NATURAL POLYMERS
PROTEINS I

Dr. Ladislav Pospíšil

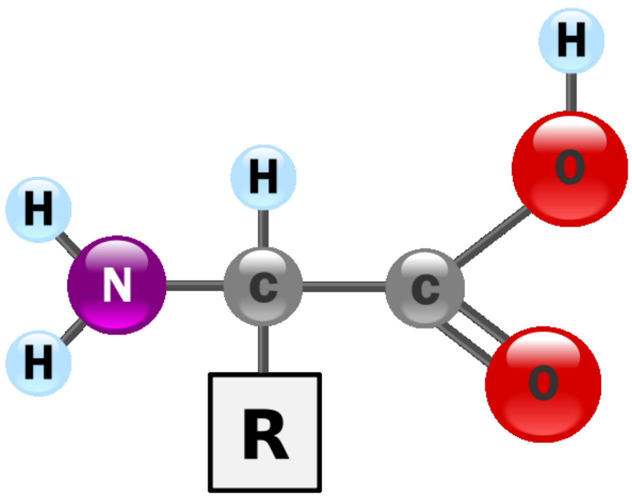
Time schedule

LECTURE	SUBJECT
1	Introduction to the subject – Structure & Terminology of nature polymers, literature
2	Derivatives of acids – natural resins, drying oils, shellac
3	Waxes
4	Plant (vegetable) gums, Polyterpene – natural rubber (extracting, processing and modification), Taraxacum_kok-saghyz
5	Polyphenol – lignin, humic acids
6	Polysaccharides I – starch
7	Polysaccharides II – celullose
8	Protein fibres I
9	Protein fibres II
10	Casein, whey, protein of eggs
11	Identification of natural polymers
	Laboratory methods of natural polymers' evaluation

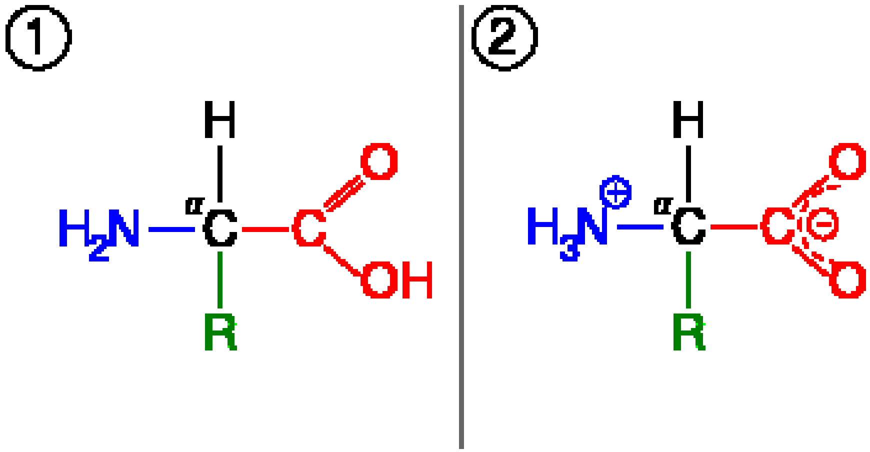
1. **Chemistry of Peptides and Proteins**
2. **Supermolecular Structure of Peptides and Proteins**

Chemistry of Peptides and Proteins

In the structure **shown BELLOW the SLIDE**, **R** represents a side chain specific to each amino acid. The carbon atom next to the carboxyl group (which is therefore numbered 2 in the carbon chain starting from that functional group) is called the α–carbon. Amino acids containing an amino group bonded directly to the alpha carbon are referred to as *alpha amino acids*. These include amino acids such as **PROLINE** which contain **secondary amines**, which used to be often referred to as **"imino acids".**



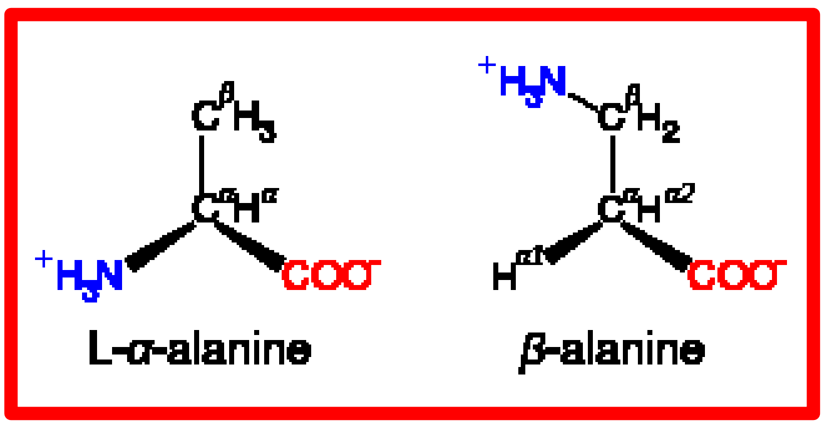
Chemistry of Peptides and Proteins

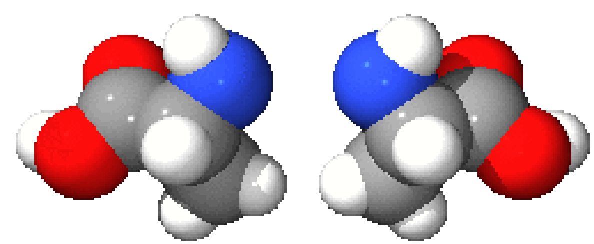


An amino acid in its (1) un-ionized and (2) zwitterionic forms

amfion

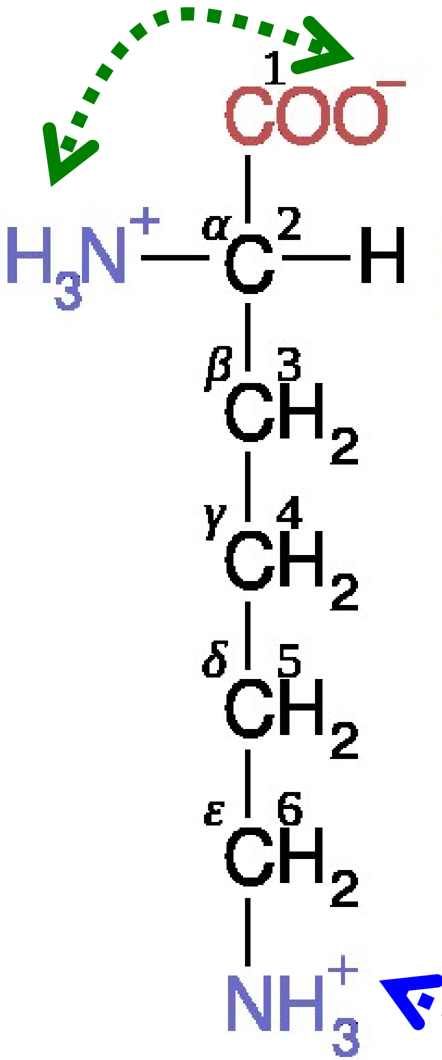
Převzato z NĚMČINY

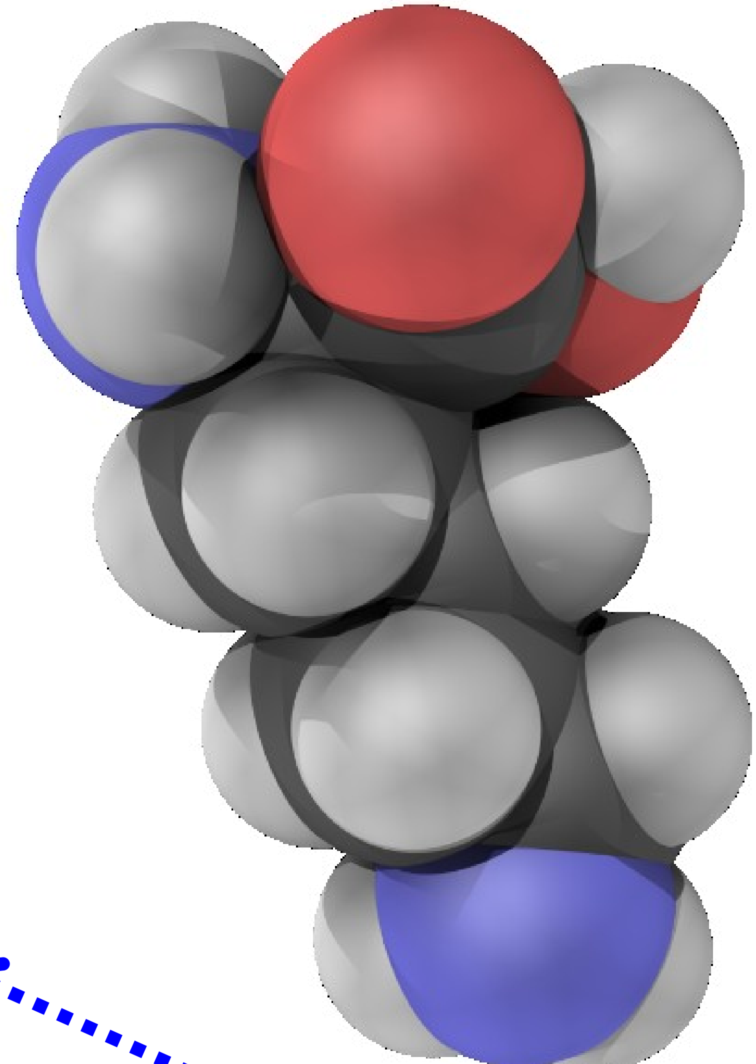




β-alanine and its α-alanine isomer

Chemistry of Peptides and Proteins





LYSINE– it has „LENT“ one H+ Cation here !

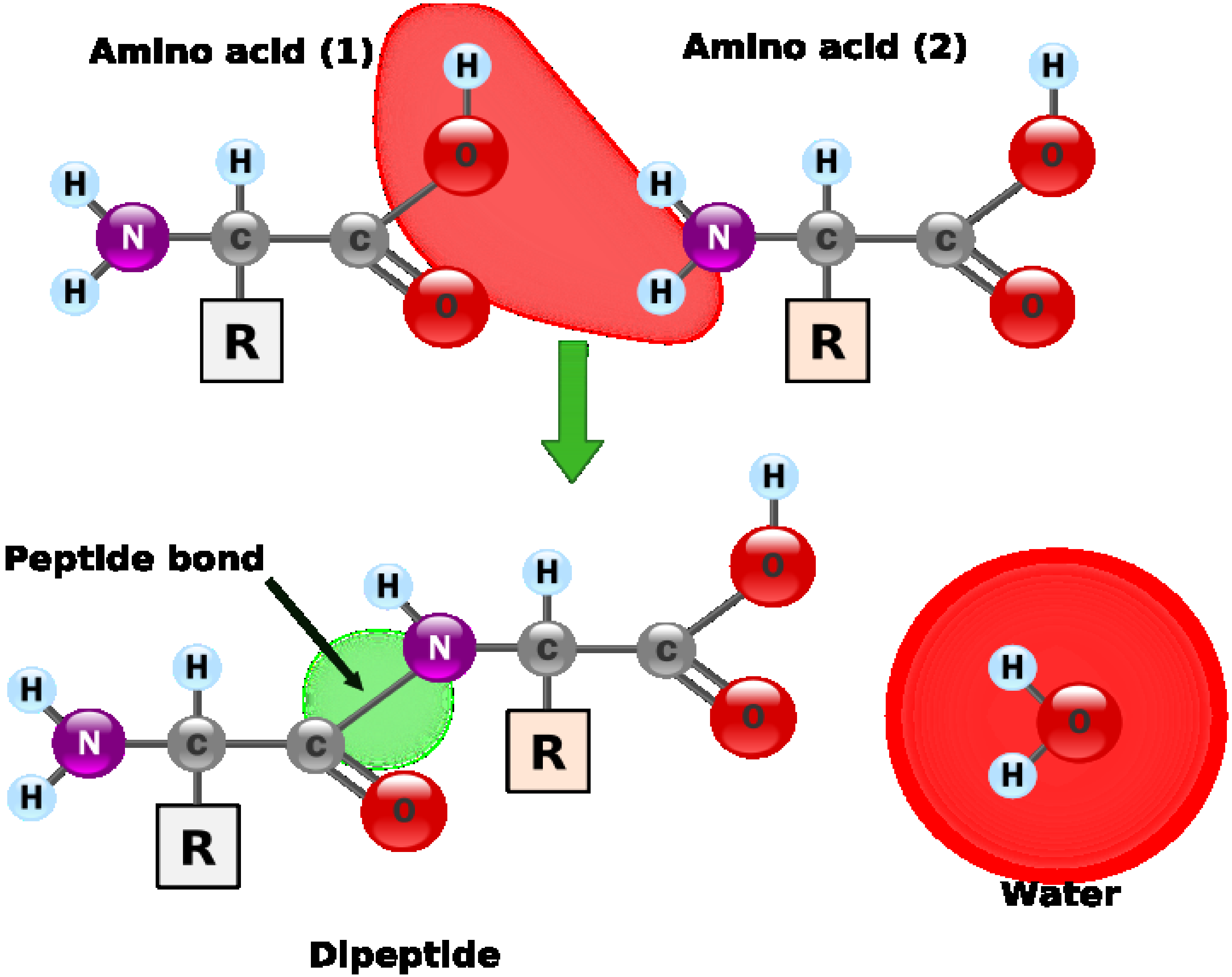
Amino acids are the structural units (monomers) that make up proteins. They join together to form short polymer chains called peptides or longer chains called either polypeptides or proteins. These polymers are linear and unbranched, with each amino acid within the chain attached to two neighboring amino acids.
Twenty-two amino acids are naturally incorporated into polypeptides and are called proteinogenic or natural amino acids.

Proteinogenic amino acids are amino acids that are incorporated biosynthetically into proteins during translation. The word "proteinogenic" means "protein creating". Throughout known life, there are 22 genetically encoded (proteinogenic) amino acids, 20 in the standard genetic code and an additional 2 that can be incorporated by special translation mechanisms

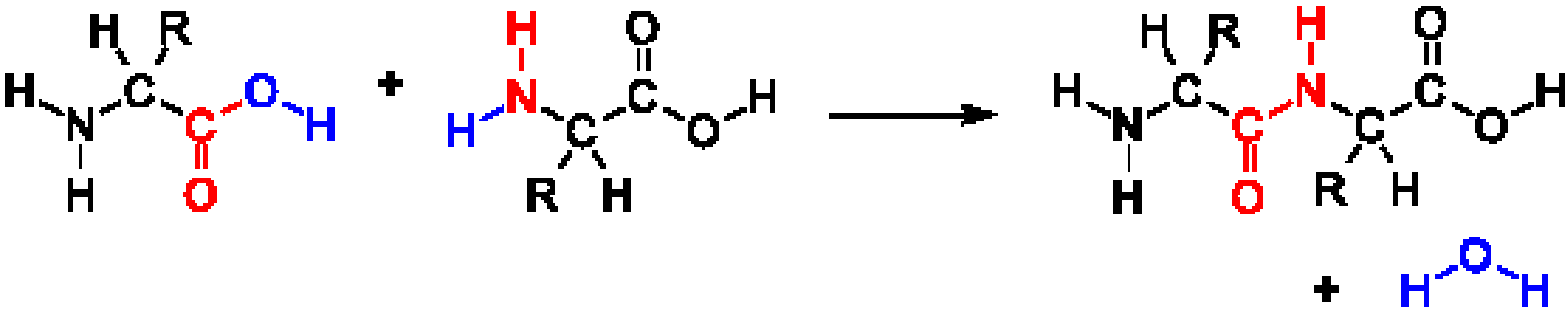
A **peptide bond**, also known as an **amide bond**, is a covalent chemical bond linking two consecutive amino acid monomers along a peptide or protein chain.

The **peptide bond** is synthesized when the carboxyl group of one amino acid molecule reacts with the amino group of the other amino acid molecule, causing the release of a molecule of water (H_2O), hence the process is a dehydration synthesis reaction (also known as a condensation reaction).

Chemistry of Peptides and Proteins



A **peptide bond**, also known as an amide bond, is a covalent chemical bond linking two consecutive amino acid monomers along a **PEPTIDE** or **PROTEIN CHAIN**



PEPTIDES are short chains of amino acid monomers linked by peptide (amide) bonds.

PROTEINS are large biomolecules, or macromolecules, consisting of one or more long chains of amino acid residues. A linear chain of amino acid residues is called a polypeptide. A protein contains at least one long polypeptide. Short polypeptides, containing less than 20–30 residues, and are commonly called peptides, or sometimes oligopeptides.

HIERARCHI

AMINOACID = *monomer*

PEPTID = *oligomer*

PROTEIN = *polymer*

AminoACIDS with aliphatic Side chain

Glycine **Gly** (G)
Alanine **Ala** (A)
Valine **Val** (V)
Leucine **Leu** (L)
Isoleucine **Ile** (I)

AminoACIDS with Carboxyl or Amide Group in the Side chain (Acid Groups)

Asparagic Acid **Asp** (D)
Asparagine **Asn** (N)
Glutamic Acid **Glu** (E)
Glutamine **Gln** (Q)

AminoACIDS with Amine Group in the Side chain (Basic Groups)

Arginine **Arg** (R)
Lysine **Lys** (K)

AminoACIDS with Aromatic nucleus (ring) or Hydroxyl Group in the Side chain

Histidine **His** (H)
Phenylalanine **Phe** (F)
Serine **Ser** (S)
Threonin **Thr** (T)
Tyrozine **Tyr** (Y)
Tryptophane **Trp** (W)

AminoACIDS with Sulphur Atom in the Side chain
Methionine Met (M)
Cysteine Cys (C)

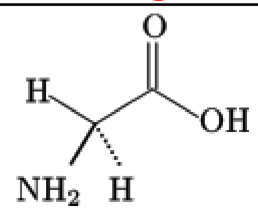
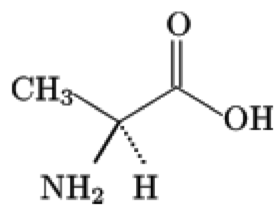
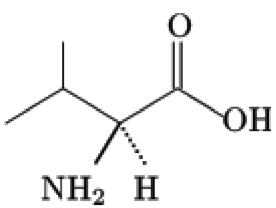
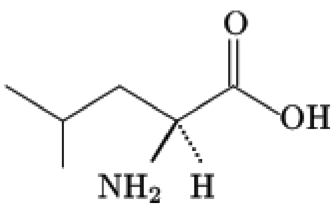
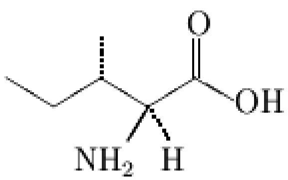
AminoACIDS with the SECONDARY AMINE
ProlinE Pro (P)

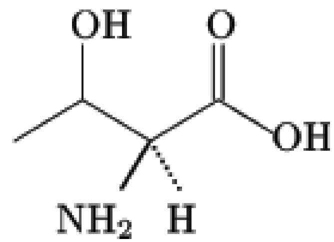
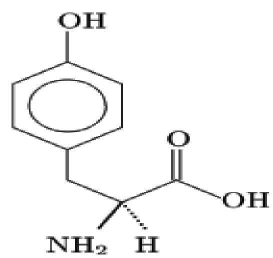
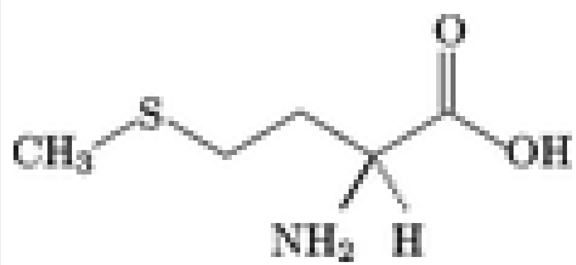
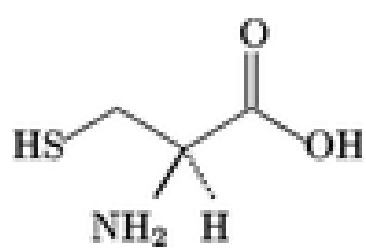
21. AminoACID (CONTAINING Se)
SelenocysteinE SeCys

22. AminoACID
Pyrolysine Pyl

Chemistry of Peptides and Proteins

Class	Name of the amino acids
Aliphatic	**Glycine, Alanine, Valine, Leucine, Isoleucine**
Hydroxyl or Sulfur-containing	**Serine, Cysteine, Threonine, Methionine**
Cyclic	**Proline**
Aromatic	**Phenylalanine, Tyrosine, Tryptophan**
Basic	**Histidine, Lysine, Arginine**
Acidic and their Amide	**Aspartate, Glutamate, Asparagine, Glutamine**

Biogenic aminoacids	
Glycine (Gly, G)	
Alanine (Ala, A)	
Valine (Val, V)	
Leucine (Leu, L)	
Isoleucine (Ile, I)	

Biogenní aminokyseliny	
Threonine (Thr, T)	
Tyrosine (Tyr, Y)	
Methionine (Met, M)	
Cysteine (Cys	

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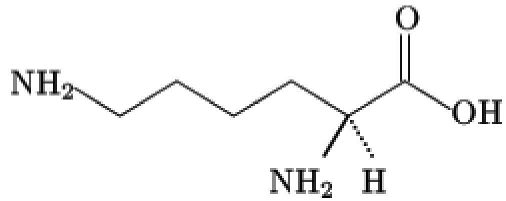
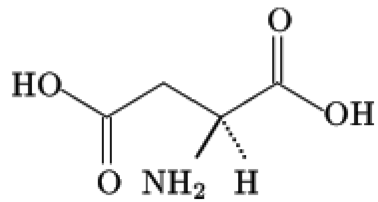
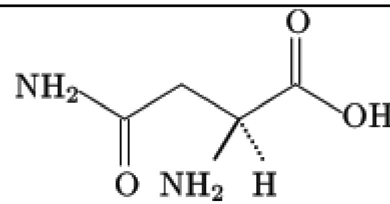
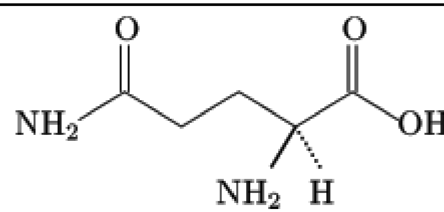
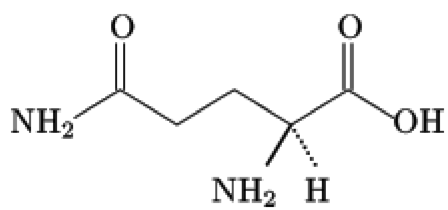
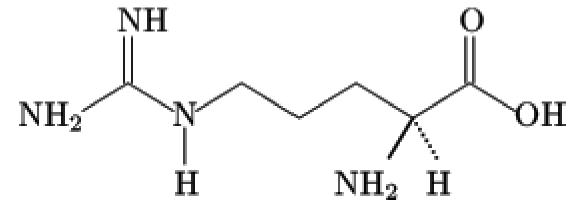
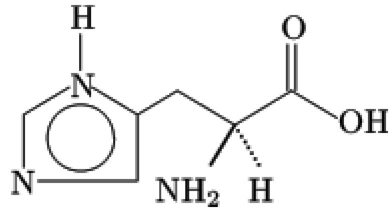
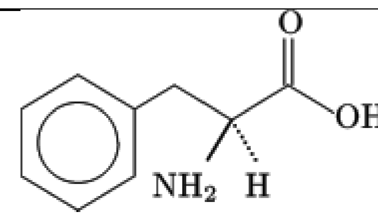
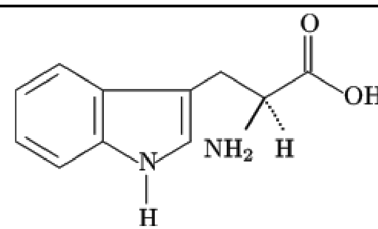
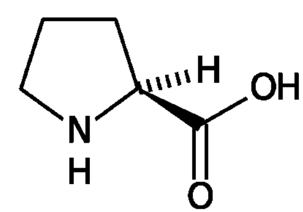
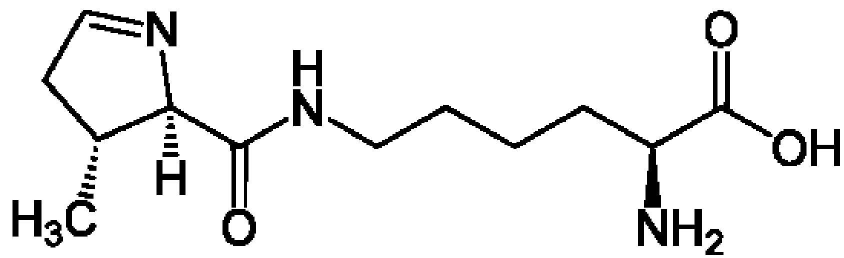
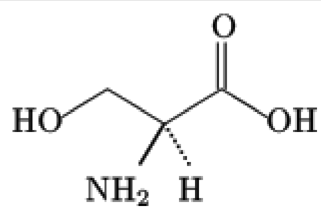
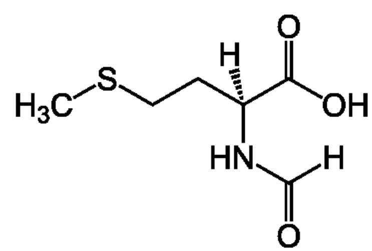
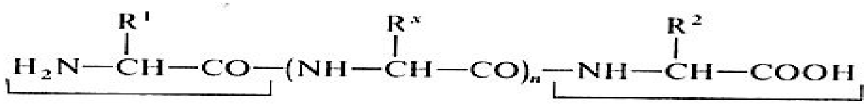
Lysine (Lys, K)	
Asparagová **ACID** (Asp, D)	
Asparagine (Asn, N)	
Glutamic **ACID** (Glu, E)	
Glutamine (Gln, Q)	

Biogenní aminokyseliny	
Arginine (Arg, R)	
Histidine (His, H)	
Phenylalanine (Phe, F)	
Tryptofane (Trp, W)	
Proline (Pro, P)	

Biogenní aminokyseliny	
Selenocysteine (SeCys,U)	[redacted]
Pyrolysine (Pyl,O)	
Serine (Ser, S)	
N-formylmethionine (fMet)	

Chemistry of Peptides and Proteins

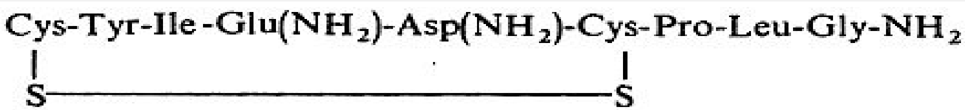


The Rest of N- ending Amino acid

The Rest of C- ending Amino acid

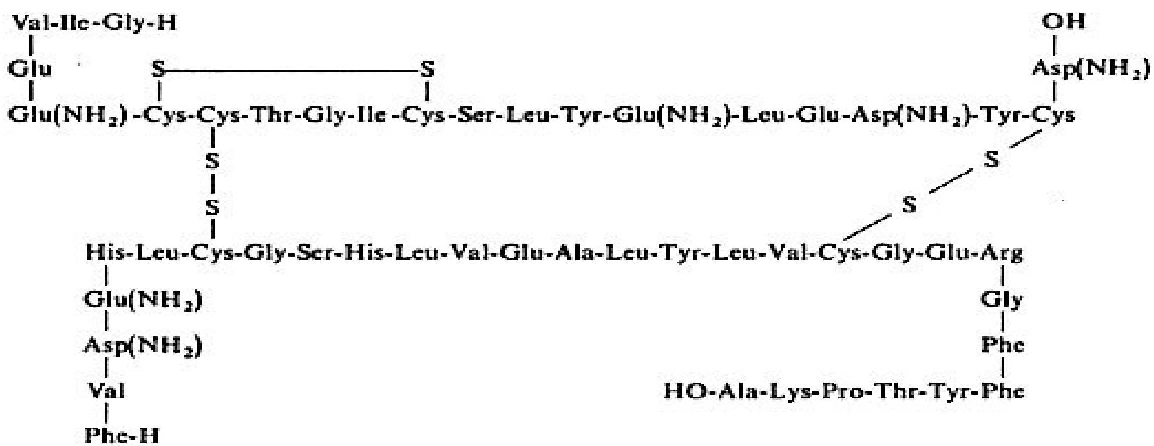
H—Gly-Leu-Asp-Phe—OH

Peptide Chains are written horizontally using the Abbreviations of the particular Amino acids. An Example showing the Structure of the Oxitocine Hormone is as follows:



(6.57)

An Example showing the Structure of the Horse Insulin Hormone (M = 5 802, containing 51 Amino acids) is as follows:



(6.58)

SCLEROPROTEINS or fibrous proteins

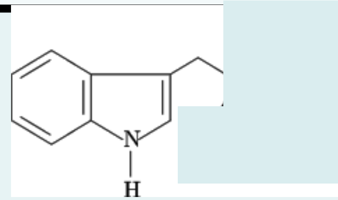
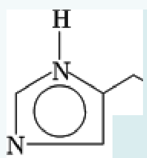
The roles of such proteins include protection and support, forming connective tissue, tendons, bone matrices, and muscle fiber. A SCLEROPROTEIN forms long protein filaments, which are shaped like rods or wires. SCLEROPROTEINS are structural proteins or storage proteins that are typically inert and water-insoluble. A SCLEROPROTEIN occurs as an aggregate due to hydrophobic side chains that protrude from the molecule.

A SCLEROPROTEIN'S peptide sequence often has limited residues with repeats; these can form unusual secondary structures, such as a collagen helix. The structures often feature cross-links between chains (e.g., cys-cys disulfide bonds between keratin chains).

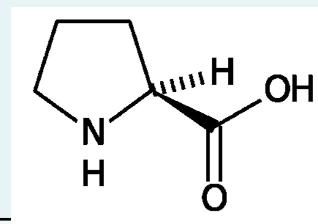
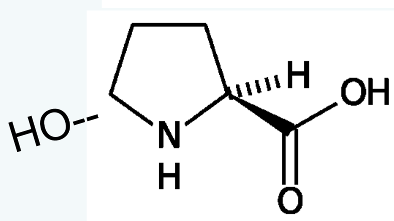
Composition of the Fibrous Proteins

Aminoacid	R	Aminoacid Content (% Molar)		
H_2N-CHR-COOH (Abbreviation)		Merino Wool	Silk Fibroin	Beef Collagen
Glycine (Gly)	$-H$	**59,4**	**44,8**	**38,0**
Alanine (Ala)	$-CH_3$	**15,7**	**29,4**	**11,9**
Valine (Val)	$-CH(CH_3)_2$	5,8	2,2	2,2
Leucine (Leu)	$-CH-CH(CH_3)_2$	7,9	0,5	2,8
Isoleucine (Ile)	$-CH_2-C_6H_5$	3,3	0,7	1,3
Serine (Ser)	$-CH_2-OH$	**11,8**	**12,1**	1,5
Threonine (Thr)	$-CH(CH_3)OH$	7,6	0,9	4,3
Tyrosine (Tyr)	$-CH_2C_6H_4OH$	4,8	5,2	1,9

Composition of the Fibrous Proteins

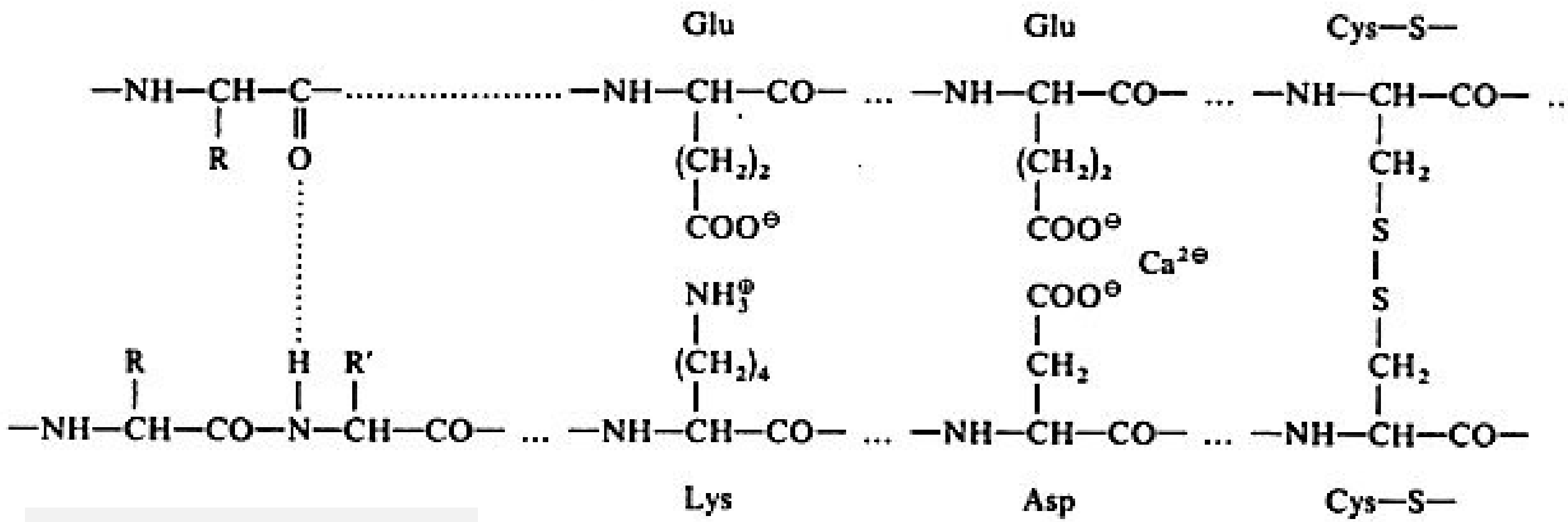
Aminoacid	R	Aminoacid Content (% w/w)		
H_2N-CHR-COOH (Abbreviation)		Merino Wool	Silk Fibroin	Beef Collagen
Tryptophan (Trp)		1,4	0,2	---
Lysine (Lys)	$-(CH_2)_4NH_2$	2,6	0,3	2,8
Arginine (Arg)	$-(CH_2)_2-N=C(NH_2)_2$	8,2	0,5	5,4
Histidine (His)		0,8	0,2	0,5
Hydroxylysine	$-(CH_2)_2CH(OH)CH_2NH_2$	Traces	---	0,8
Asparagic Acid (Asp)	$-CH_2COOH$	6,9	1,3	0,1
Glutamic Acid (Glu)	$-(CH_2)_2COOH$	13,8	1,0	0,1
Methionine (Met)	$-(CH_2)_2SCH_3$	0,5	0,1	0,8

Composition of the Fibrous Proteins

Aminoacid	R	Aminoacid Content (% w/w)		
H_2N-CHR-COOH (Abbreviation)		Merino Wool	Silk Fibroin	Beef Collagen
Cystine (Cys-S-S-Cys)	$-CH_2-S-S-CH_2CH(NH_2)COOH$	6,4	0,1	---
Cystein (Cys)	$-CH_2SH$	0,4	---	---
Proline (Pro)		---	---	**4,81,**
Hydroxyproline		---	---	**10,3**
Lanthonine	$-CH_2-S-CH_2CH(NH_2)COOH$	0,01	---	---

Chemistry of Peptides and Proteins

The Characteristic Bonds which determine Protein Conformation are in the following Formulas:



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Hydrogen Bond

Ionic Bond

Cystein disulfide Bond

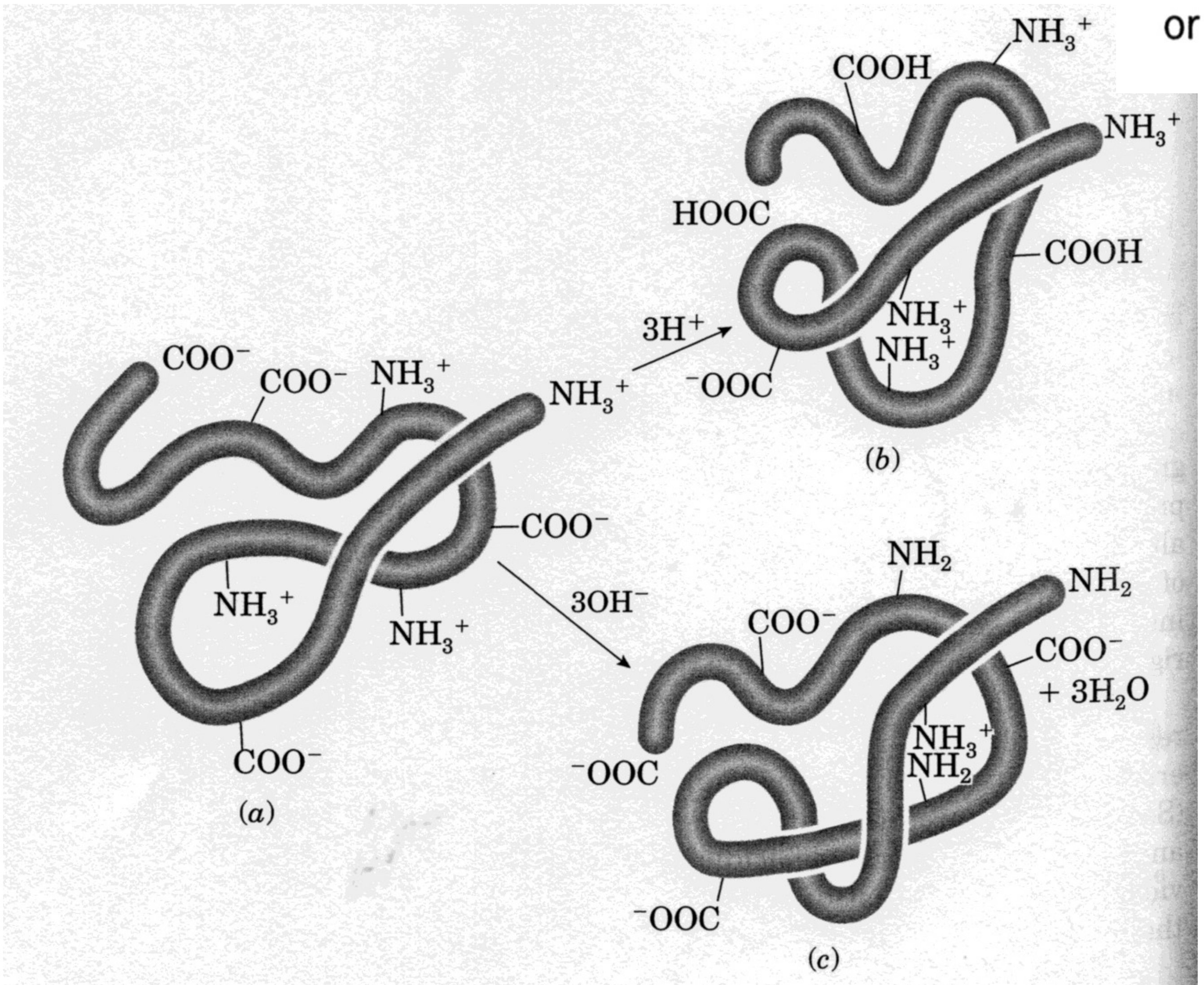
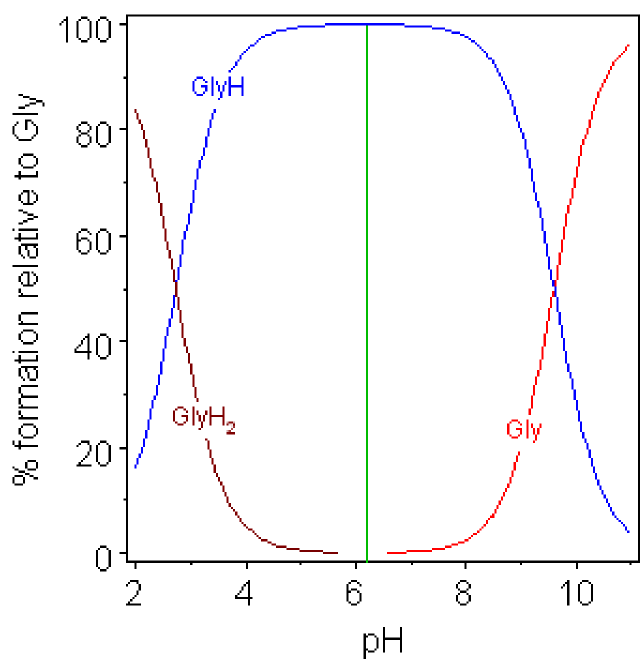
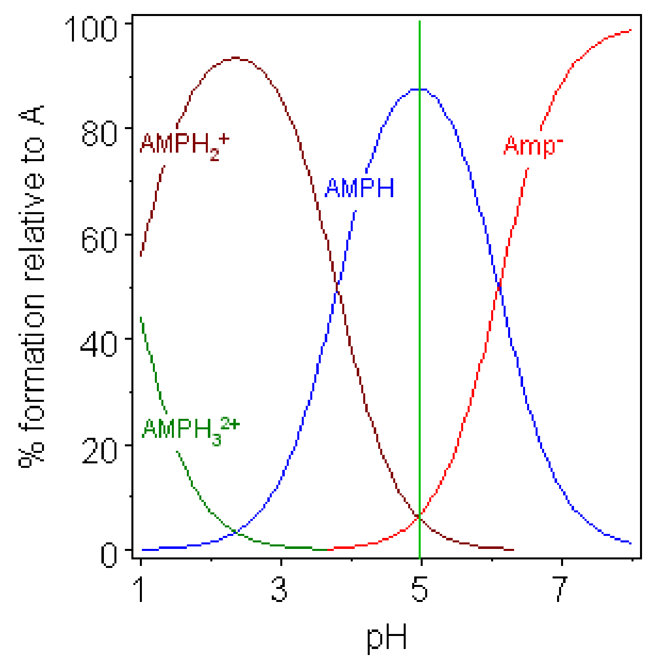


FIGURE 22.7 Schematic diagram of a protein (*a*) at its isoelectric point and its buffering action when (*b*) H^+ or (*c*) OH^- ions are added.

Chemistry of Peptides and Proteins

The isoelectric point (pI, pH(I), IEP), is the pH at which a particular molecule carries no net electrical charge in the statistical mean. The standard nomenclature to represent the isoelectric point is pH(I), although pI is also commonly seen, and is used in this article for brevity. The net charge on the molecule is affected by pH of its surrounding environment and can become more positively or negatively charged due to the gain or loss, respectively, of protons (H^+).





glycine pK = 2.72, 9.60

adenosine monophosphate pK = 2.15, 9.16, 10.67

Chemistry of Peptides and Proteins

For an amino acid with only one amine and one carboxyl group, the pI can be calculated from the mean of the pKas of this molecule.

$$pI = (pKa + pKb)/2$$

Each Amino acid contains at least two Groups, which are able to dissociate giving: -COOH a $-NH_3^+$ and they form conjugated Bases $-COO^-$ a $-NH_2$.

The Acid and their conjugated Base are in the proton Equilibrium:

$R\text{-}COOH \leftrightarrow R\text{-}COO^- + H^+ R\text{-}NH_3^+ \leftrightarrow R\text{-}NH_2 + H^+$

It is depends on the Environments (Conditions) pH Value, so on the H^+ Concentration, how is the Equivalence set. The Carboxylic Group is the stronger Acid and so the H^+ is easily cleaved from this Group then taken by this Group.

pK and pI Values of Amino Acids

Name	pK pK α-CO_2H	pK NH_3	*pK R-group*	pI at 25°C
Alanine	2.35	9.87		6.11
Arginine	2.18	9.09	*13.2*	10.76
Asparagine	2.18	9.09	*13.2*	10.76
Aspartic Acid	1.88	9.60	*3.65*	2.98
Cysteine	1.71	10.78	*8.33*	5.02
Glutamic Acid	2.19	9.67	*4.25*	3.08
Glutamine	2.17	9.13		5.65
Glycine	2.34	9.60		6.06
Histidine	1.78	8.97	*5.97*	7.64
Isoleucine	2.32	9.76		6.04
Leucine	2.36	9.60		6.04
Lysine	2.20	8.90	*10.28*	9.47
Methionine	2.28	9.21		5.74
Phenylalanine	2.58	9.24		5.91
Proline	1.99	10.60		6.30
Serine	2.21	9.15		5.68
Threonine	2.15	9.12		5.60
Tryptophan	2.38	9.39		5.88
Tyrosine	2.20	9.11	*10.07*	5.63
Valine	2.29	9.74		6.02

Chemistry of Peptides and Proteins

Essential	Nonessential
Histidine	Alanine
Isoleucine	Arginine*
Leucine	Asparagine
Lysine	Aspartic acid
Methionine	Cysteine*
Phenylalanine	Glutamic acid
Threonine	Glutamine*
Tryptophan	Glycine
Valine	Ornithine*
	Proline*
	Selenocysteine*
	Serine*
	Tyrosine

(*) Essential only in certain cases

Of the 22 standard amino acids, 9 are called essential amino acids because the human body cannot synthesize them from other compounds at the level needed for normal growth, so they must be obtained from food.[52] In addition, cysteine, taurine, tyrosine, and arginine are considered semiessential amino-acids in children (though taurine is not technically an amino acid), because the metabolic pathways that synthesize these amino acids are not fully developed.[53][54] The amounts required also depend on the age and health of the individual, so it is hard to make general statements about the dietary requirement for some amino acids.

Amino acid > Peptide > Protein

- **Amino acid –** monomer, L- configuration only
- **Peptide –** it has less then **50** Amino acids, it is MW up to approx. $5*10^5$, it goes through Cellophane membrane at <u>DIALYSIS</u>
- **Protein –** MW is over approx. $5*10^5$ to $X*10^6$, $X \in (1;10)$

Determination of the Peptide and Protein Composition

- Acid hydrolysis to Amino acids
- Chromatography (**Thin layer**, GPC)

PEPTIDES X PROTEINS

PEPTIDES

- It contains β and γ Amino acids also
- Configuration both D and L

It belongs here:

- GLUTATHIONE (biological redox system)
- HORMONE
- ANTIBIOTICS
- **TOXINE (death angel and the other TOXIC mushrooms, bee poison etc.)**

PROTEINS

- α Amino acids only
- Configuration D only

Structure Hierarchie of Peptides and Proteins

- **Primary structure** – the Amino acids Sequence of the Protein
- **Secondary structure** – No covalent Interactions in the Backbone of the one Polypeptide (Protein) Chain, usually the near Parte of the Backbone (α – Helix and/or β – Sheet)
- **Tertiary structure** – various Interactions between the Backbones of more then the one Polypeptide (Protein) Chain of Chains or remote NO neighbouring) Segments of one Chain
- **Quaternary structure** – Interactions between the Chain Bundles, between the **Tertiary structures**

Tertiary & Quaternary Structures – we give attention to this in the next Lesson!

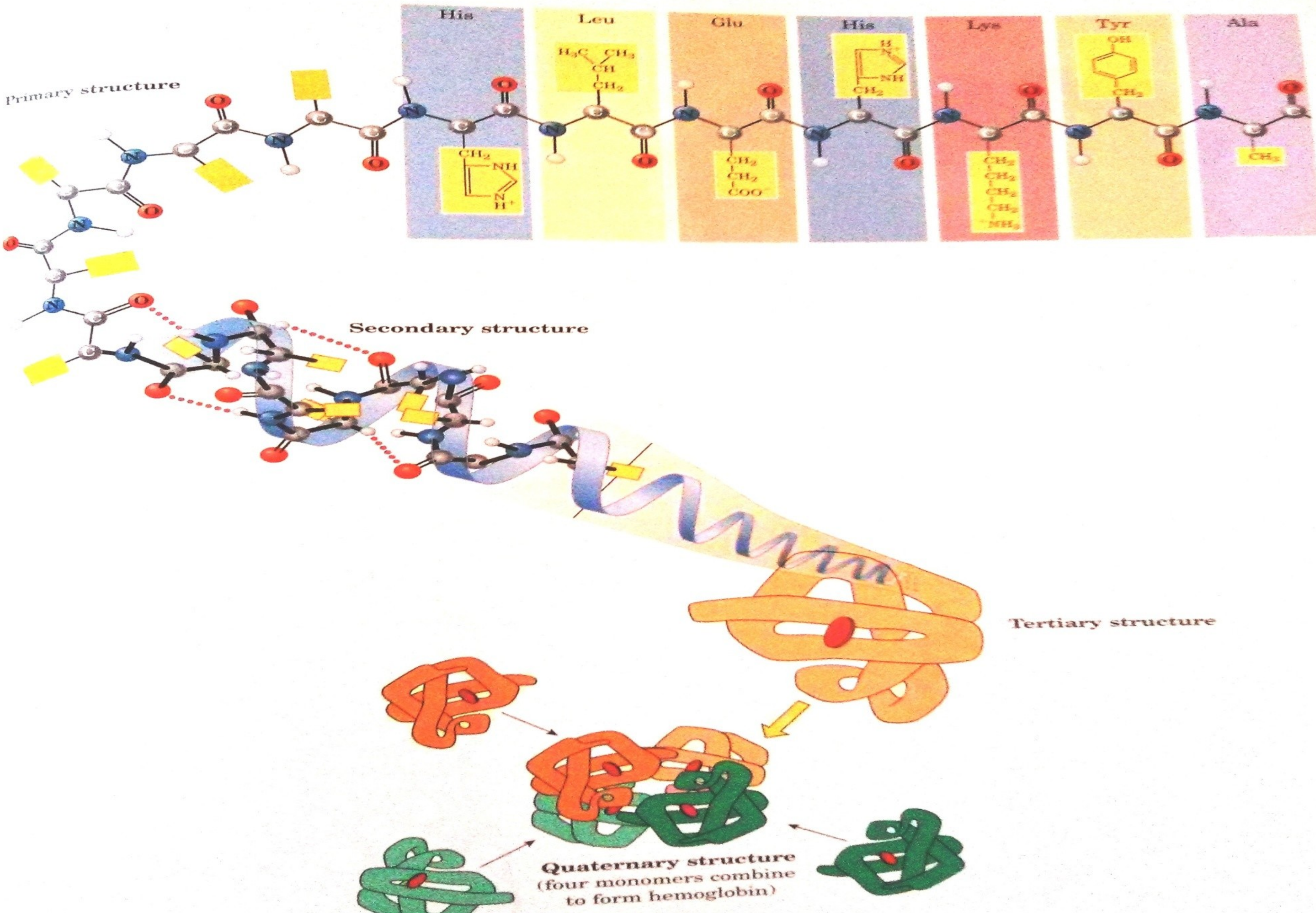
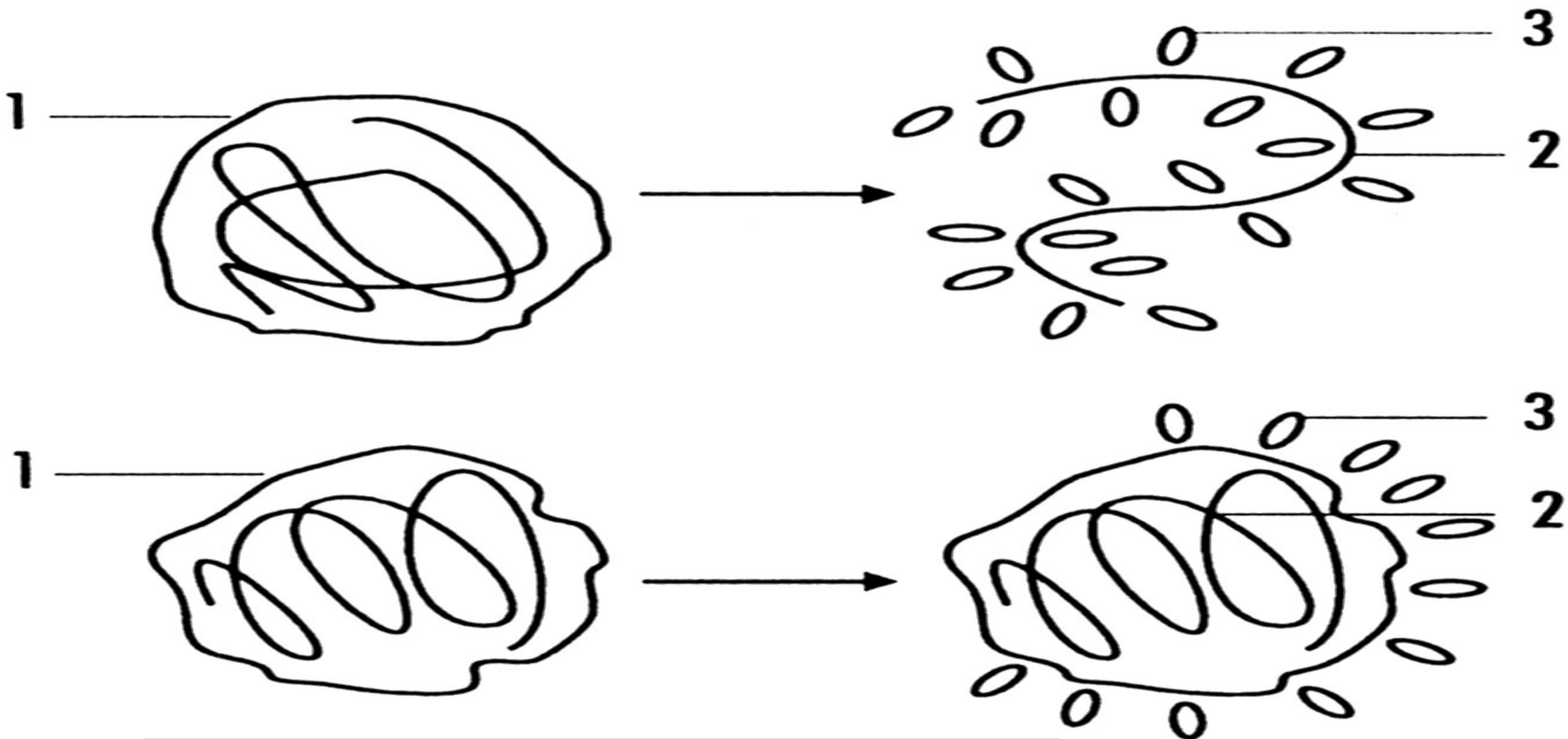


FIGURE 22.21 Primary, secondary, tertiary, and quaternary structures of a protein.

Proteins dividing – the Occurrence of other Components in Macromolecule accordingly

- **Simple protein** – they are broken by Hydrolysis to Amino acids only
- **Compound protein** – they are broken by Hydrolysis to Amino acids, Saccharides, Fats, …
  - LIPOPROTEINE (Fats)
  - GLYKOPROTEINE (Saccharides)
  - FOSFOPROTEINE (Phosphate groups > **KASEIN**)
  - CHROMOPEROTEINE (Colorants, e.g. Haemoglobin, Melamine)

SOLUBILITY versus SWELING



1 — **Biopolymer Molecule**

2 — **Biopolymer Backbone**

3 — **Water or the other Solvent (Solvating Agent) Molecule**

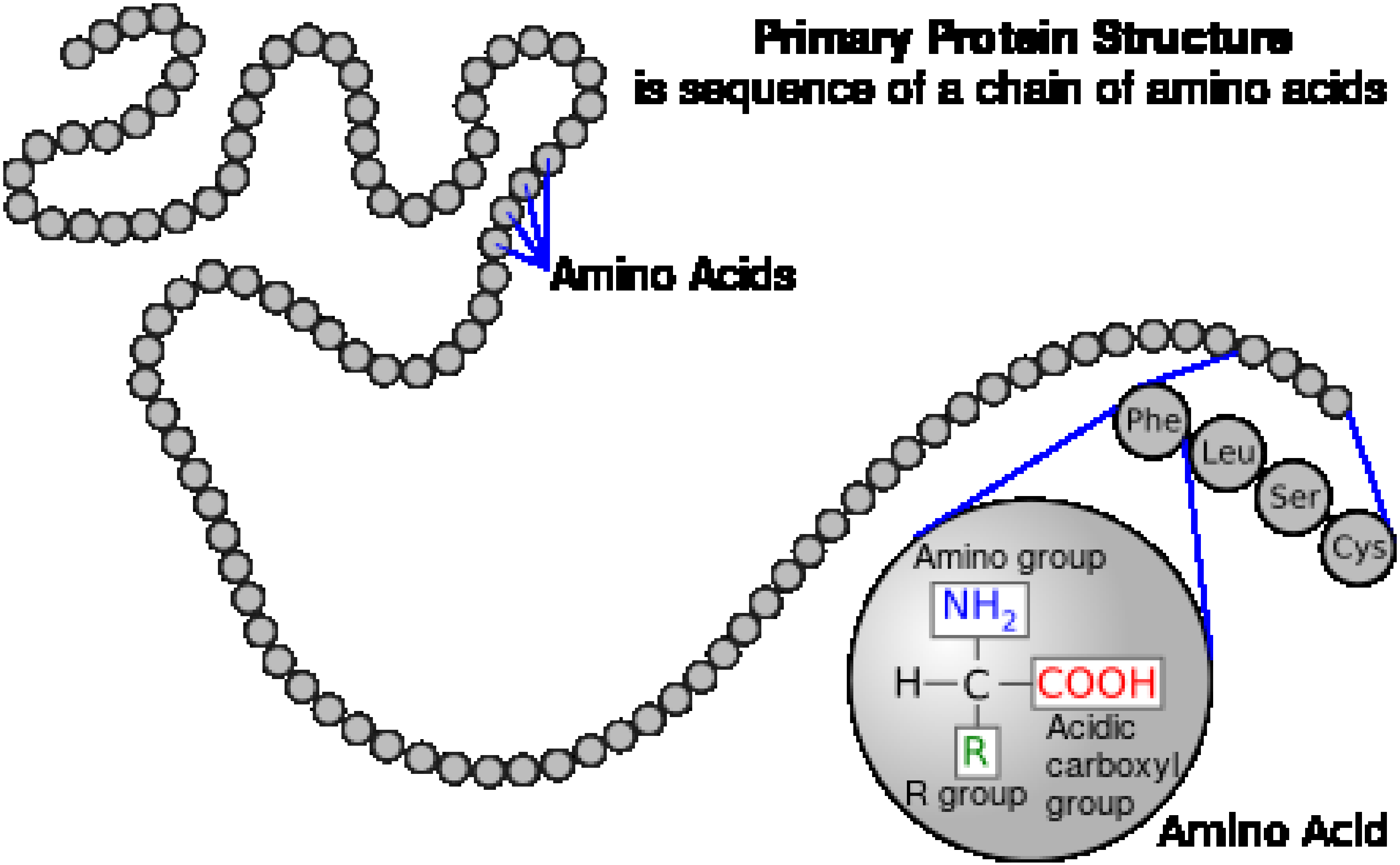
Proteins dividing – Macromolecules' Solubility in Water of accordingly

- **SOLUBLE (SFEROPROTEINE)**
  - HEAT > COAGULATION
  - Albumin > **Egg white**
  - Glutelin > **Glutelin from Wheat**
- **UNSOLUBLE (SKLEROPROREINE)**
  - Keratin α and β
  - Collagen

Proteins dividing – Macromolecules' Shape and Supermolecular Structure accordingly

- **FIBRILAR** > natural/genuine Silk, Hair, animal Hair, Muscles, fibrous connective Tissue
- **GLOBULAR** > ENZYM, Egg white, Milk white, INSULIN, …

PRIMARY STRUKTURE of Proteine I



Proteines Molecular Weight

Protein	MW (Relativ, Mean)
cytochrom c	12 400
ribonukleasa	13 700
lysozym	14 600
myoglobin	17 800
α-laktalbumin	23 000
trypsin	23 300
α-chymotrypsin	25 170
pepsin	34 500
vaječný albumin	44 000
hemoglobin	64 500
α-elastin	70 000
peroxydasa	200 000
tropokollagen	300 000
fibrinogen	340 000
myosin	480 000
Tobacco mosaic virus	39 400 000

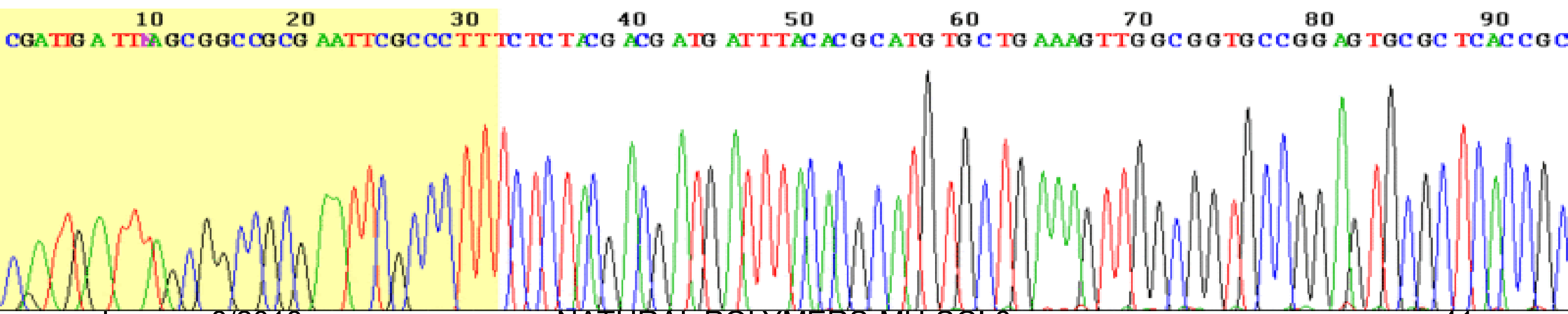
I do not know, if it is the $\overline{M}_n$ or the $\overline{M}_w$

PRIMARY PROTEINS STRUCTURE II DETERMINATION OF THE AMINO ACIDS' SEQUENCE

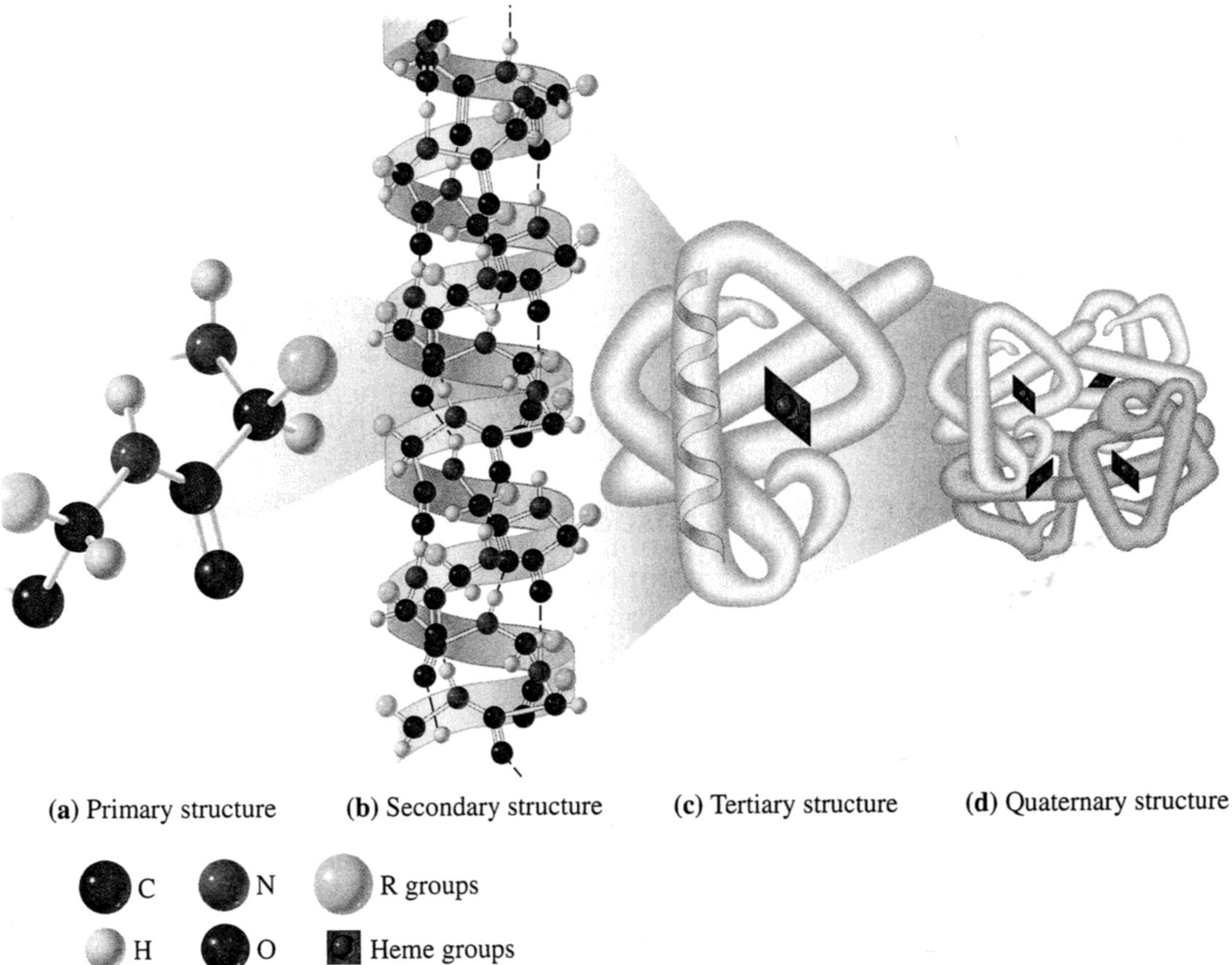
- **PROTEINS are broken (cleaved) to Amino acids by ENZYMS** - the given **ENZYM break (cleave) only the Bond between** the Definite **AMINO ACIDS**
- **Using the Different ENZYMS** - **Different Grafts (Broken Parts)** > **AMINO ACIDS SEQUENCE** Determination
-

PRIMARY PROTEINS STRUCTURE III DETERMINATION OF THE AMINO ACIDS' SEQUENCE

- Breaking (Cleaving) on the well define points (**only the Bond between** the Definite **AMINO ACIDS)** to shorter Parts by **ENZYMS „RESTRICTIVE ENDONUCLEASES“** (their Number is approx. 200 Types)
- Consecutive Breaking (Cleaving) of this shorter Parts taken by Primary Breaking (Cleaving) by **„RESTRICTIVE ENDONUCLEASES“** again, but other Types then used primary
- Electrophoretic Sorting (Separation) of the **Grafts (Broken Parts)**
- Computer Processing of the Results



PROTEIN SECUNDARY STRUCTURE I



PROTEIN SECUNDARY STRUCTURE II A

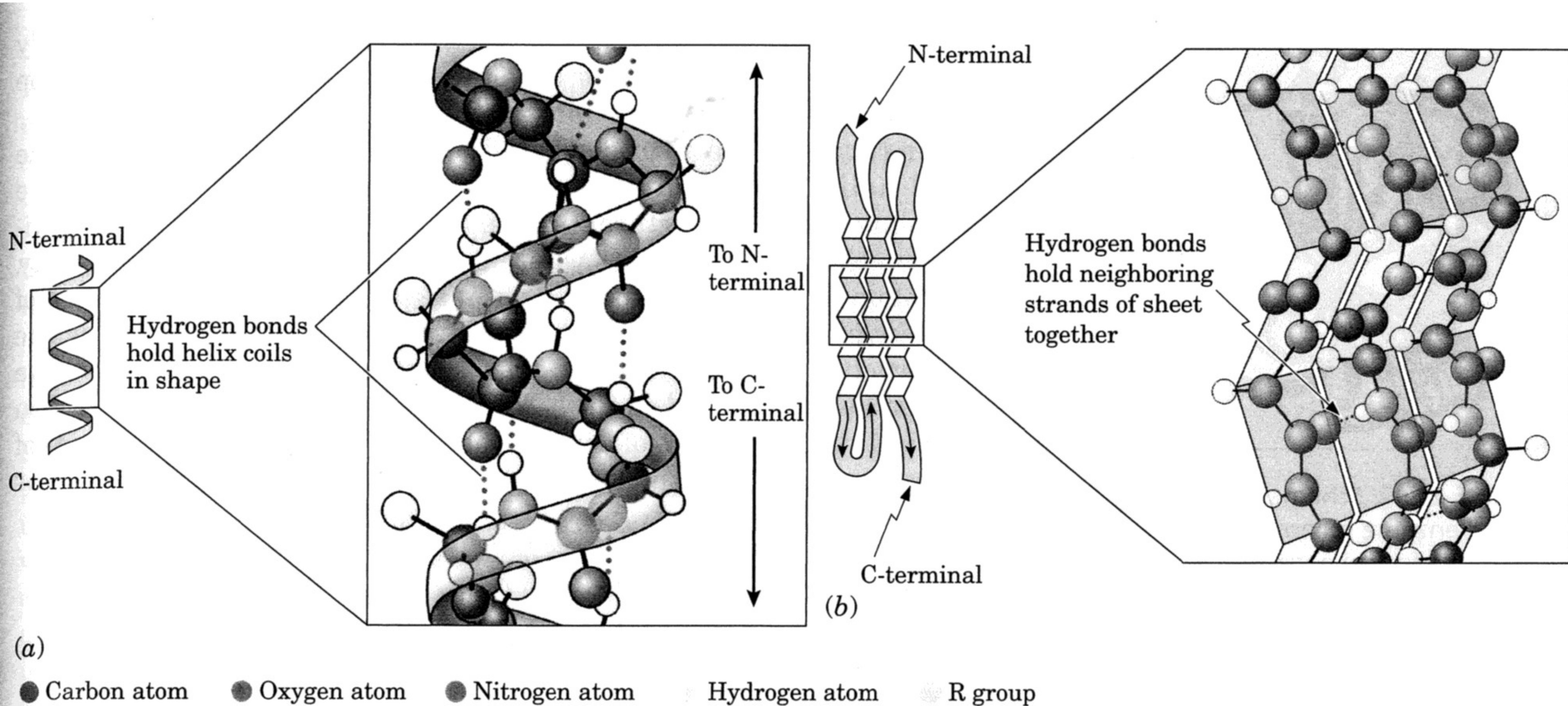
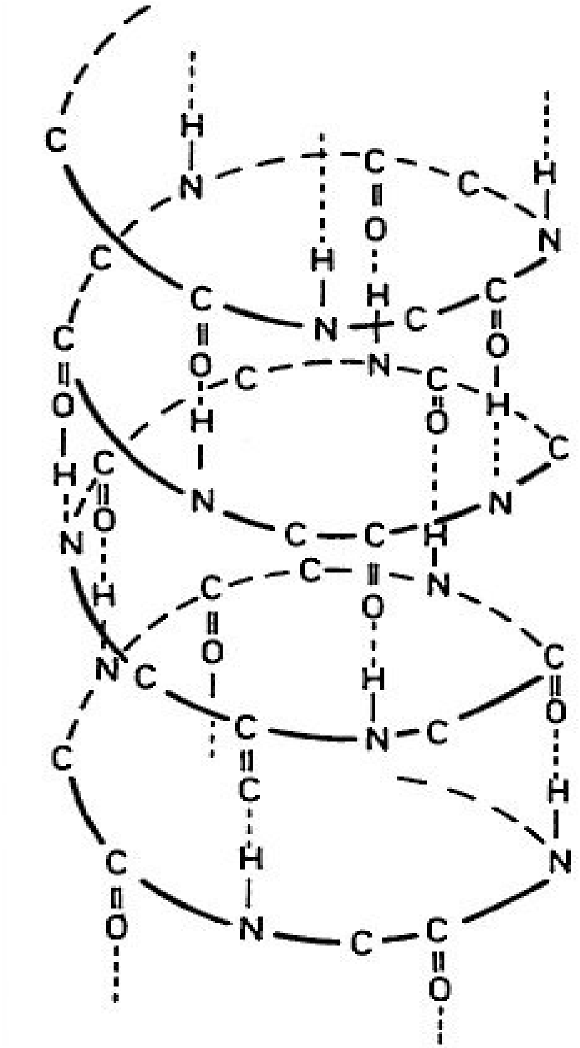
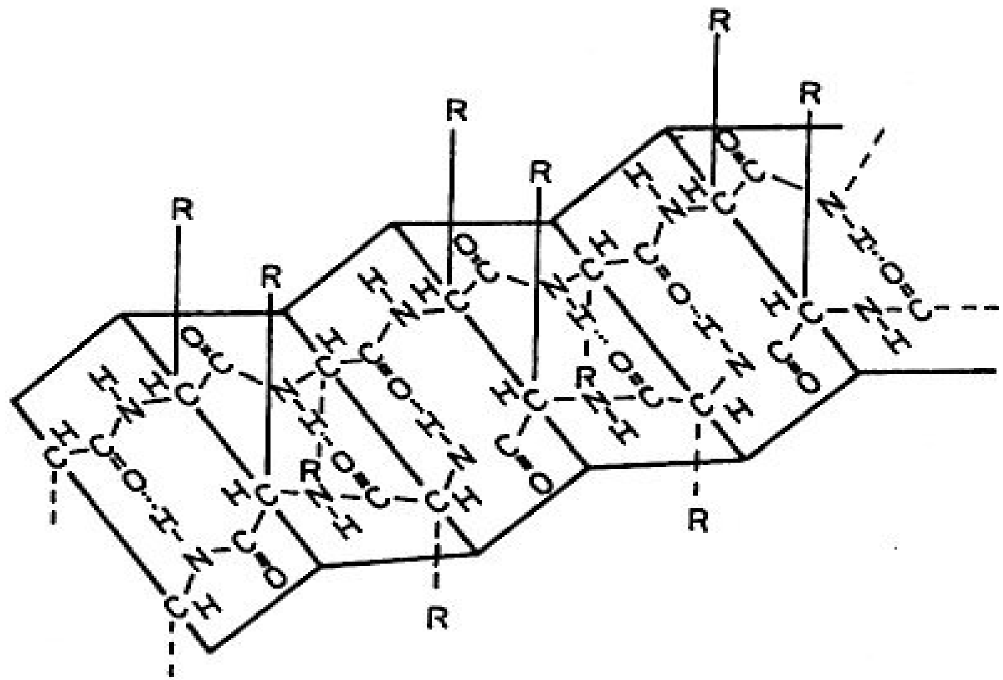


FIGURE 22.10 (*a*) The α-helix. (*b*) The β-pleated sheet structure.

Left-handed Helix

PROTEIN SECUNDARY STRUCTURE II B



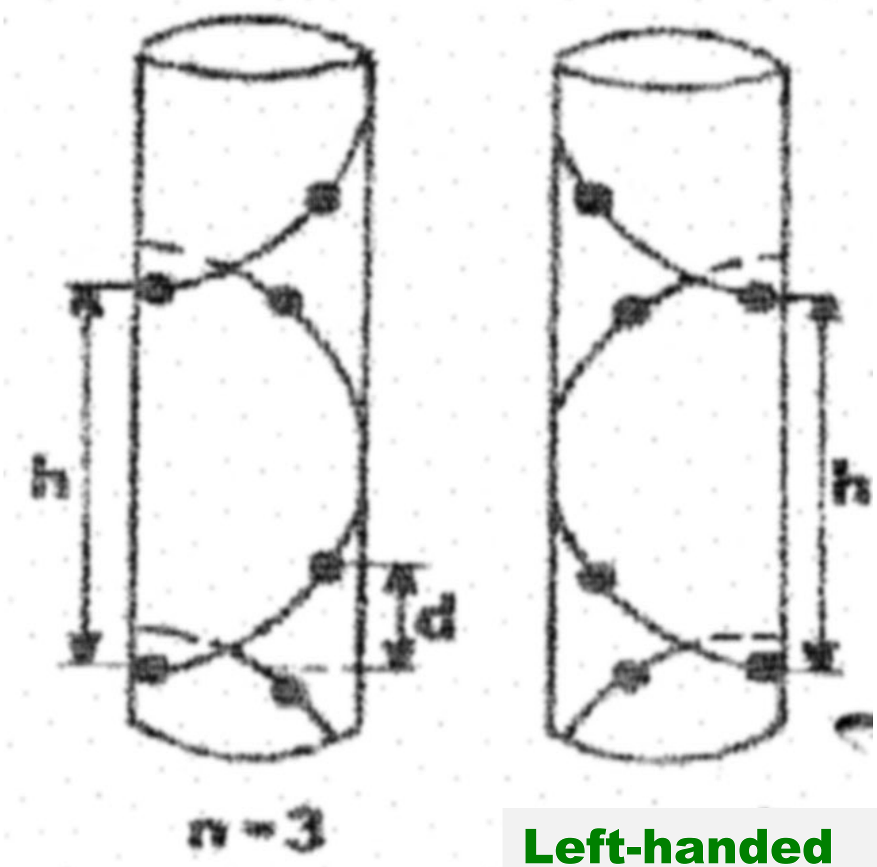


β **Skládaný list**

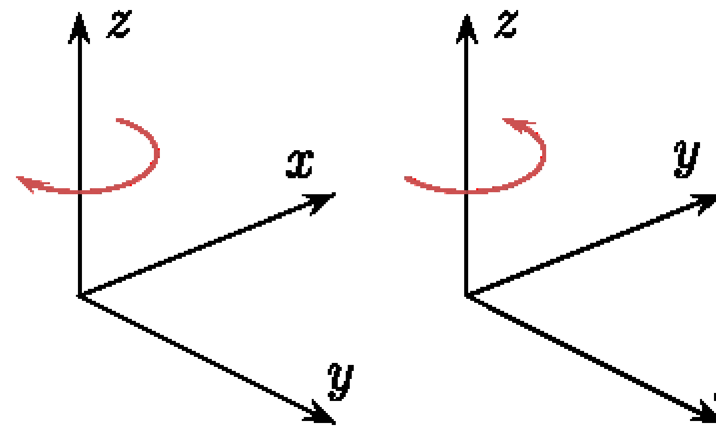
Left-handed α Helix

PROTEIN SECUNDARY STRUCTURE III

Right-handed Helix



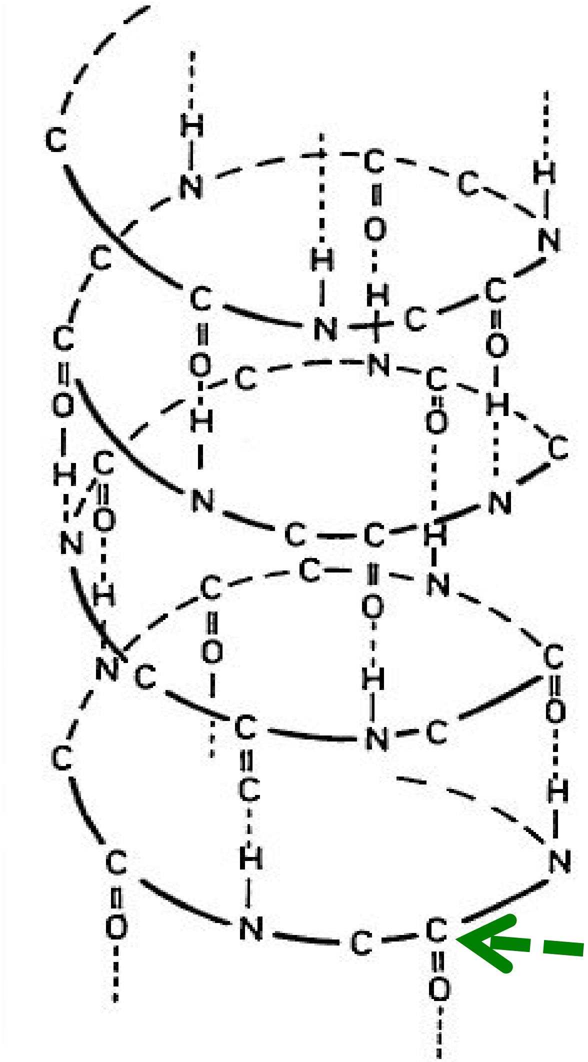
Left-handed Helix



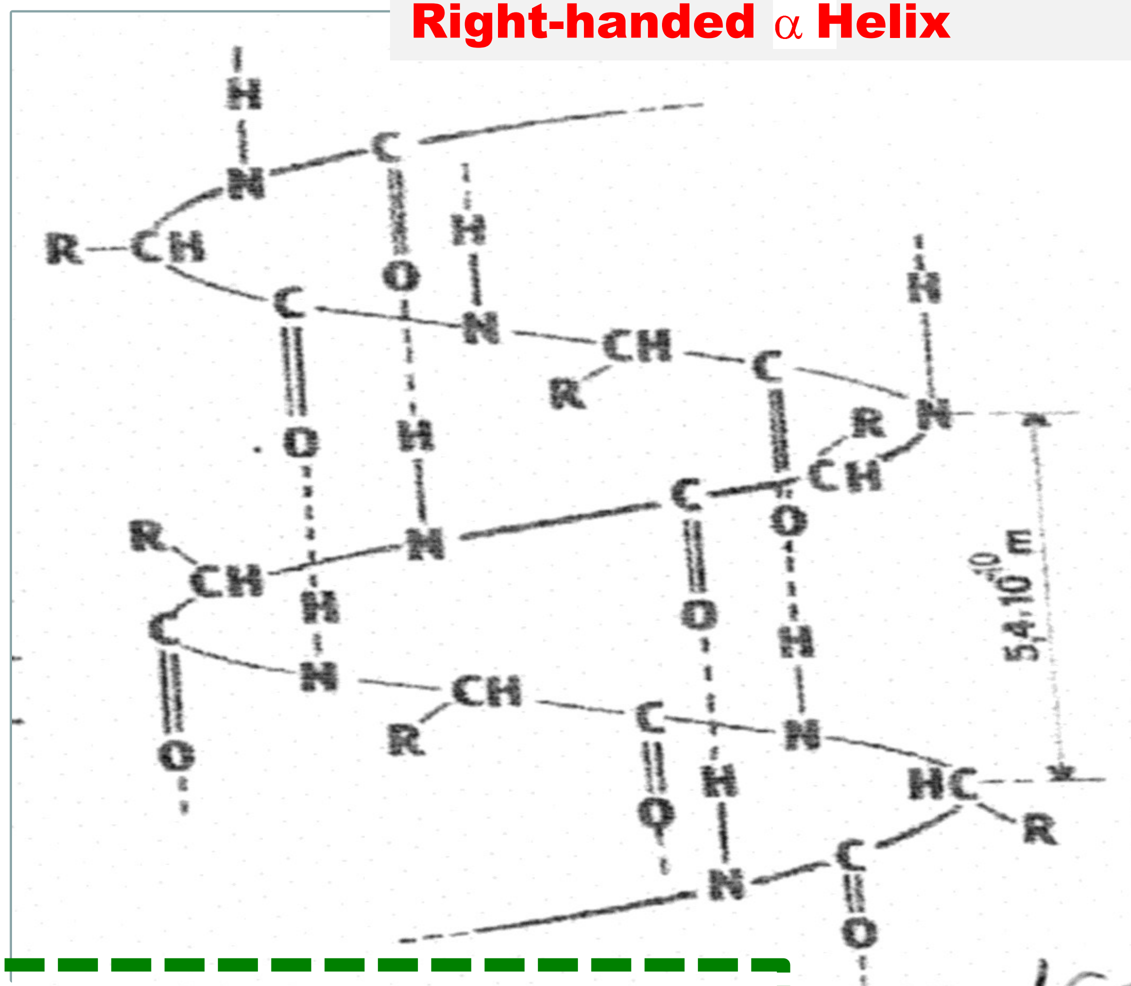
Right-handed
RIGHT HAND
> thumb UP >
Fingers round oriented in the Row Direction

Left-handed
LEFT HAND **>**
thumb UP >
Fingers round oriented in the Row Direction

PROTEIN SECUNDARY STRUCTURE IV



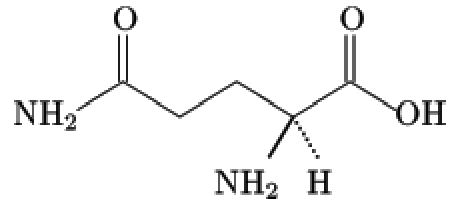
Right-handed α Helix



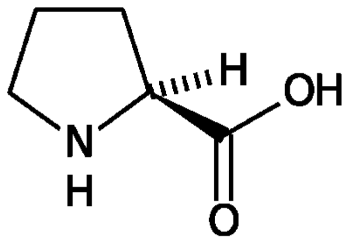
Left-handed α Helix

Casein – the main Amino acid Components

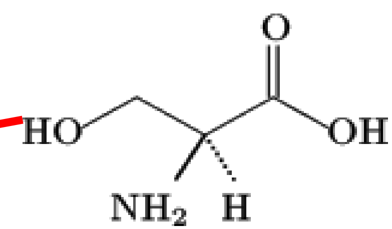
Glutamic acid (Glu, E)

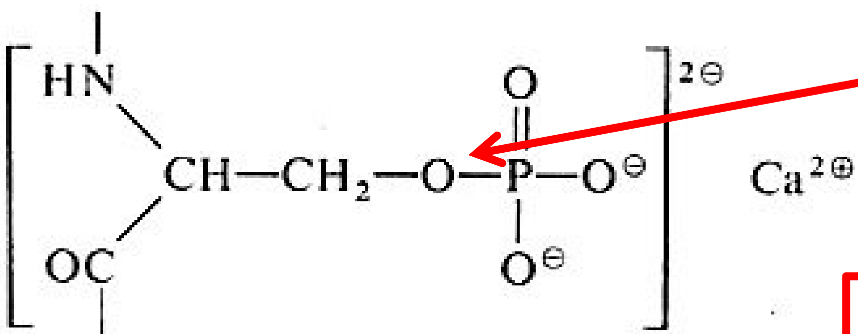


Proline (Pro, P)



Serine (Ser, S)





Casein is the PHOSPHOPROTEID

Amino acids Content in various Proteins

Amino acid	PROTEIN			
	Gelatine	Casein	Egg white	Egg yellow
	(Molar %)			
Hydroxyproline	6	0	0	0
Asparagic acid	4	6	**10**	**11**
Theorine	2	3	4	6
Serine	4	5	7	11
Glutamic acid	7	**18**	**12**	**13**
Proline	**12**	**15**	5	5
Glycine	**35**	3	6	6
Alanine	12	4	9	8
Valine	2	8	9	7
½ Cystine	0	0	2	2
Methionine	1	2	1	2

Amino acids Content in various Proteins

Amino acid	PROTEIN			
	Gelatine	Casein	Egg white	Egg yellow
	(Molar %)			
Isoleucine	1	6	6	5
Leucine	3	9	10	9
Thyrosine	0	4	1	2
Phenylalanine	1	4	4	3
Lysine	3	6	7	5
Histidine	1	3	2	2
Arginine	5	3	5	4

Gelatine = Denaturated Collagen

Casein – characteristics

Cacein Type (Sort)	Water	Fat	Ash	Acidity
Acid, grain	9,5	**0,3**	1,7	9,9
Acid, Cheese, Lumps	7,8	**0,4**	4,1	7,6
Acid, Salt, Lumps	7,1	**0,2**	5,7	6,7
Rennet coagulated	8,3	**0,6**	8,0	7,9

CASEIN versus QUARK

CASEIN is manufactered from the skimmed (fat-free) MILK, THE HIGH FAT CONTENT IS a DEFECT!

QUARK is manufactered from the Whole (fat) MILK, but it can be also manufactered as the Fat-free or Low Fat Product!

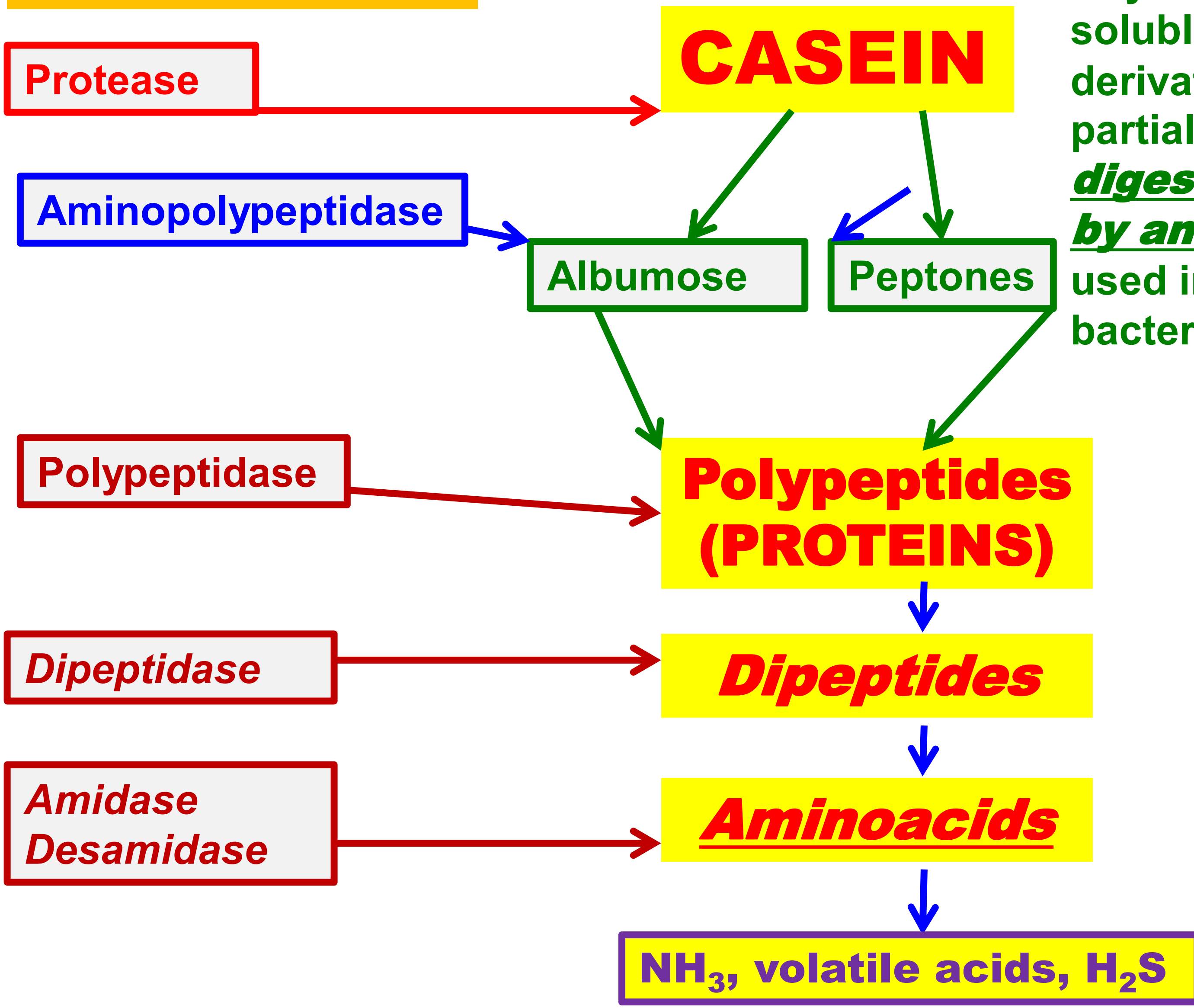
Casein – Charasteristics

- Protein Part of Milk
- Four Types of Casein recognised: αS1, αS2, β, κ (kappa)
- Casein is gained by precipitating of Milk using Acids or Enzymes
- MW = approx. 75 000 – 350 000
- Insoluble in Water
- Soluble in Acids or Bases
- Alkali Solutions have the dispergation (dispersion) Ability

From Casein to Cheese

- **Casein**
  - **ENZYMEs**
    - **PROTEASE - it cleavages peptide Bond in the Middle of the Casein Backbone > ALBUMOSE & PEPTONS are the Results**
    - **PEPTIDASE - it cleavages peptide Bond on the End the Casein Backbone**
    - **AMINASE – it cleavages Amino acids (UNDSIBABLE)**
- **Cheese = cleavaged CASEIN**
- **„Holes " in Cheese = it is done by Bacterias & Enzymes, which release CO_2**

ENZYMS



PEPTONES:

Any of various water-soluble ***protein*** derivatives formed by partial ***hydrolysis or digestion of proteins by an acid or enzyme***, used in culture media in bacteriology.

ALBUMOSE:

Any of a class of substances derived from albumins and formed by the ***enzymatic breakdown of proteins*** during digestion

ALBUMOSE – they are only the shorter Proteins from CASEIN

PEPTONES - they are Proteins in general or the Mixture of Proteins which results from Proteins by partial Hydrolysis done by Enzyme Pepsin and HCl in Stomach It is stated, that PEPTONES have 3 – 4 Amino acids.

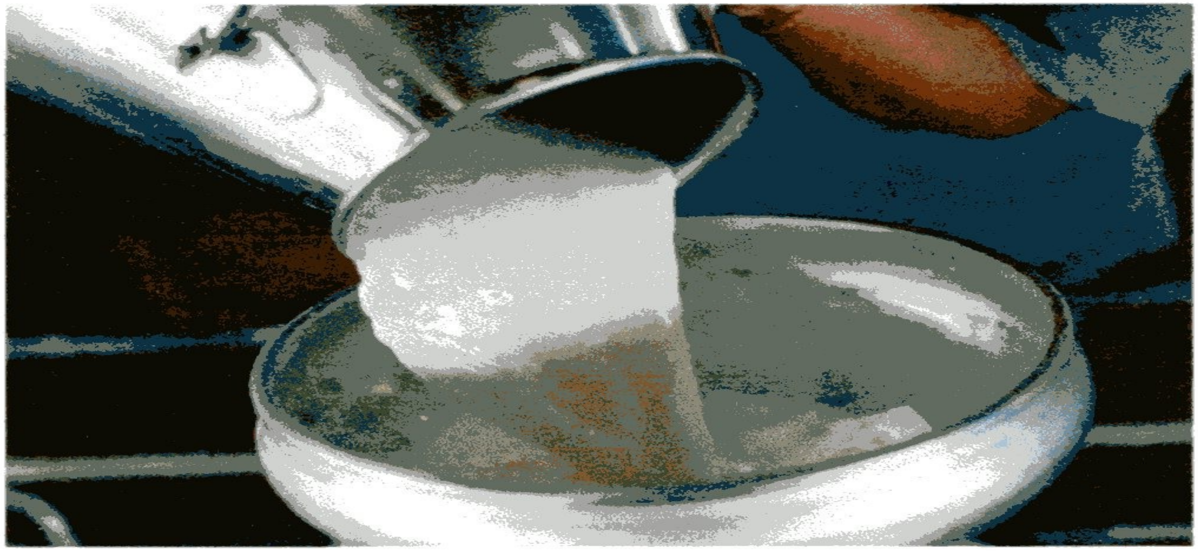
PEPTONES are further cleaved in the Small intestine by Trypsin and Chymotripsin, which are further cleaved in to the individual Amino acids.

Casein – Use

- Glus
- Paints
- **Galalit** (Thermoset crosslinked by FORMALDEHYDE)
- …………..

Galalit is coming back (returning)!

EU funds 'plastics from protein' project in France



Lactips has won funding to turn milk protein into plastic

French company Lactips says that its bioplastics project, Ecolactifilm, has attracted funding of €1.5m from the European Union's H2020 SME phase 2 programme.

The company produces water-soluble and biodegradable thermoplastic pellets from casein, a protein found in milk. The material, called Ecolactifilm and can be used in water-soluble or edible packaging.

Lactips said the funding would allow it to expand from 20 to 30 staff, and generate a turnover of €20m ($24m) by 2020, according to a report in Dairy Reporter.

The process begins by making pellets of the material, which can then be extruded into film. The company says that its first application will be to make a dissolvable film for dishwasher tablets.

The material will biodegrade in less than three weeks, says the company. In addition, it has an oxygen barrier and can support printing.

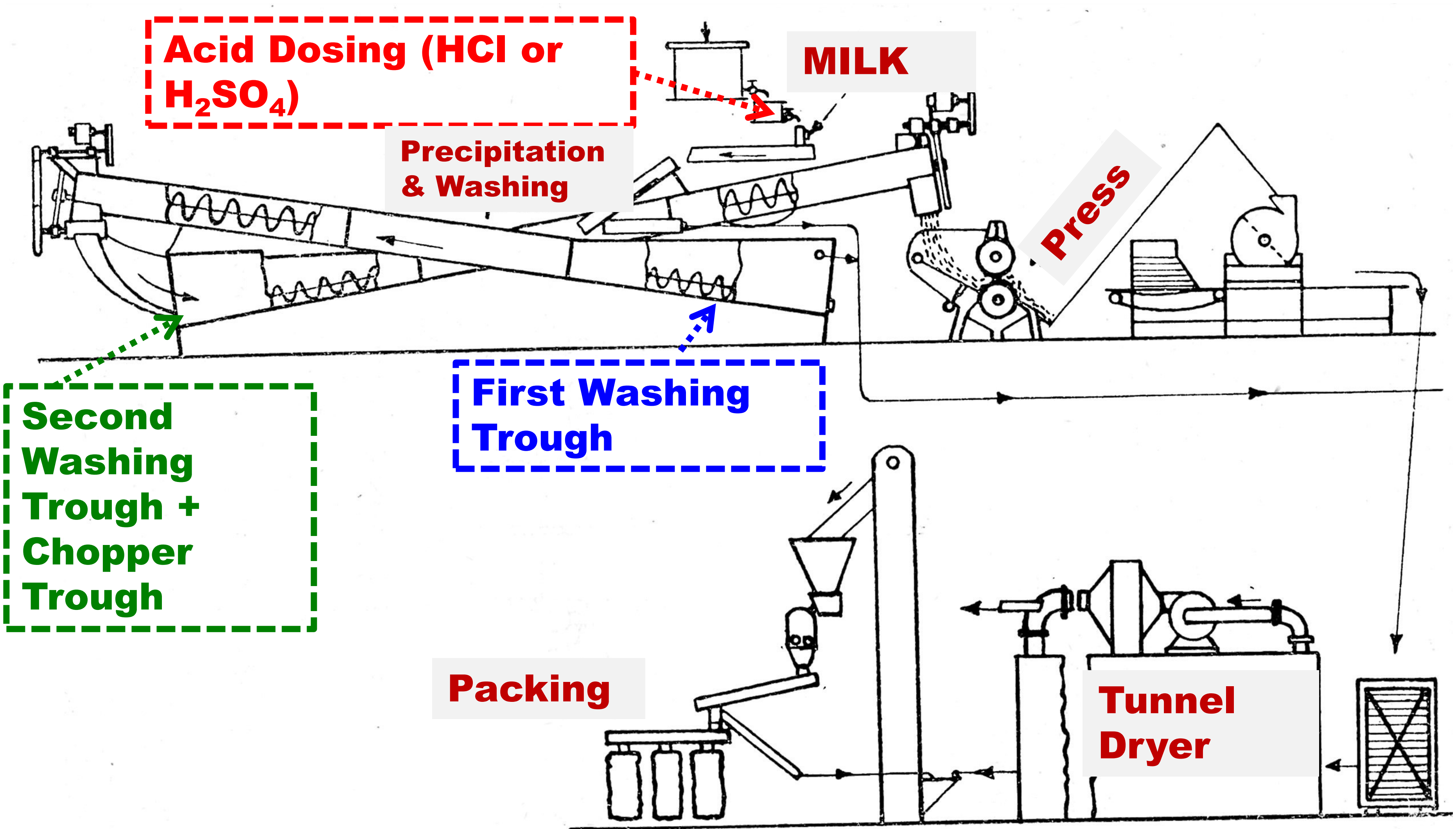
Lactips will also expand its research with the Jean Monnet University of Saint Etienne with a project called Hydroprint.

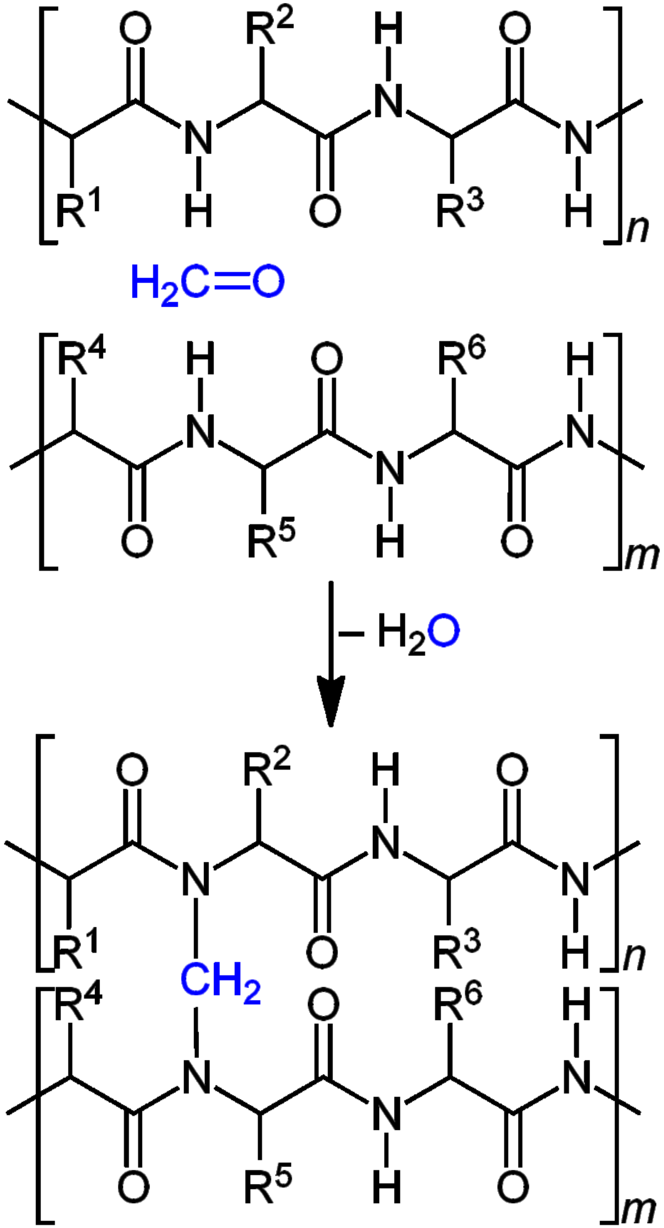
This project will look to develop water-soluble plastic filaments for use in 3D printing.

› **www.lactips.com**

Continual Manufacture of CASEIN

The BYPRODUCT is WHEY (Proteins, Saccharides, Inorganic Substances etc. ...)





CASEIN Crosslinking by Formaldehyde

Procedure :

- Prepare formulation from the **CASEIN** Paste, pour it into 4 % w/w **Formaldehyde** and leave it mature several Days
- Form the Product from the **CASEIN** Paste + **Formaldehyde** (approx. 5 – 10 parts of **CASEIN** + 1 part of **Formaldehyde** , leave it several Hours or several Days mature at Temperature of 30 – 40 °C

Casein Glues

CASEIN Glue with Ammonia :

50 g of pure (industrial Grade) **CASEIN** is mixed with 250 ml Water and is slightly heated.

15 g of **Ammonia** is mixed with a bit of Water and is poured into heated **CASEIN.** The Solution boils over and CO_2 is released. **CASEIN Glue** is mixed up to point, when the releasing of CO_2 is finished.

CASEIN Glue with Lime:

4 Parts of Fat free **QUARK** is mixed with 1 Part of well matured (two Years old) $Ca(OH)_2$. The Glue is finished after 10 Minutes. **CASEIN Glue with Lime** must be freshly prepared every Day. It is diluted by 2 – 3 Parts of Water if used for binding Agent for Paints.

CASEIN Glue with $NaHCO_3$:

50 g of **$NaHCO_3$** is dissolved in hot Water is chilled at continuous mixing. Add 500 g of Fat free **QUARK** and mix it in the Kitchen mixer. Leave it stay for 30 Minutes. Dilute it by cold Water to desired Consistency. **CASEIN Glue with $NaHCO_3$** is suitable as the Glue and/or binding Agent for Paints.

Casein Paints

CASEIN Glue – a simple Recipe:

One Soup Spun (approx. 10 g) of Borax ($Na_2[B_4O_5(OH)_4]\cdot 8H_2O$) is dissolved in approx. 250 ml of Water. Fat free **QUARK** is mixed with the Borax Solution. Leave it stay for 20 Minutes and mix one more.

CASEIN based Paints working:

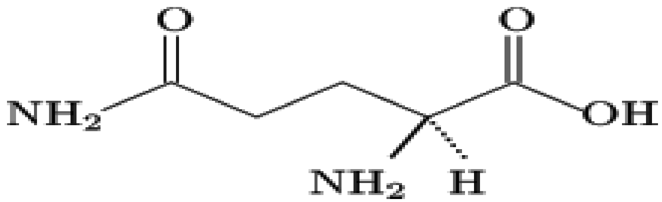
The Pigments are mixed with a bit of Water to a Paste. Mix 1 Part of the Coloured Paste with 1 Part **CASEIN Glue** and 3 Parts of Water.

CASEIN based Wall Paint:

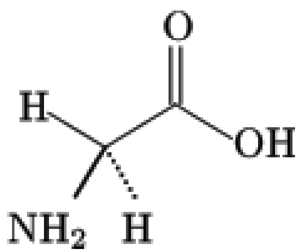
1. **2 kg** fat free **QUARK**
2. 90 g of Borax ($Na_2[B_4O_5(OH)_4]\cdot 8H_2O$) is dissolved in 500 ml of Water and this Solution is mixed together
3. Mix it in the Kitchen mixer for 20 Minutes and leave it for 20 Minutes stay
4. It is diluted by 8 Litres of Water for basic Painting
5. Mix 1 – 2 Parts of the Pigments Water Paste with 1 Part of the **CASEIN Glue** and 2 – 3 Parts of Water .

Egg Proteins – the main Amino acids Components

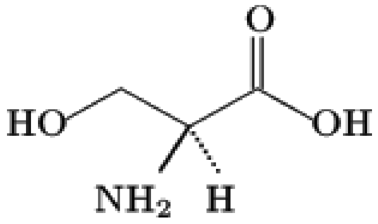
Glutamic acid (Glu, E)

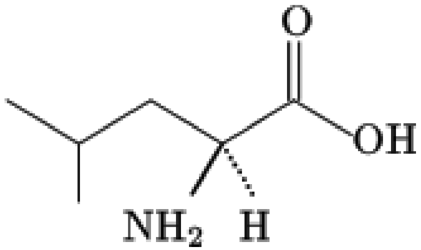


Glycine (Gly, G)



Serine (Ser, S)





Leucine (Leu, L)

Amino acids Content in various Proteins

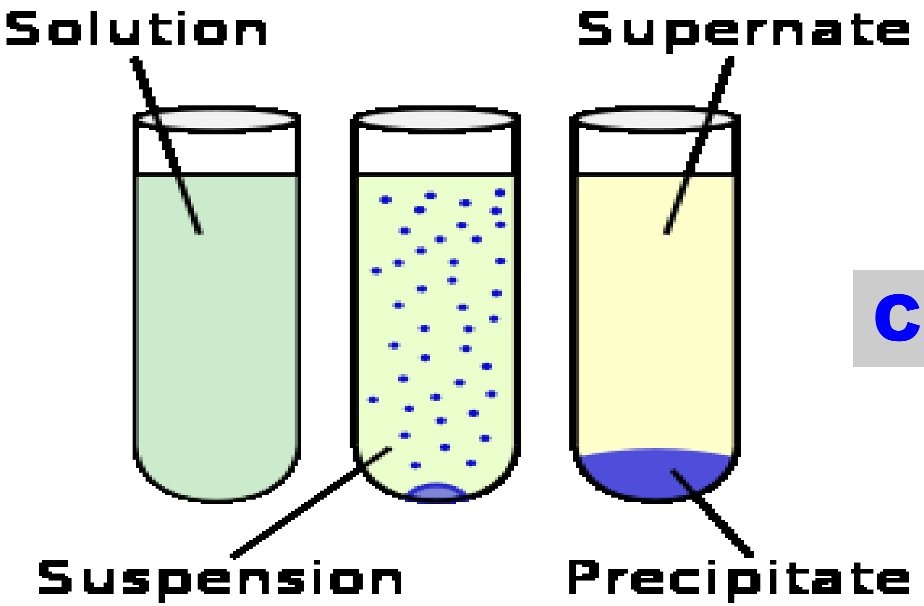
Amino acid	PROTEIN			
	Gelatine	Casein	Egg white	Egg yellow
	(Molar %)			
Hydroxyproline	6	0	0	0
Asparagic acid	4	6	**10**	**11**
Theorine	2	3	4	6
Serine	4	5	7	11
Glutamic acid	7	**18**	**12**	**13**
Proline	**12**	**15**	5	5
Glycine	**35**	3	6	6
Alanine	12	4	9	8
Valine	2	8	9	7
½ Cystine	0	0	2	2
Methionine	1	2	1	2

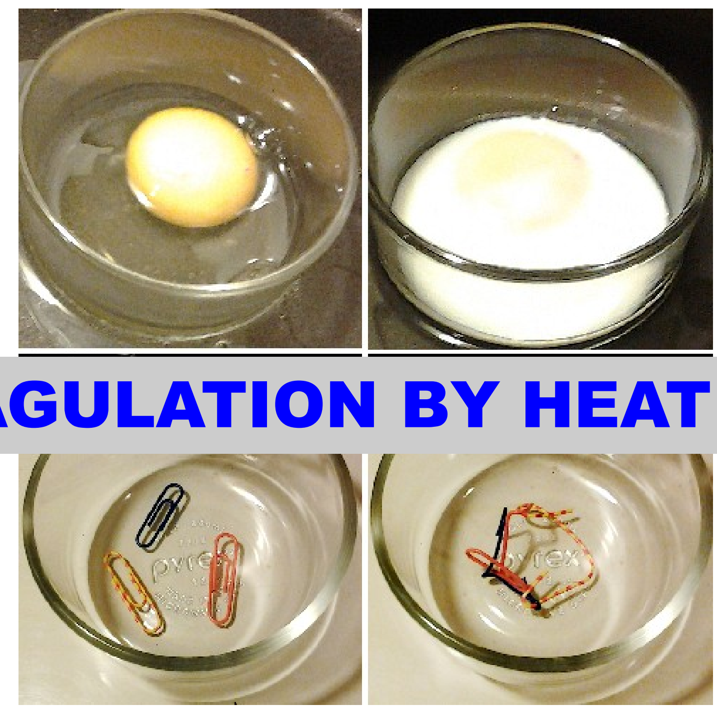
Amino acids Content in various Proteins

Amino acid	PROTEIN			
	Gelatine	Casein	Egg white	Egg yellow
	(Molar %)			
Isoleucine	1	6	6	5
Leucine	3	9	10	9
Thyrosine	0	4	1	2
Phenylalanine	1	4	4	3
Lysine	3	6	7	5
Histidine	1	3	2	2
Arginine	5	3	5	4

Gelatine = Denaturated Collagen

Denaturation is a process in which proteins or nucleic acids lose the quaternary structure, tertiary structure and secondary structure which is present in their native state, by application of some external stress or compound such as a strong acid or base, a concentrated inorganic salt, an organic solvent (e.g., alcohol or chloroform), radiation or heat.[3] If proteins in a living cell are denatured, this results in disruption of cell activity and possibly cell death. Denatured proteins can exhibit a wide range of characteristics, from loss of solubility to communal aggregation

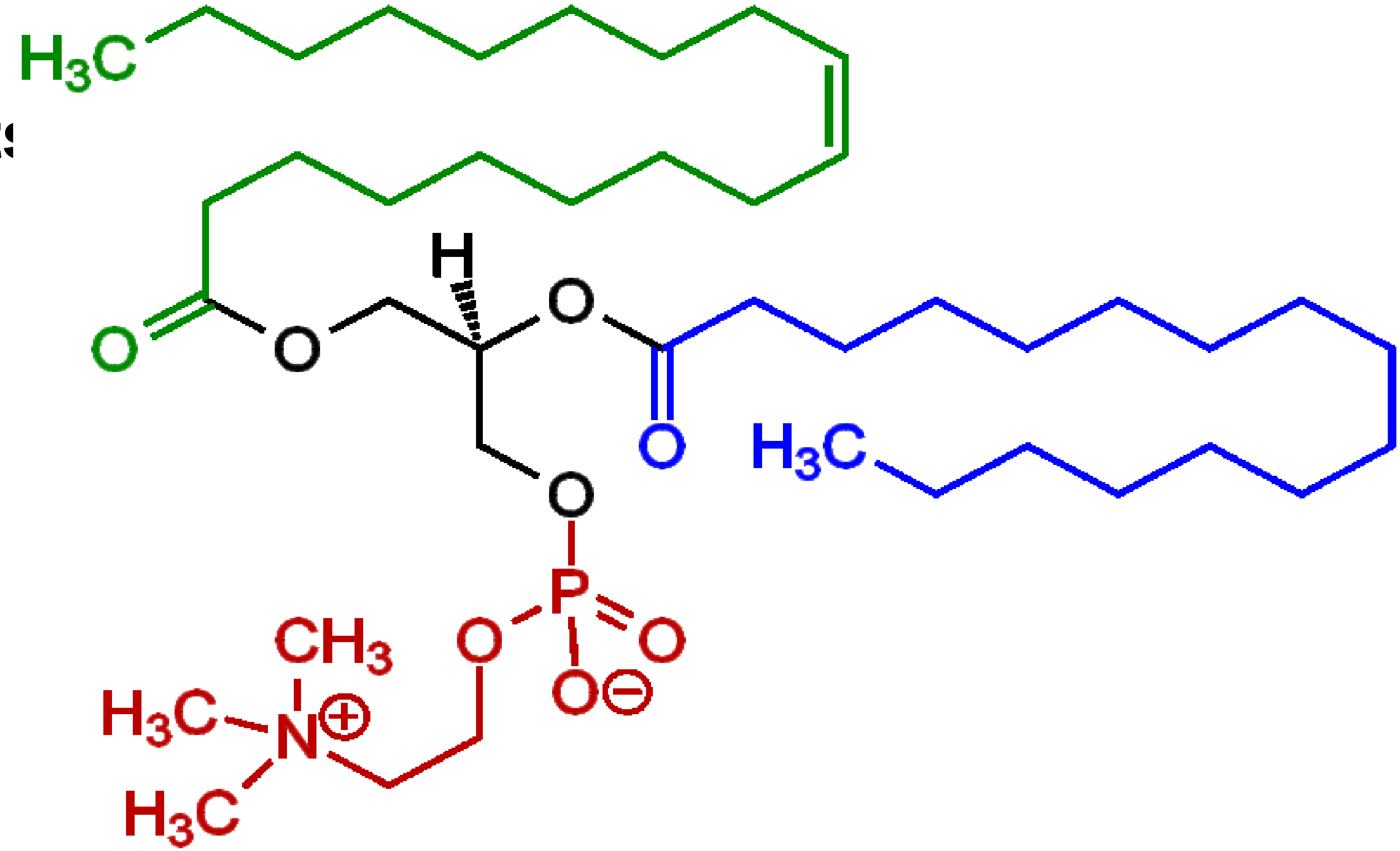




COAGULATION BY HEAT

ANALOGY with paper Clips

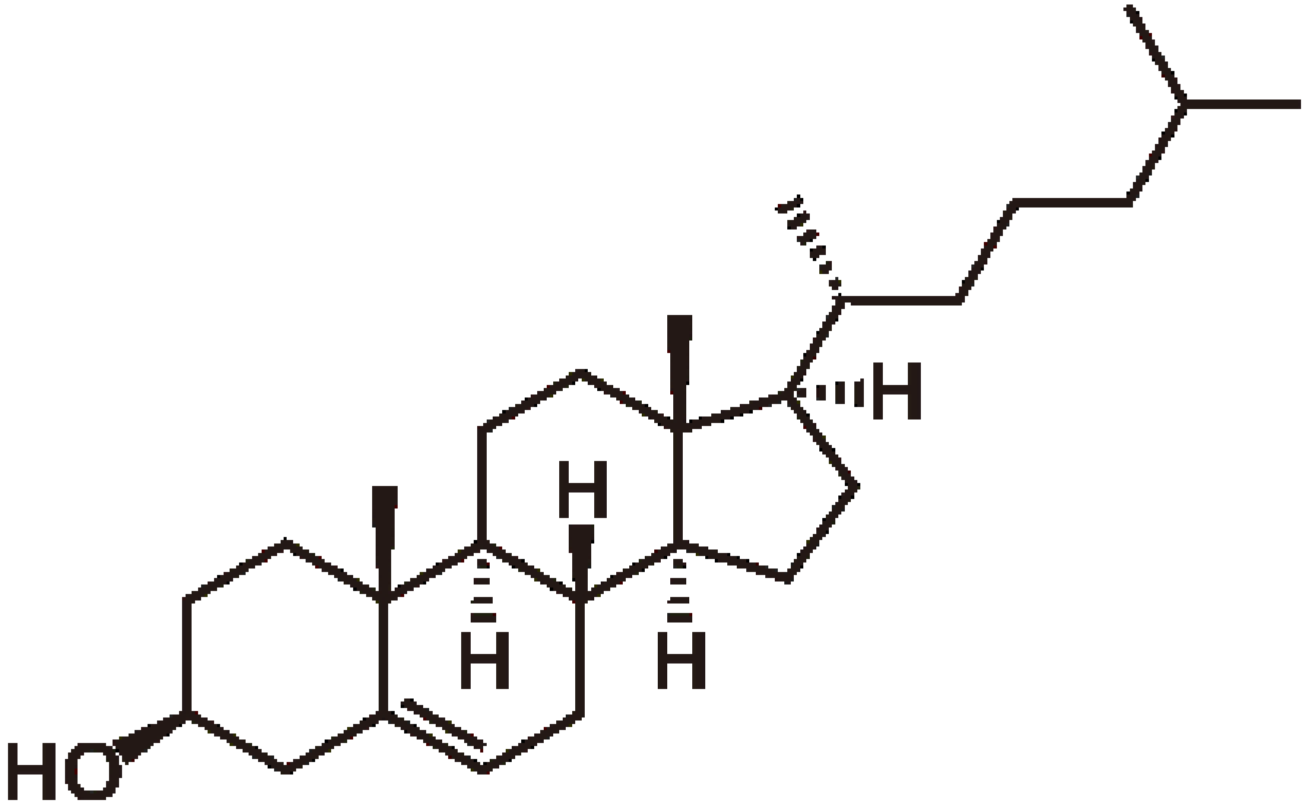
Egg Proteins – Use1

- Paint

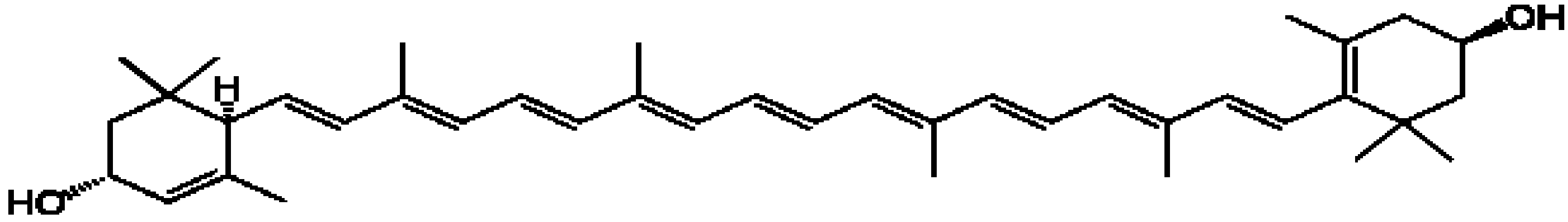
PHOSPHOLIPID LECITINE – emulsifying Agent
It is Part of the Egg yellow, but is NOT its Protein Part

Egg Proteins – USE 2

- Pain



CHOLESTEROL – STEROID & emulsifying AgentIt is Part of the Egg yellow, but is NOT its Protein Part



It is Part of the Egg yellow, but is NOT its Protein Part

Luteine - Colorant in the Egg yellow	
Chemical Name	β,ε-karoten-3,3'-diol
Summary Formula	$C_{40}H_{56}O_2$
CAS registration Number	127-40-2
Appearance	Solid, red – orange Crystalic Matter
Molar Mass	568,871 g/mol
Melting Temperature	190 °C
Solubility in Water	no
Solubility in Fats	yes

Egg White &Drinks

- **Clarifying of Fruit Juices**
- **Probably the oldest Clarifying Agent for Fruit Juices and Wine**

Whey

- **Whey** is a yellow-green Liquid, which is the Rest gained after precipitation of Milk using Acids or Enzymes. **Whey** is in fact Milk Serum. It looks like in Practise, that the Milk is precipitated and the Solid Part is **CASEIN** and the Liquid Part is **Whey**.
- **Dried Whey** arises also as the By-product at Manufacture of Cheese and/or **QUARK.**
- **Whey** contains Vitamins B1, B2, B6, B12 and further Vitamins C and E. As to Inorganic Elements it contains Mg, P, Ca, K, Na, Zn. It contains also the Saccharide LACTOSE.
- **Whey** has antiflammable Effect when used externally, so it is suitable for the sensitive Skin also. The other Uses as Dermatologic Agents are also widely used.

Whey –contained PROTEINS

- **Whey protein** is a mixture of globular proteins isolated from whey
- **Whey protein** is the collection of globular proteins isolated from whey, a by-product of cheese manufactured from cow's milk. The protein in cow's milk is 20% whey protein and 80% casein protein, whereas the protein in human milk is 60% whey and 40% casein. The protein fraction in whey constitutes approximately 10% of the total dry solids in whey. This protein is typically a mixture of beta-lactoglobulin (~65%), alpha-lactalbumin (~25%), bovine serum albumin (~8%)(see also serum albumin), and immunoglobulins. These are soluble in their native forms, independent of pH.
- **β-Lactoglobulin** is the major whey protein of cow and sheep's milk (~3 g/l),
- **α-Lactalbumin** is an important whey protein in cow's milk (~1 g/l) that enhances efficiency of brain function,
- **Serum albumin**, often referred to simply as **albumin** is a globular protein. **Serum albumin** is the most abundant plasma protein in mammals.
- An **antibody** (Ab), also known as an **immunoglobulin** (Ig), is a large Y-shaped protein produced by B cells that is used by the immune system to identify and neutralize foreign objects such as bacteria and viruses.

Plant Proteins

- **Proteins are usually related with Animal Products, but Proteins can be also of the Plant Origin:**
- **Glutens (glutelins)**
- **Prolamins (gliadins)**
- **They are MOSTLY Water insoluble (approx . 80 % of them)**

Plant	Group	Protein	Remark, more Specific
Wheat, Barley, Rye	**Gluten**	glutenin	8 – 13, sometimes also 15 % w/w **Proteins**
Rice		oryzenin	
Wheat, Rye	**Prolamin**	**gliadin**	**coeliac disease, allergy to *Gluten***
Corn		zein	
Barley		**hordein**	**GLYCOPROTEIN, coeliac disease, allergy to *Gluten***
Legumes	**Pea, Bean, Lentil, Soya, Ground-nut etc., up to 45 % w/w Proteins**		

Prolamins are a group of plant storage proteins having a high proline content and found in the seeds of cereal grains: wheat (**gliadin**), barley (hordein), rye (secalin), corn (zein), sorghum (kafirin) and as a minor protein, avenin in oats. They are characterised by a high glutamine and proline content and are generally soluble only in strong alcohol solutions. Some prolamins, notably gliadin, and similar proteins found in the tribe Triticeae (see Triticeae glutens) may induce coeliac disease in genetically predisposed individuals.

Gluten is a composite of storage proteins termed **prolamins** and **glutelins** and stored together with starch in the endosperm (which nourishes the embryonic plant during germination) of various cereal (grass) grains. It is found in wheat, barley, rye, oat, related species and hybrids (such as spelt, khorasan, emmer, einkorn, triticale, kamut, etc.) and products of these (such as malt). Glutens, and most especially the Triticeae glutens, are appreciated for their viscoelastic properties. It gives elasticity to dough, helping it rise and keep its shape and often gives the final product a chewy texture.

Gliadin (a type of **prolamin**) is a class of proteins present in wheat and several other cereals within the grass genus *Triticum*. Gliadins, which are a component of gluten, are essential for giving bread the ability to rise properly during baking. Gliadins and **glutenins** are the two main components of the gluten fraction of the wheat seed. This gluten is found in products such as wheat flour. Gluten is split about evenly between the gliadins and glutenins, although there are variations found in different sources.

Gliadin is the water-soluble component of gluten, while glutenin is insoluble. There are three main types of gliadin (α, γ, and ω), to which the body is intolerant in coeliac (or celiac) disease. Diagnosis of this disease has recently been improving