

Amino acids, proteins

Biological macromolecules

- Proteins
- Carbohydrates
- Lipids
- Nucleic acids

A protein called alpha-keratin forms your hair and fingernails, and also is the major component of feathers, wool, claws, scales, horns, and hooves.

The hemoglobin protein carries oxygen in your blood to every part of your body.

Muscle proteins called actin and myosin enable all muscular movement—from blinking to breathing to rollerblading.

Ion channel proteins control brain signaling by allowing small molecules into and out of nerve cells.

Receptor proteins stud the outside of your cells and transmit signals to partner proteins on the inside of the cells.

Enzymes in your saliva, stomach, and small intestine are proteins that help you digest food.

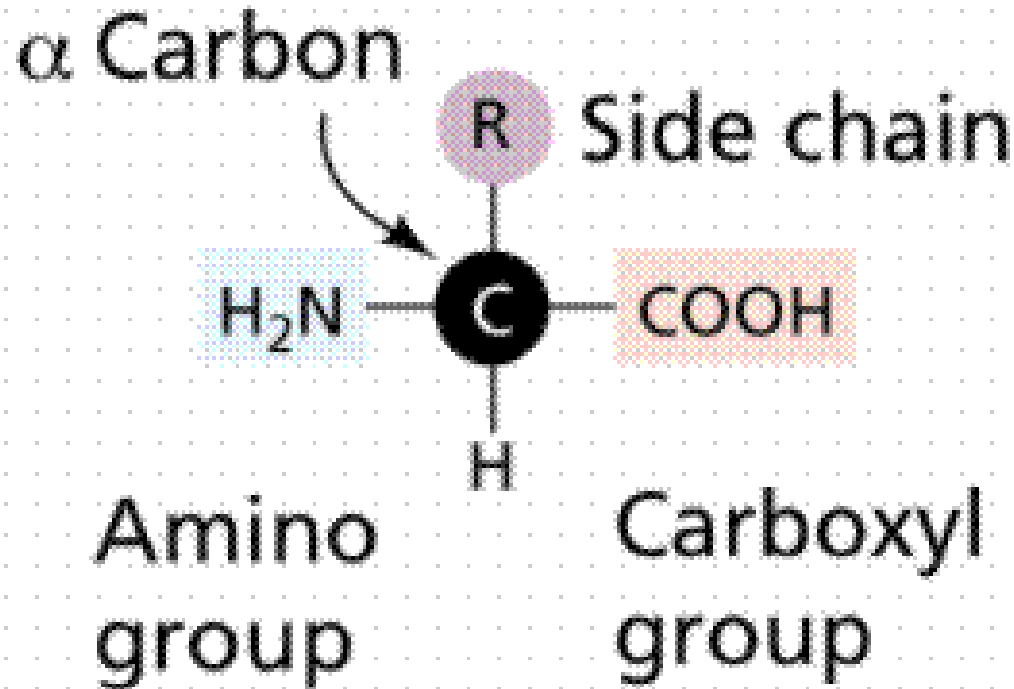
Antibodies are proteins that help defend your body against foreign invaders, such as bacteria and viruses.

Huge clusters of proteins form molecular machines that do your cells' heavy work, such as copying genes during cell division and making new proteins.

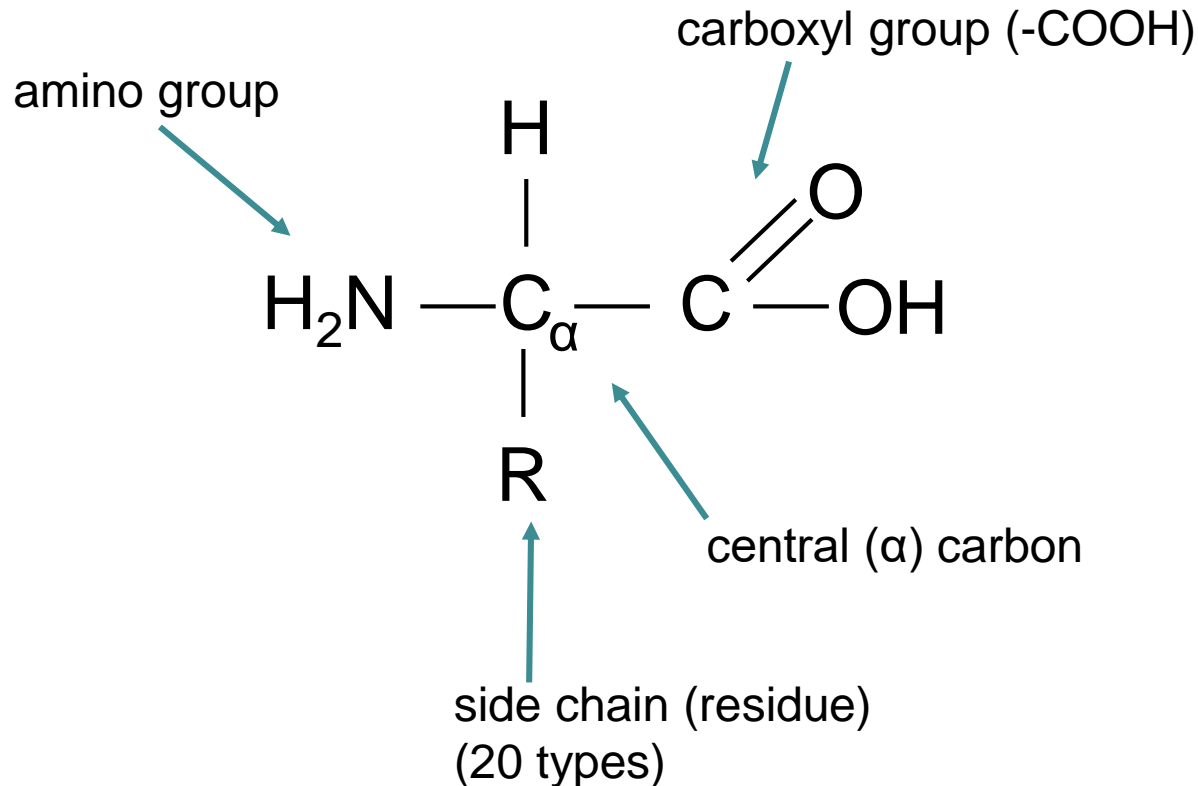


Building blocks of proteins: amino acids (20 types)

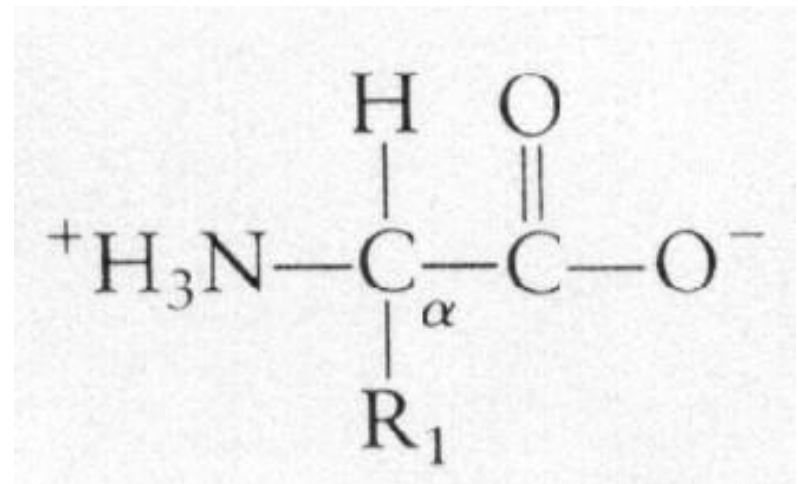
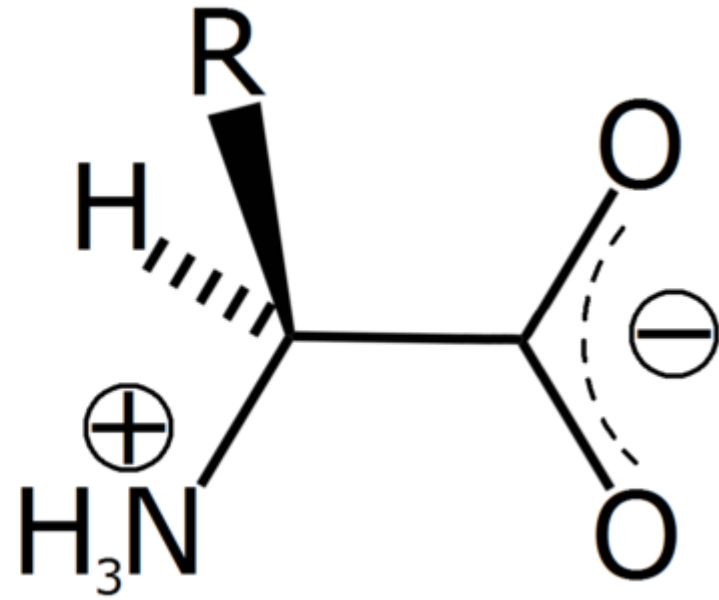
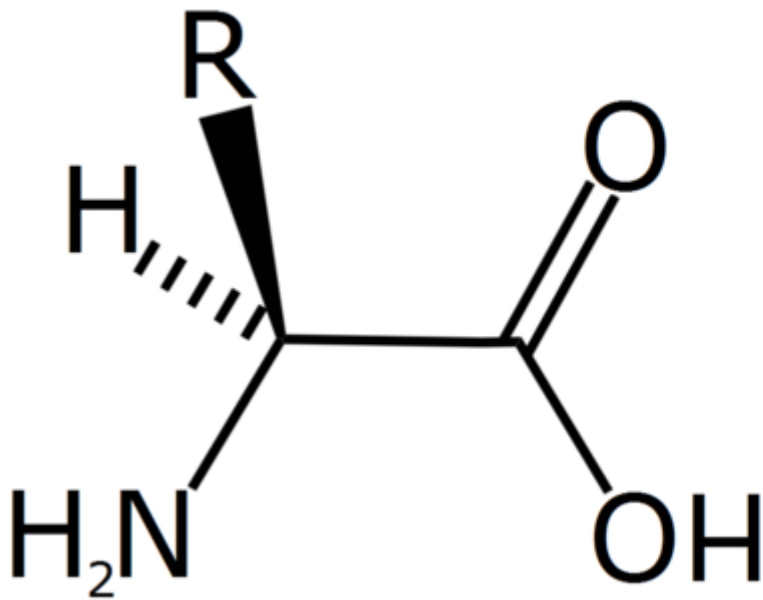
Conventional depiction



Monomers of proteins: amino acids (20 types)



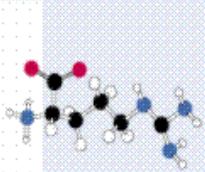
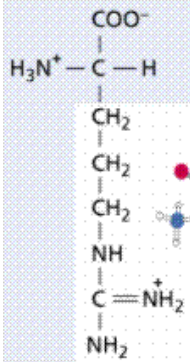
(1) normal (unionized) and (2) zwitterionic forms.



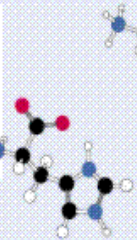
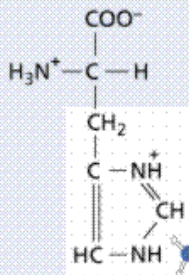
Charged: basic and acidic amino acids

A. Amino acids with electrically charged side chains: Positive

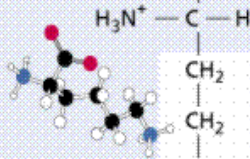
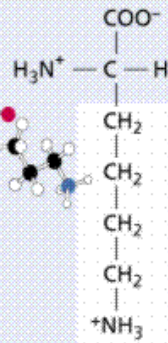
Arginine (Arg)



Histidine (His)

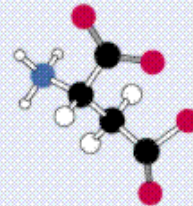
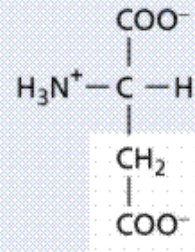


Lysine (Lys)

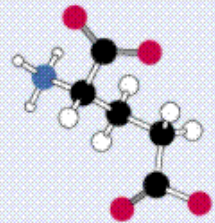
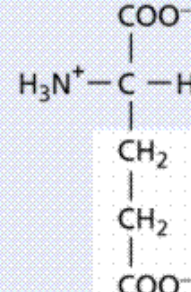


A. Amino acids with electrically charged side chains: Negative

Aspartic acid (Asp)

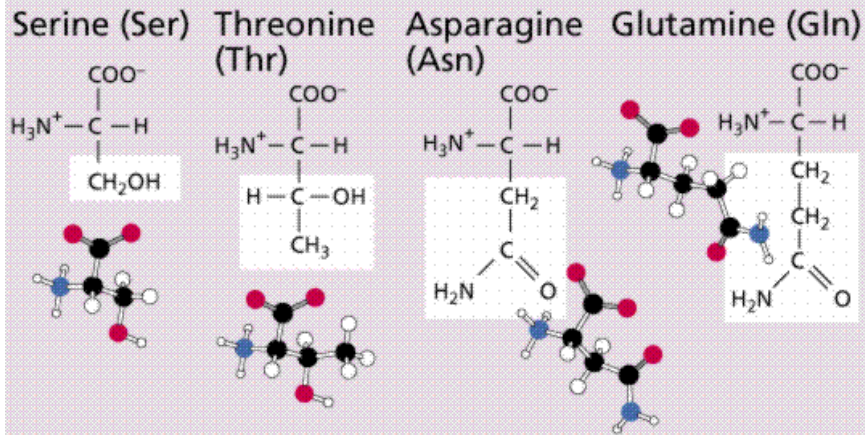


Glutamic acid (Glu)



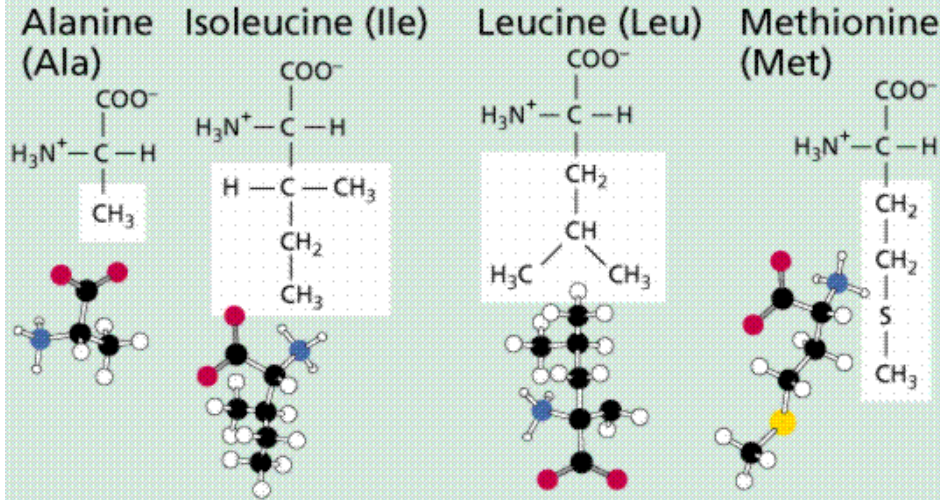
Uncharged polar amino acids

B. Amino acids with polar but uncharged side chains

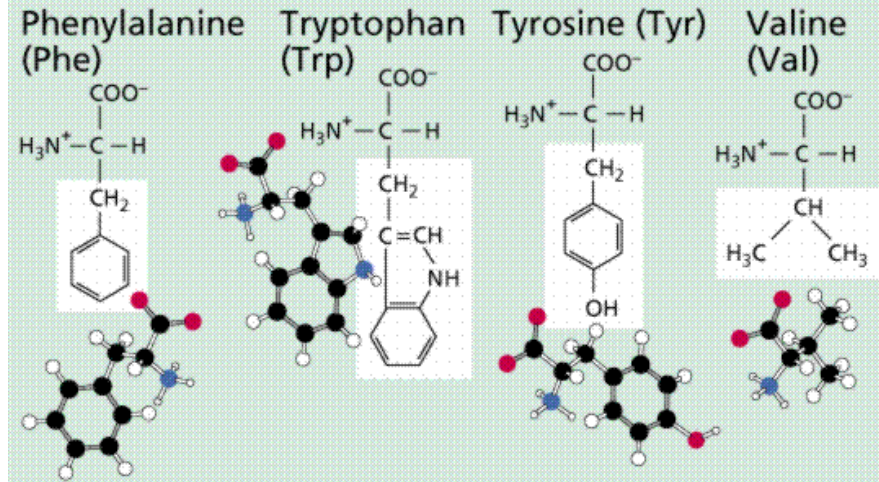


Nonpolar and special amino acids

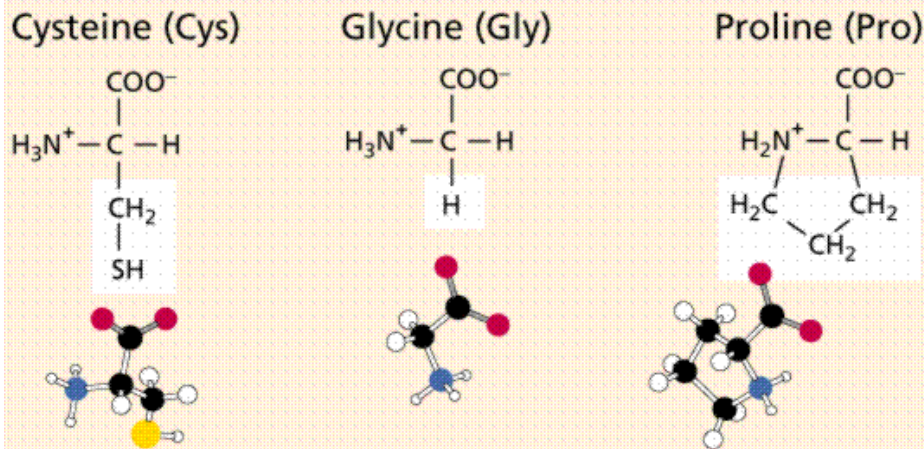
D. Amino acids with hydrophobic side chains



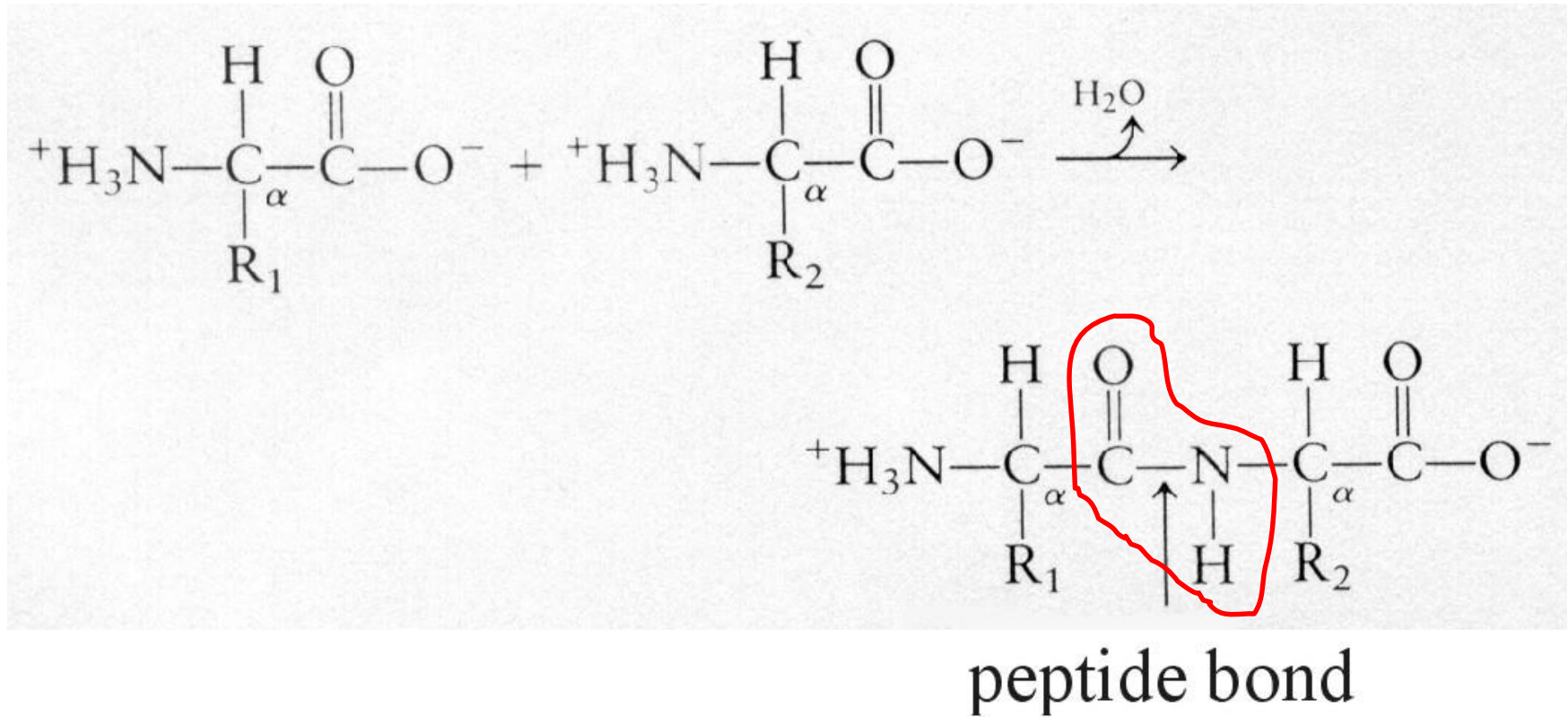
D. Amino acids with hydrophobic side chains (continued)



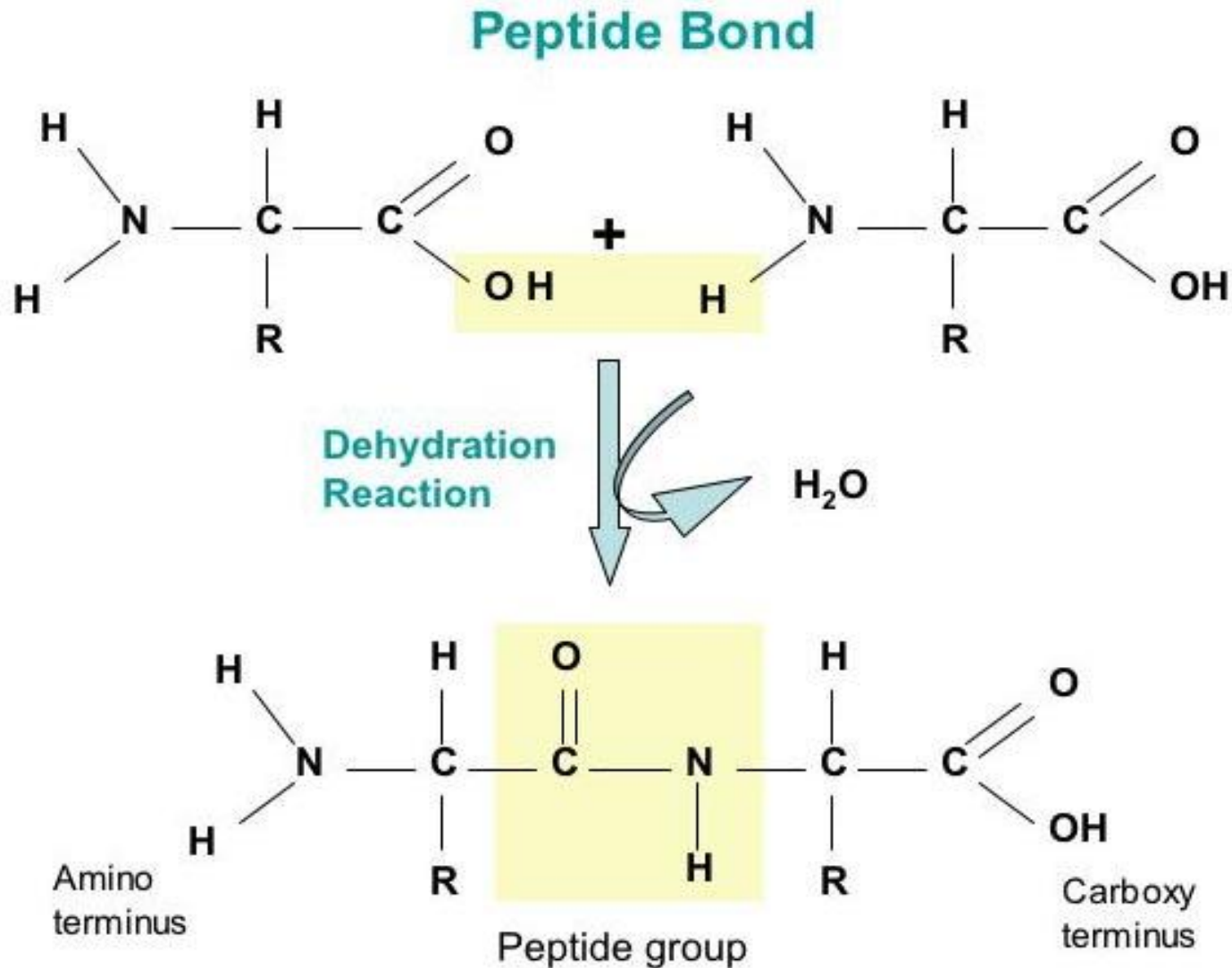
C. Special cases

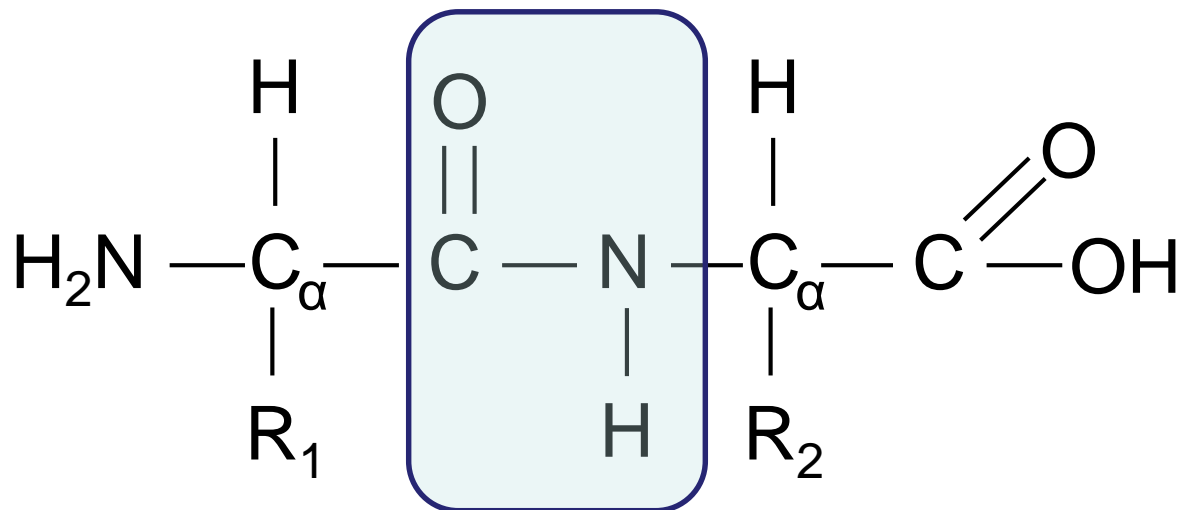


Peptide-bond formation

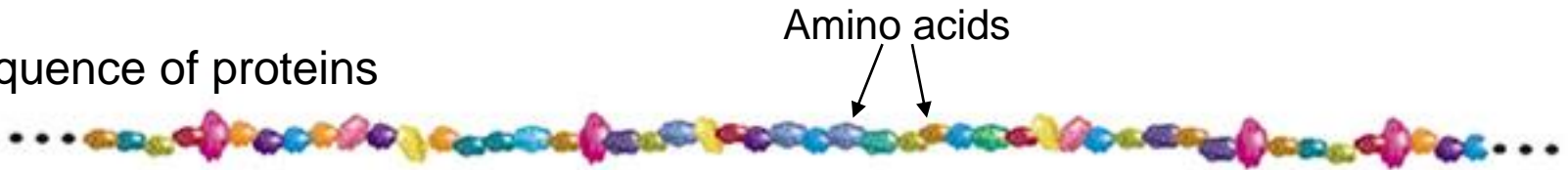


Peptide-bond formation





Sequence of proteins



Amino acids

Conformation of proteins

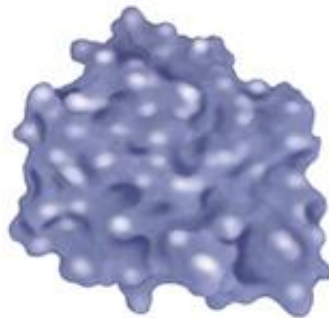


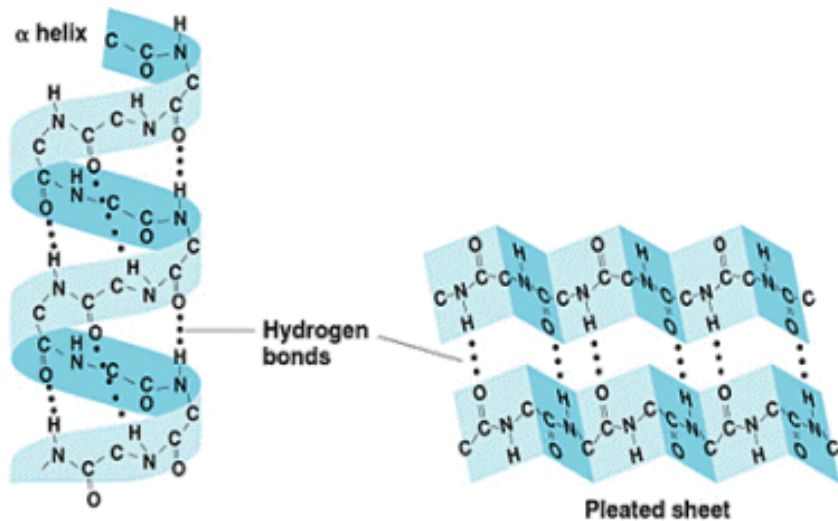
Proteins:

Polypeptides

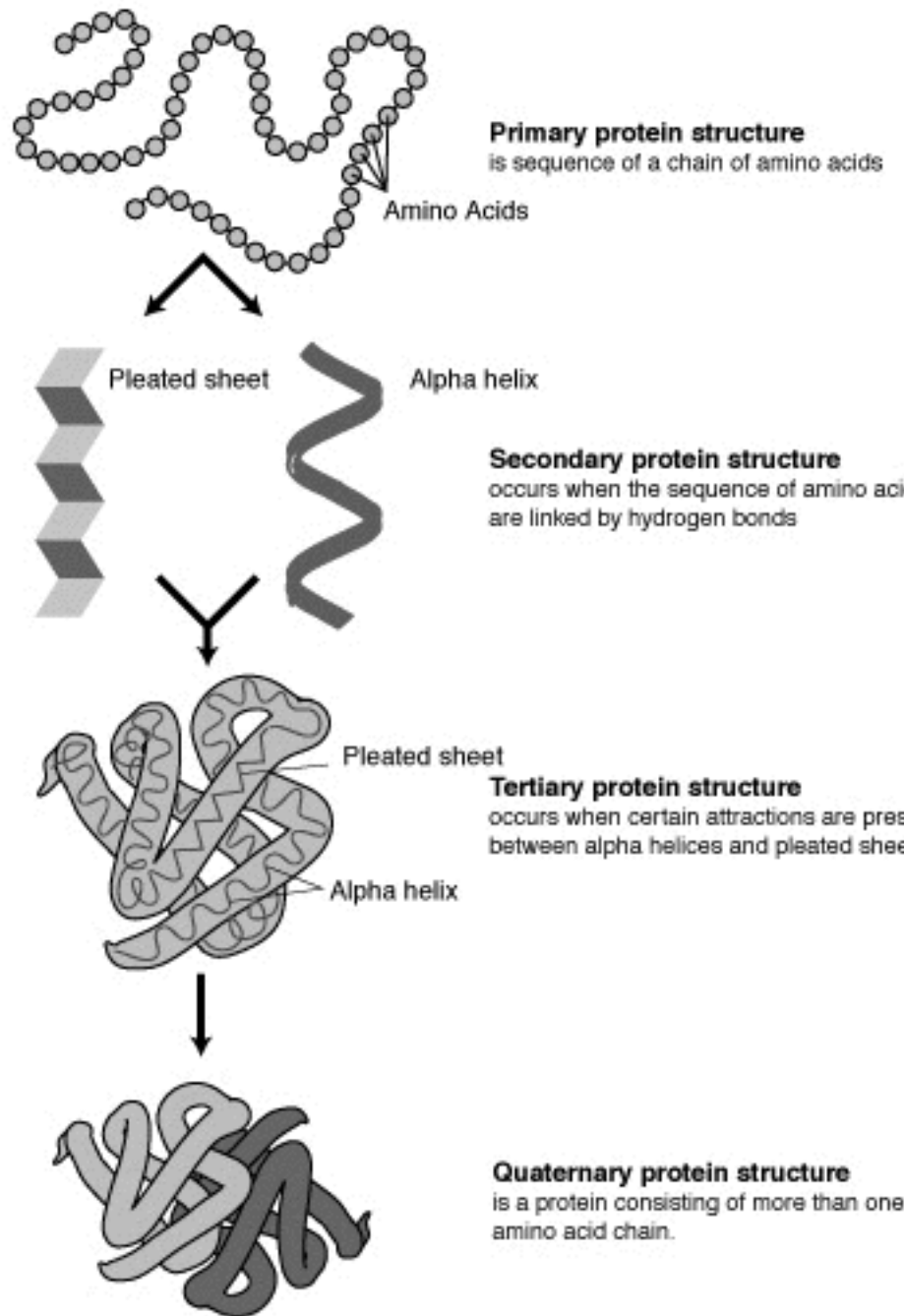
N-terminus: free amino group

C-terminus: free carboxyl group





<http://webschoolsolutions.com/biotech/amino-second.gif>



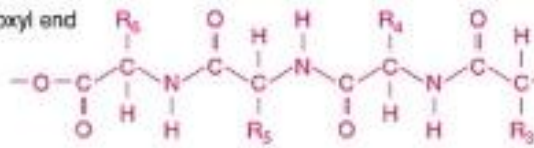
In the 1950's:
Frederick Sanger:
Amino acid sequence of insulin

Linus Pauling:
X-ray crystallography:
Structure of haemoglobin

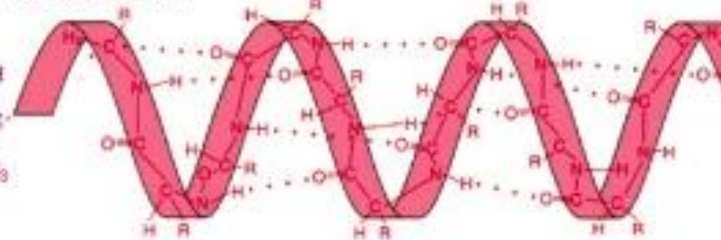
Structure of haemoglobin

(a) Primary structure

Carboxyl end

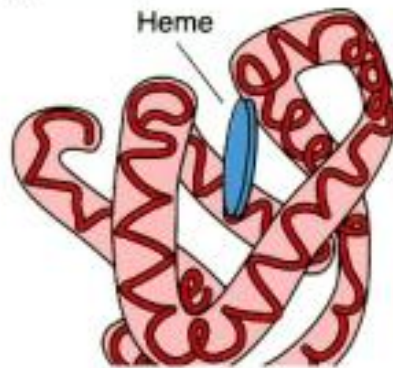


(b) Secondary structure

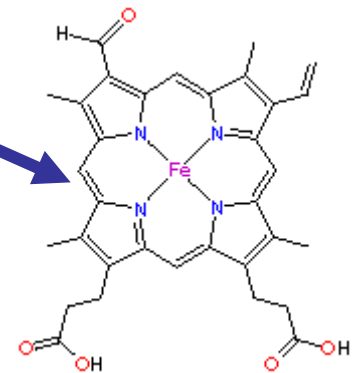
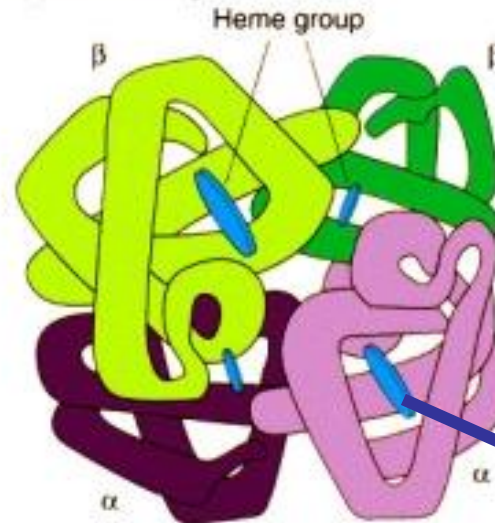


Hydrogen bonds between amino acids at different locations in polypeptide chain

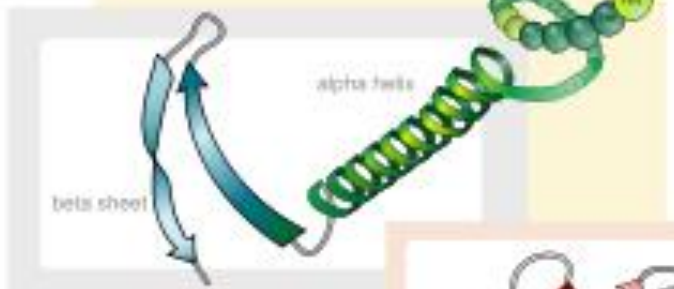
(c) Tertiary structure



(d) Quaternary structure



Primary structure
amino acid sequence



Secondary structure
regular sub-structures



Quaternary structure
complex of protein molecules

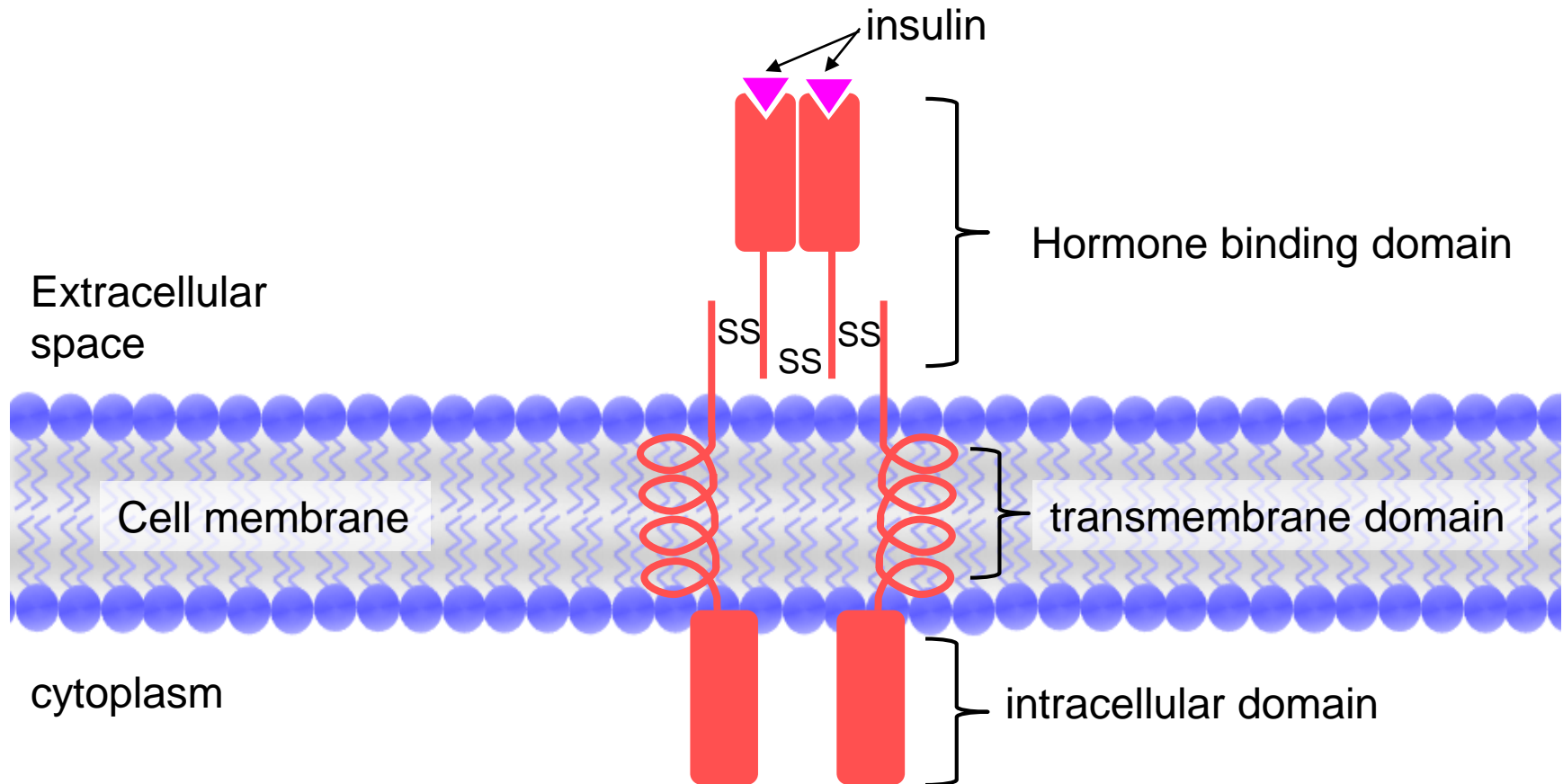


Tertiary structure
three-dimensional structure

Domain: tertiary structure element

Domain: a part of a protein, with a special function and structure.

Pl.: insulin receptor



Examples for proteins according to function:

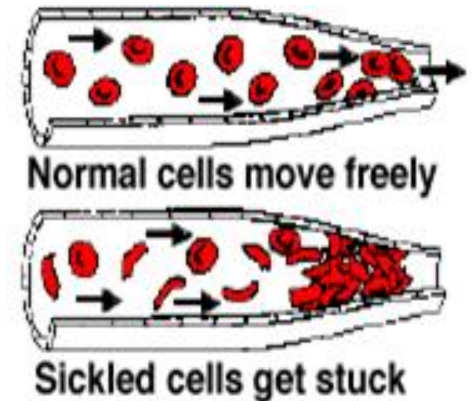
- Structural proteins (keratin in hair, nail, collagen fibers in extracellular space, actin-myosin in muscle cells)
- Enzymes (amylase, pepsin in digestive system)
- Proteins with defense function (antibodies)
- Transporters (hemoglobin transports O₂, ion channels in cell membrane)
- Regulatory proteins (Hormones eg. insulin)
- Receptors (hormone receptors)

„little” change in structure –
great problem in function

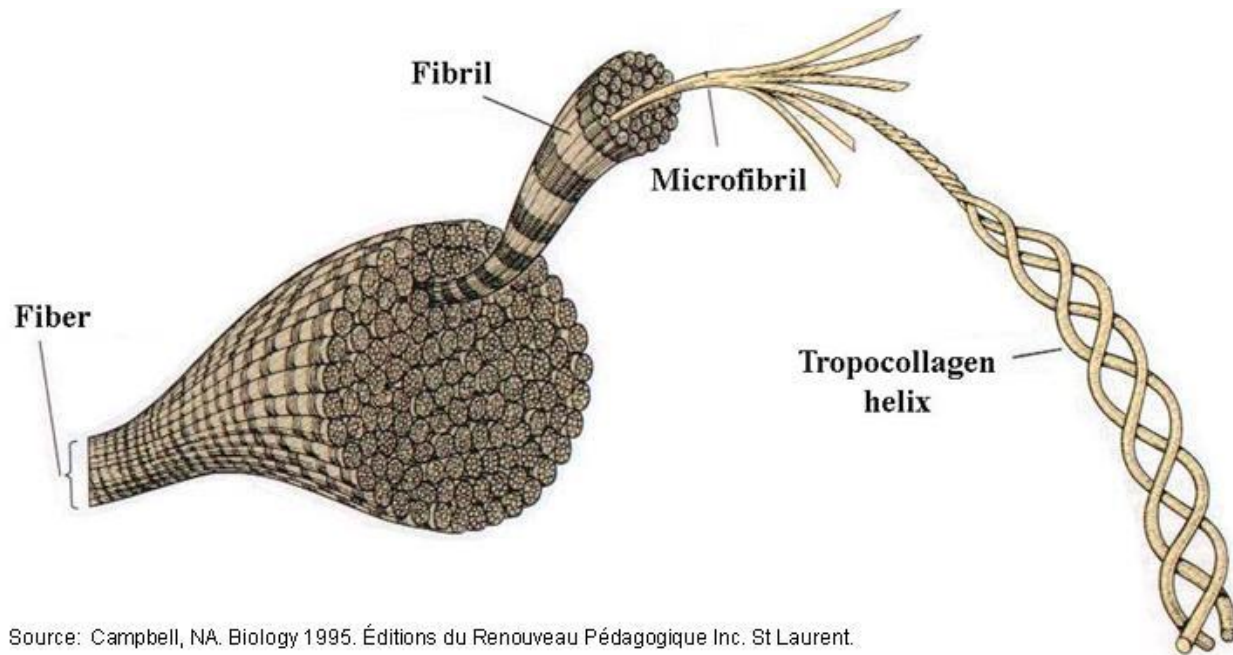


Symptoms of sickle cell anaemia

- breathlessness,
- rapid heart rate,
- delayed growth and puberty,
- susceptibility to infections
- ulcers on the lower legs (in adolescents and adults)
- jaundice,
- attacks of abdominal pain,
- weakness,
- joint pain,
- fever,
- vomiting,
- bloody (hematuria) urination,
- excessive thirst,
- excessive penis pain, priapism, chest pain and decreased fertility

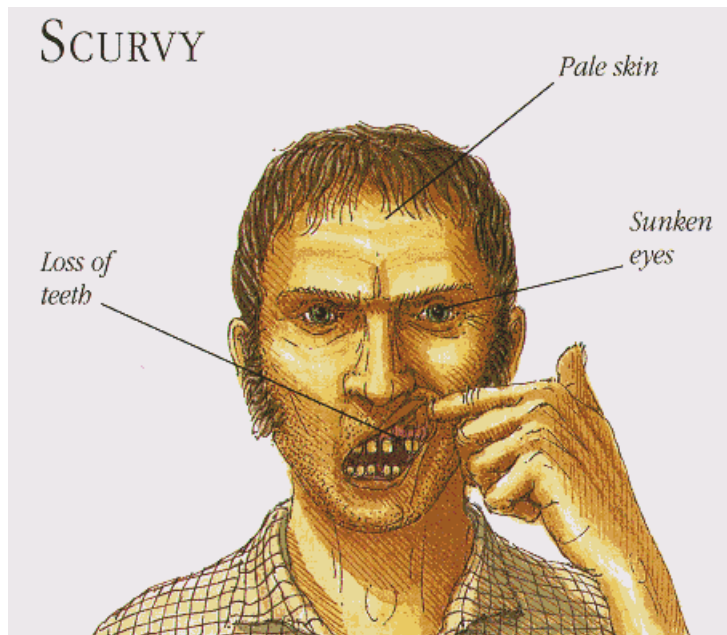


little” change in structure – great problem in function



Source: Campbell, NA. Biology 1995. Éditions du Renouveau Pédagogique Inc. St Laurent.

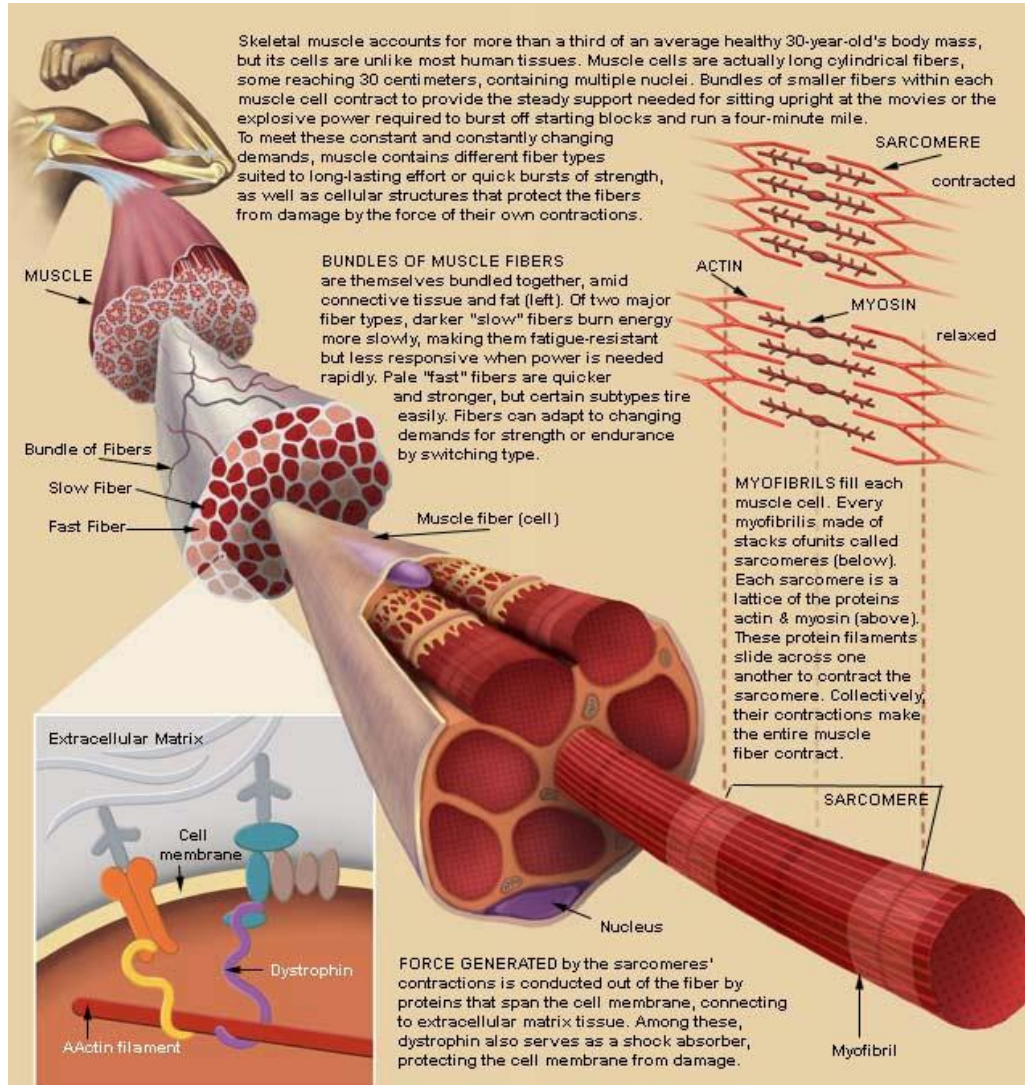
Symptoms of scurvy



- weakening,
- pale skin,
- sunken eyes,
- tender gums,
- muscle pain,
- loss of teeth,
- internal bleeding,
- the opening of wounds



„little” change in structure – great problem in function



- Age 5: Diagnosis of Duchenne Muscular Dystrophy.**
- Age 5: Used a bicycle with stabilizers.**
- Age 5: Attained 10 metre swimming badge.**
- Age 9: Used the wheelchair occasionally at school.**
- Age 10: Wheelchair bound.**
- Age 15: Back operation.**
- Age 16: Painting on stones, slates and on paper.**
- Age 20: No longer physically able to paint.**
- Age 22: Ventilator used for the first time on average 9hrs in 24hrs.**
- Age 23: Resumed an earlier, less physically demanding, interest for pen and ink drawings.**
- Age 27: No longer able, physically, to manipulate and coordinate the pen for ink drawing**
- Age 27: A portable ventilator came on the market and was purchased. It was a great liberator in that I could leave home for day trips or weekends away.**
- Age 29: A full liquid diet, supplemented with small amounts of cheese, chocolate,**
- Age 29: Time off ventilator: maximum 5hrs in 24hrs. My time off the ventilator varies according to the atmospheric conditions such as temperature, humidity, wet weather and of course whether or not I have a cold.**
- Age 34: Review of my diet/calorie intake, resulting in a substantial increase of calorie intake and, of course, energy.**
- Age 35: Time off ventilator: maximum just over 3 hrs in 24hrs.**