fade to rhino and narrator. | Proteins also make up larger structures in organisms. |
| Magnify close-up of rhino foot. | In mammals like Marcy and me, claws, nails … |
| Slide to close-up of skin  Papa Legba:Users:danjohnson:Desktop:Sa-rhino-skin.jpg | and the outer layers of skin both are made up almost entirely of keratins. These are a large family of tough, resilient fibrous proteins that we will explore more in a few minutes. |
| Slide up to the rhino’s head. Highlight ear hairs and eyelashes. | Hair and… |
| Slide to horn. | … horns are made of keratins too. |
| Slide to the eye. | Even the clear corneas and lens of the eyes are made up of specialized proteins. |
| Rhino stepping on man’s foot; man screams, blood appears.  Papa Legba:Users:danjohnson:Downloads:blob-160409.png | GAAAAGGGHHH!!  Marcy get off my foot! |
| Punching | Unh, unh, unh! (not fading) |
| Crying man  Blood starts spreading under foot. | Please, please, please, please move! |
| Pushing | Unh, unh, unh! (fading) |
| Marcy turns to right, zoom in. | Bones are made up of tough proteins called **collagens**. |
| Flip to micro-view of bone. | Collagen fibers are embedded in a matrix of other proteins and crystals of calcium and phosphate. |
| Flip to micro-view of blood.  Papa Legba:Users:danjohnson:Downloads:blood-75302.jpg  Papa Legba:Users:danjohnson:Downloads:blood-75301.jpg | Blood also is rich in protein. |
| Close-up of blood. Arrow on RBC | Red blood cells are basically sacs of the protein **hemoglobin**, which is specialized for carrying oxygen. |
| Arrow on plasma space. | The liquid part of blood, called the **plasma**, is an aqueous solution mostly of electrolytes and dissolved proteins. |
| Zoom to plasma, showing clotting factors | Among those dissolved proteins are clotting factors, which he’s going to need as soon as I move my foot. |
| Illustrate clotting. | When clotting factors contact air, they undergo a chemical reaction. Soluble blood proteins turn into a meshwork of fibers that trap red blood cells and form a clot. |