

STRUKTURA PROTEINŮ

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MUNI

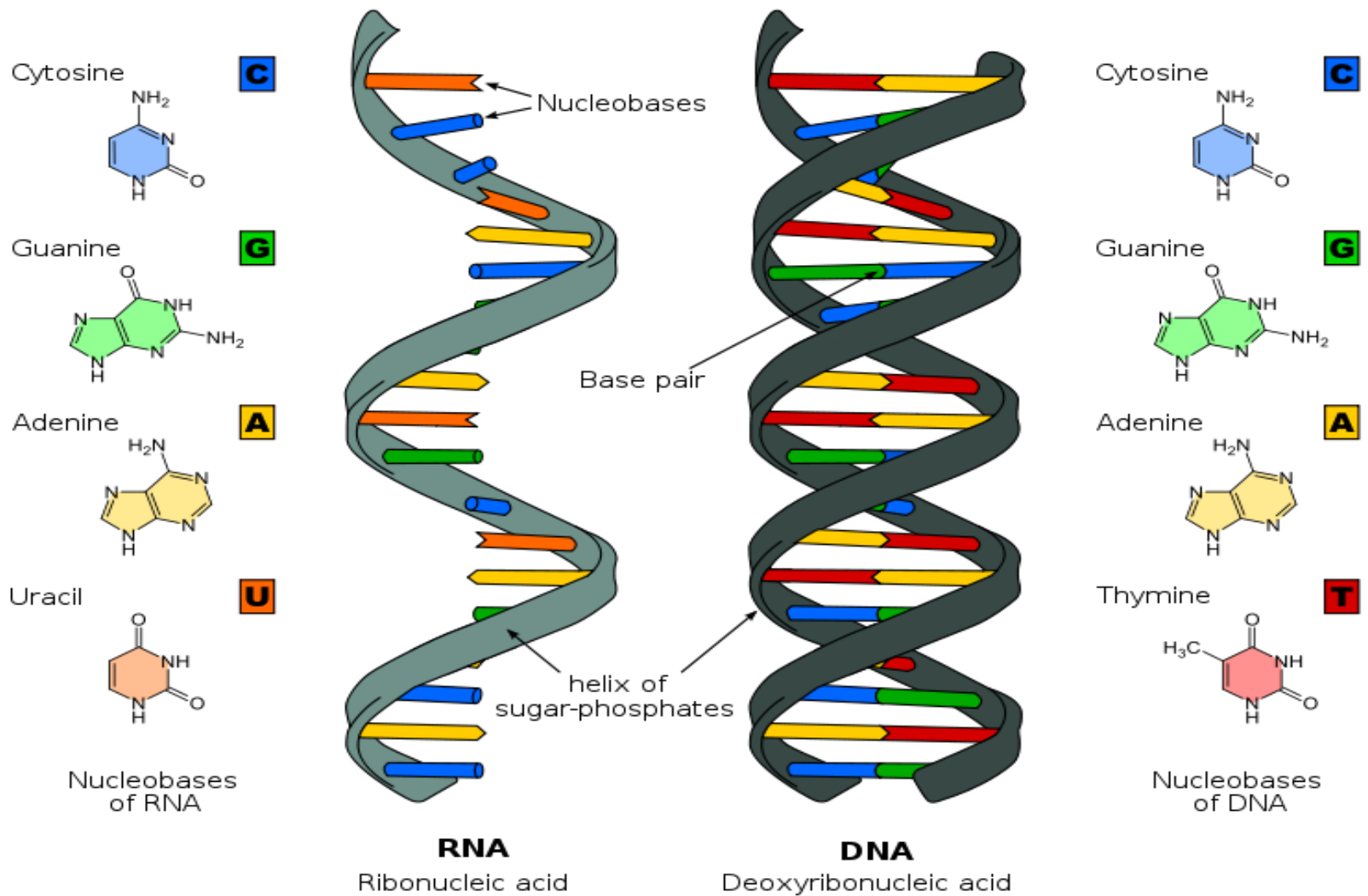
Obsah

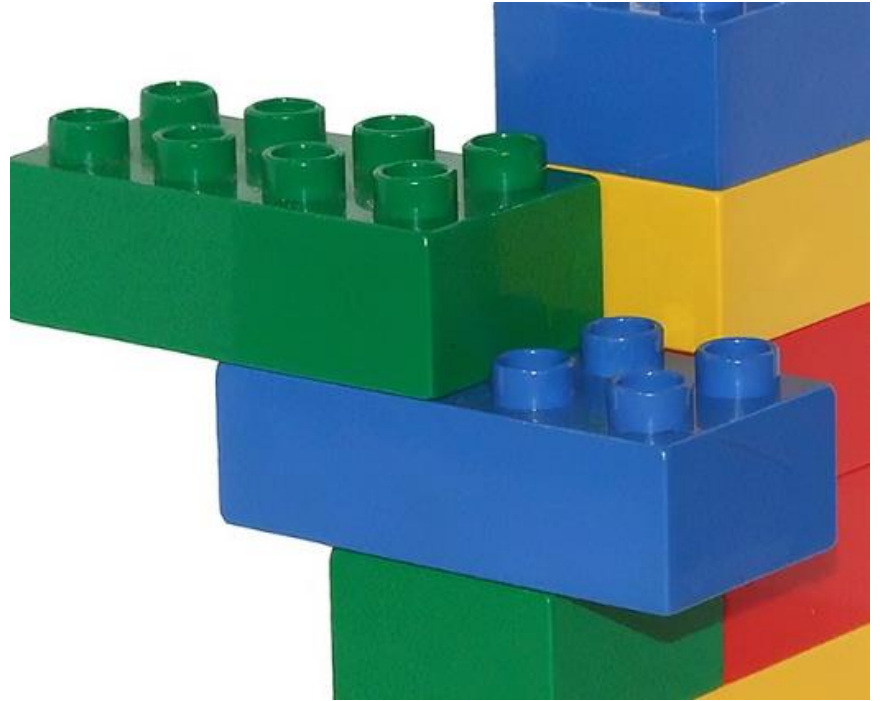
- PRIMARNI STRUKTURA
 - Přepis RNA a DNA
- SEKUNDARNI STRUKTURA
- TERC. A KVARTERNI STRUKTURA
- Závěr

Literatura

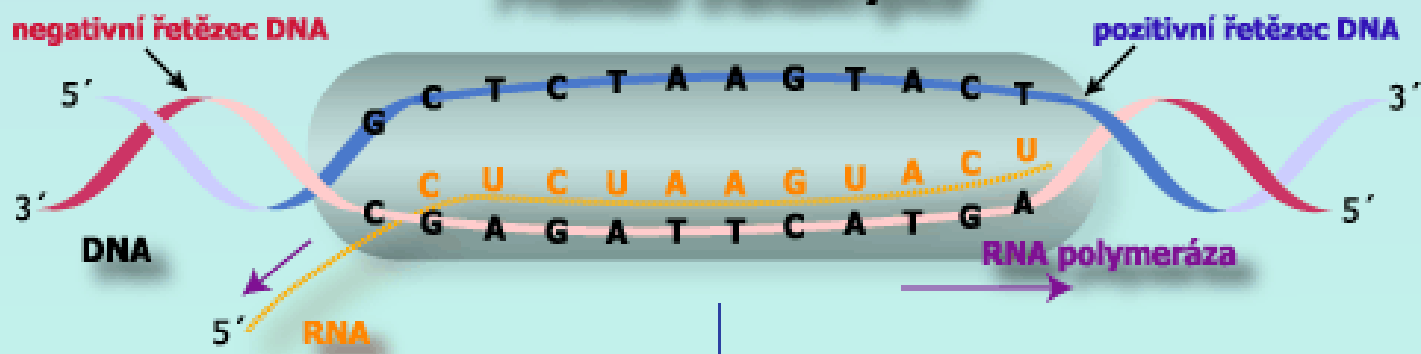
- C. Branden, J. Toonze: Introduction to protein structure. Garland Publishing, New York – London, 1991.
- D. Eisenberg: The discovery of the α -helix and β -sheet, the principal structural features of proteins.
- . W. Kabsch, C. Sander: Dictionary of protein secondary structure. Biopolymers 22 (1983) 2577–2637.
- D. Voet, J. G. Voetová: Biochemie. Victoria Publishing, Praha, 1995.

Základní přehled

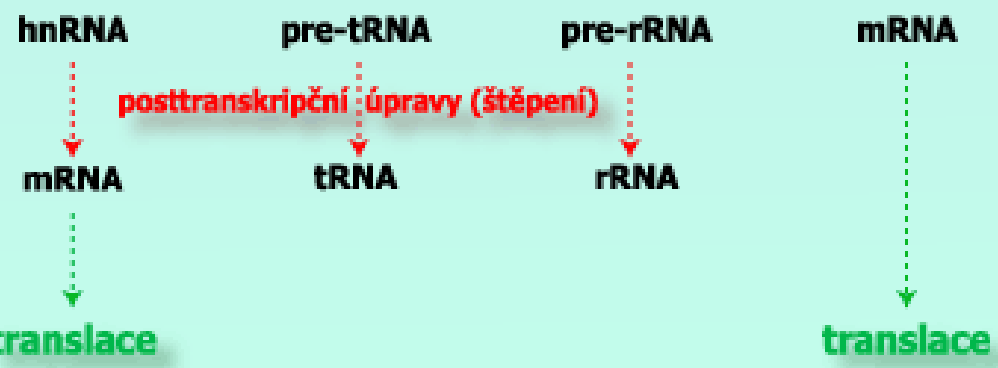




Přehled transkripce



primární transkript



DNA vřiry eukaryota

DNA vřiry prokaryota eukaryota

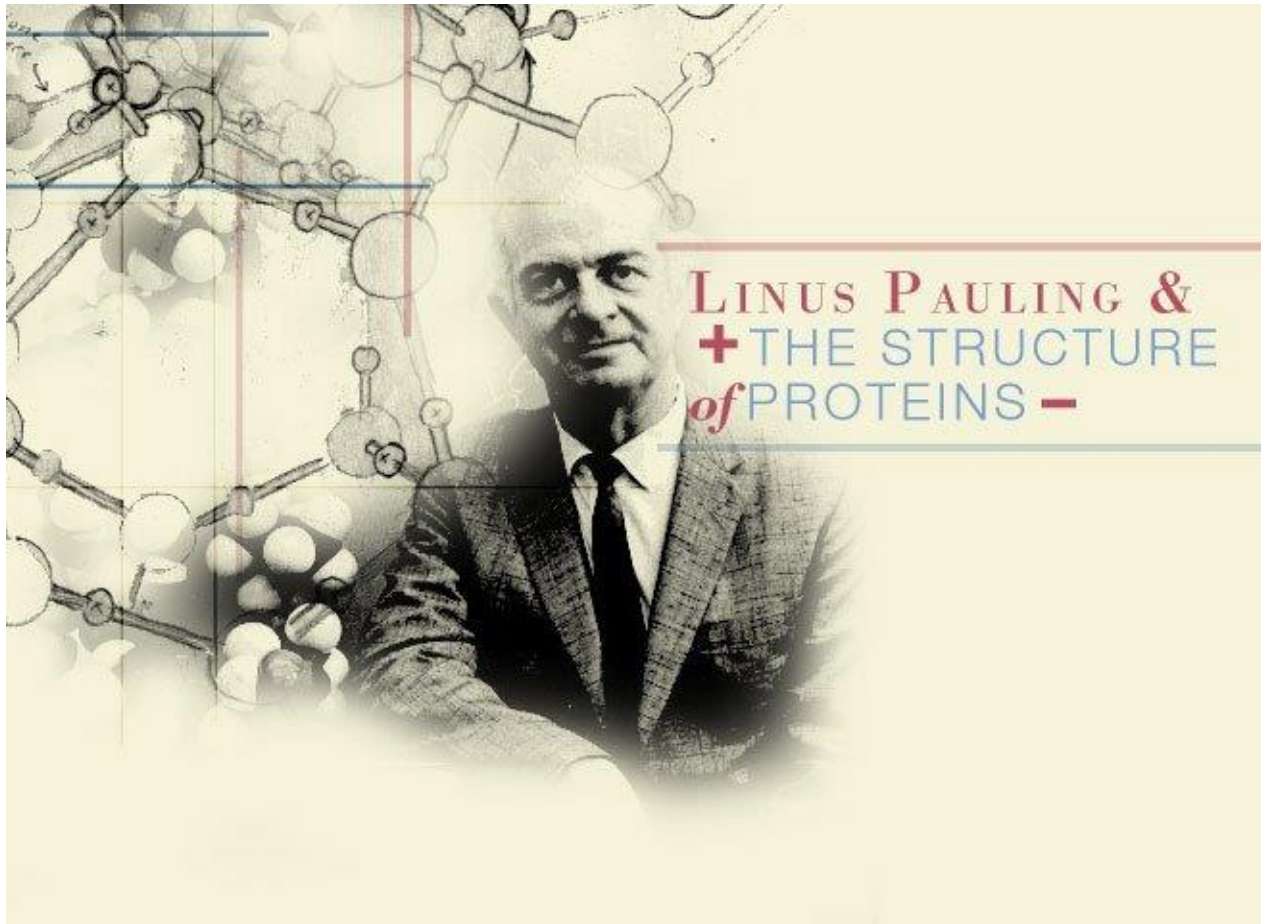
prokaryota

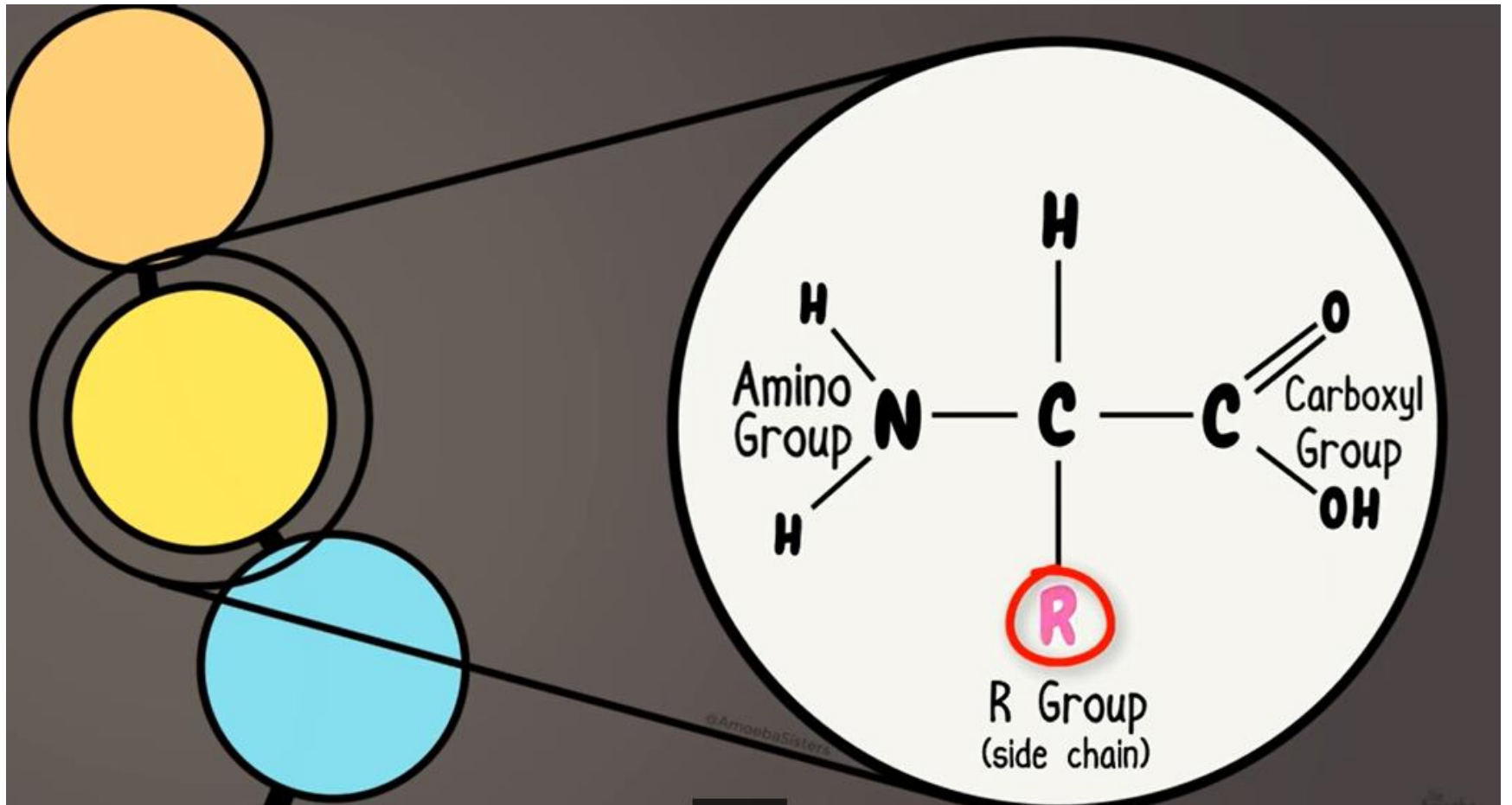
PROTEINY - Historie

- Dutch chemist **Gerhardus Johannes Mulder** carried out elemental analyses of common animal and plant proteins in **1837**
- To everyone's surprise, all proteins had nearly the same empirical formula, roughly $C_{400}H_{620}N_{100}O_{120}$ with individual sulfur and phosphorus atoms.
- He hypothesized that there was **one basic substance (*Grundstoff*)** of proteins, and that it was synthesized by plants and absorbed from them by animals in digestion.



PROTEINY - HISTORIE





STRUKTUR

Primary



α Helix



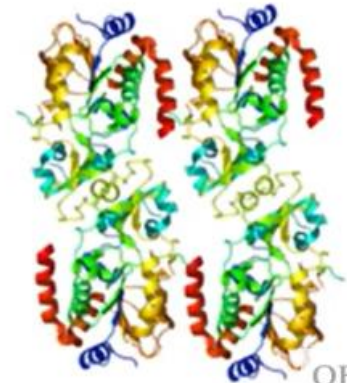
β sheet



Tertiary



Quaternary



PRIMARNÍ STRUKTURA

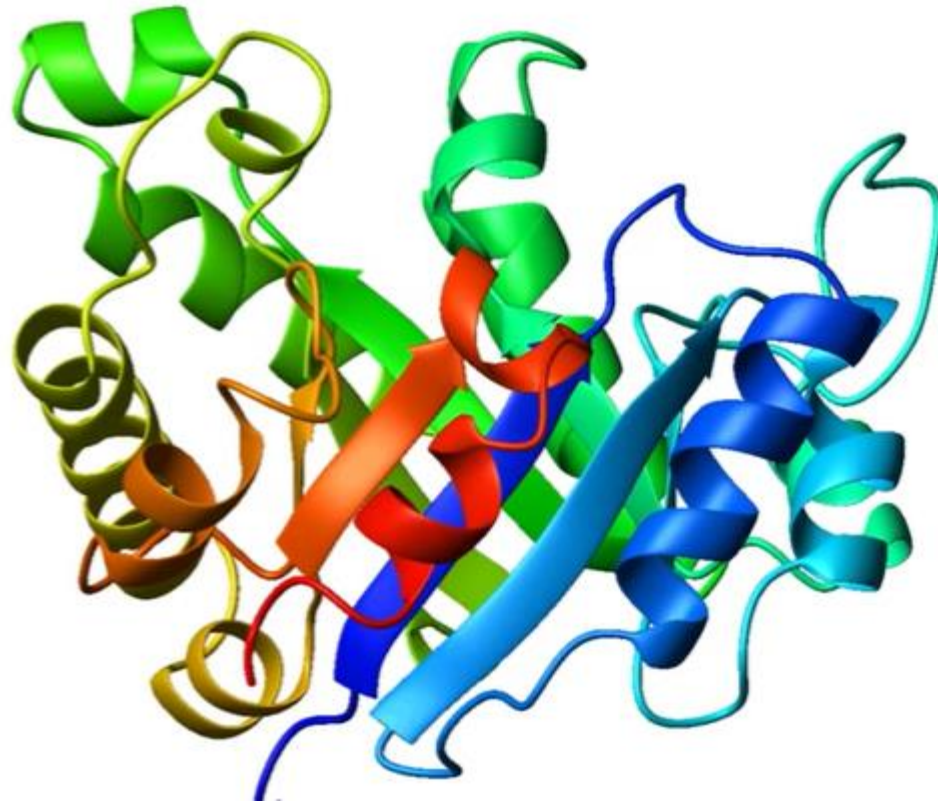
primary protein structure = sequence of amino acids

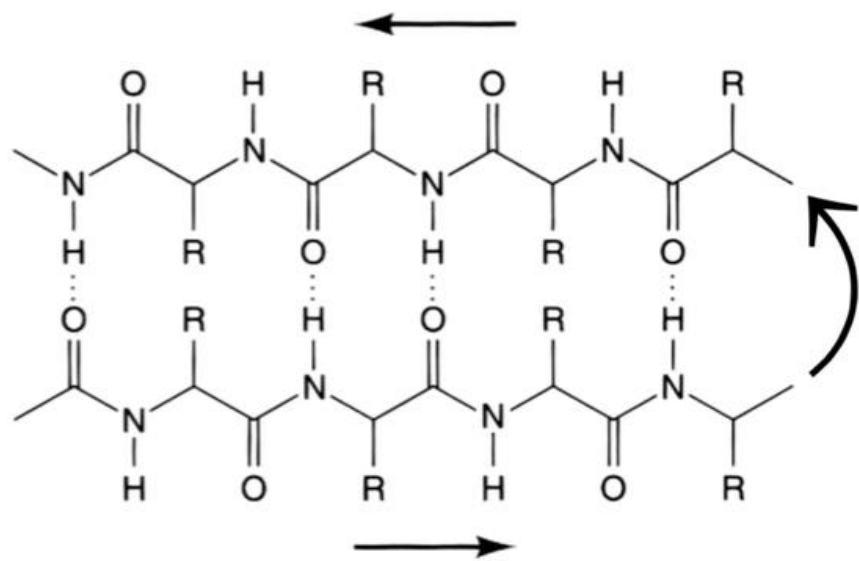
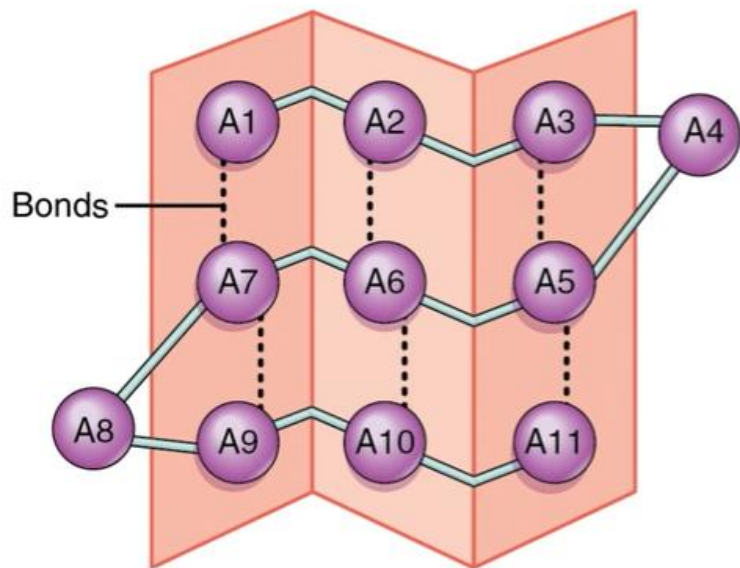
amino acid	codes	amino acid	codes
Alanine	(Ala, A)	Leucine	(Leu, L)
Arginine	(Arg, R)	Lysine	(Lys, K)
Asparagine	(Asn, N)	Methionine	(Met, M)
Aspartic Acid	(Asp, D)	Phenylalanine	(Phe, F)
Cysteine	(Cys, C)	Proline	(Pro, P)
Glutamic Acid	(Glu, E)	Serine	(Ser, S)
Glutamine	(Gln, Q)	Threonine	(Thr, T)
Glycine	(Gly, G)	Tryptophan	(Trp, W)
Histidine	(His, H)	Tyrosine	(Tyr, Y)
Isoleucine	(Ile, I)	Valine	(Val, V)

of abbreviations for your reference. The shape the protein will take depends on

SEKUNDÁRNÍ STRUKTURA

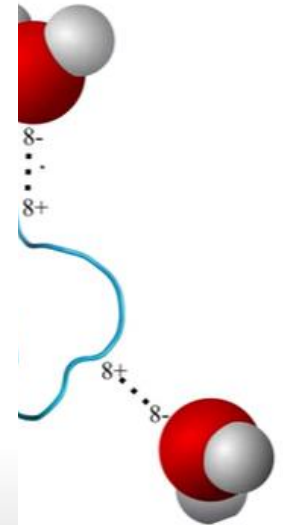
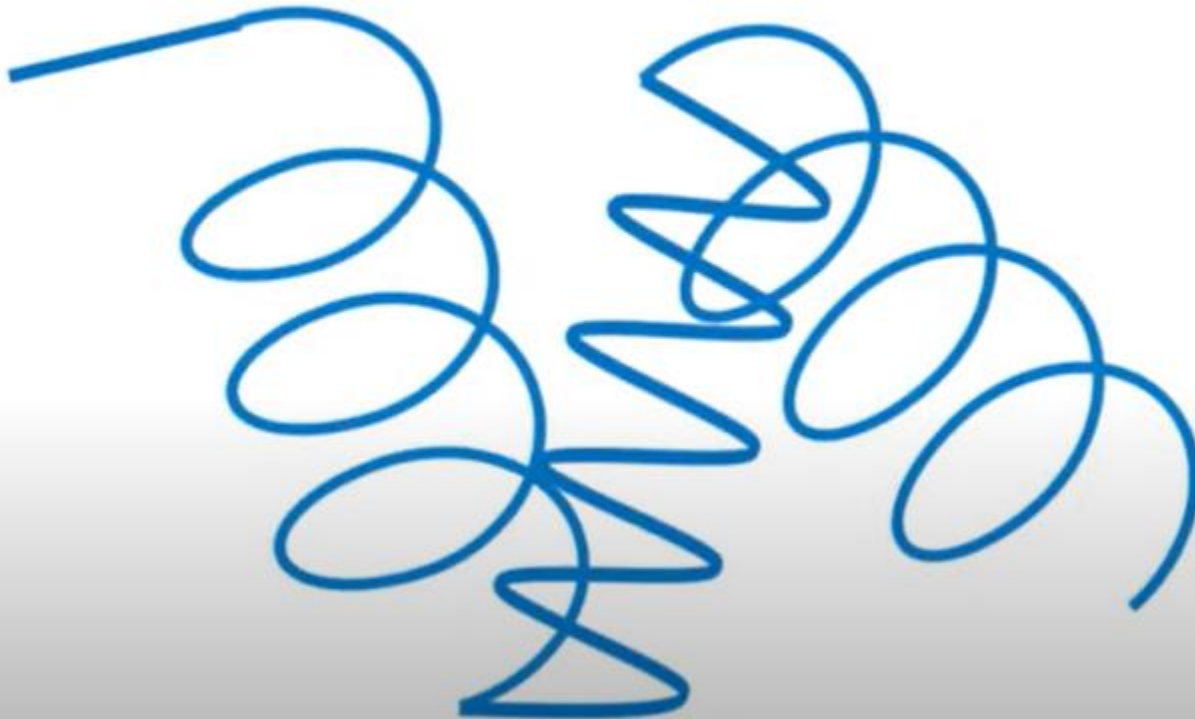
- ALFA HELIX
- BETA SKLADANY LIST





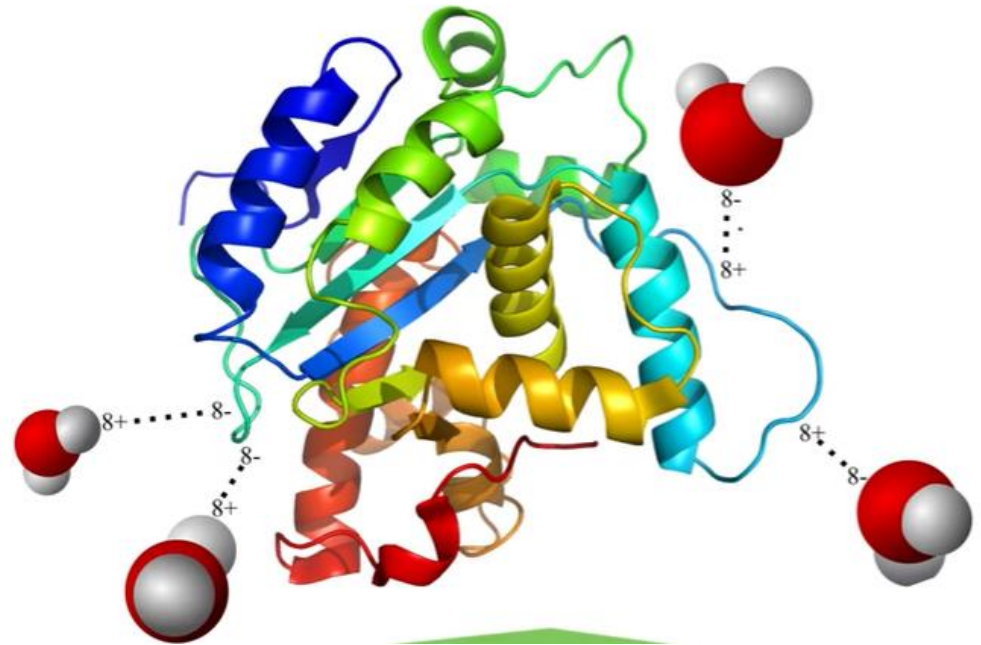
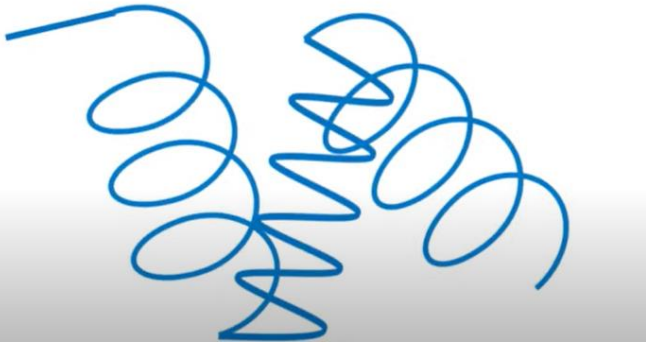
TERCIÁLNÍ STRUKTURA

Arrangement of protein in 3D space



TERCIÁLNÍ STRUKTURA

Arrangement of protein in 3D space



- Uplatňuje se : dipol – dipol interakce

Arrangement of protein in 3D space

Tertiary

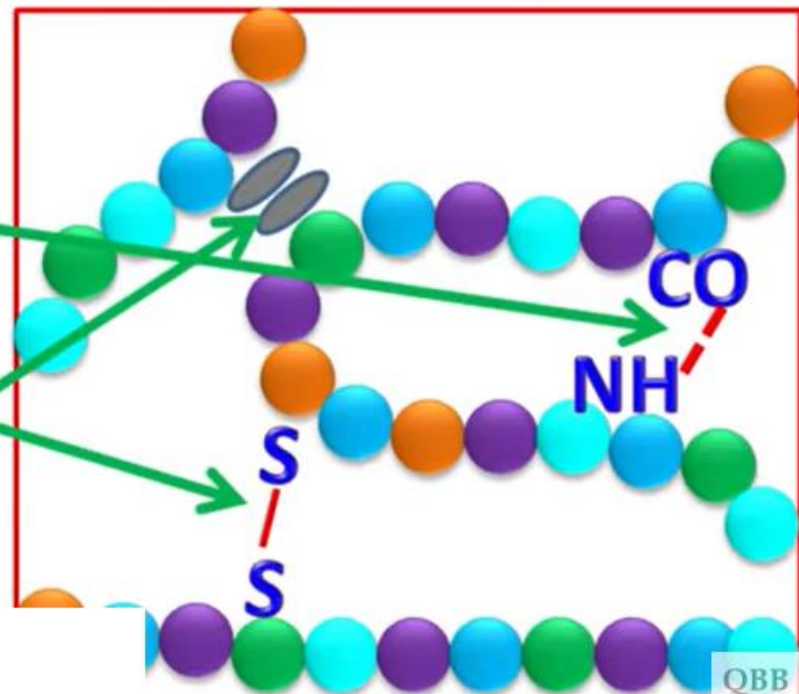
Bonds

Hydrogen bond

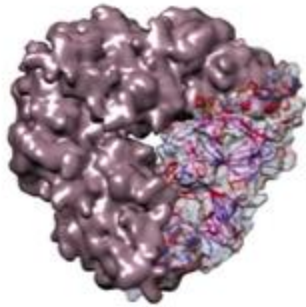
Disulphide bond

Hydrophobic interaction

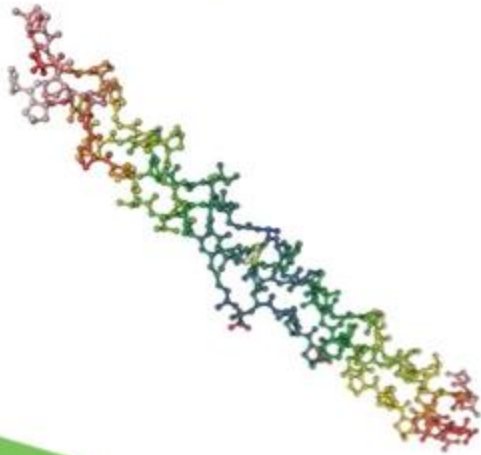
Ionic bond



(význam terciální struktury)



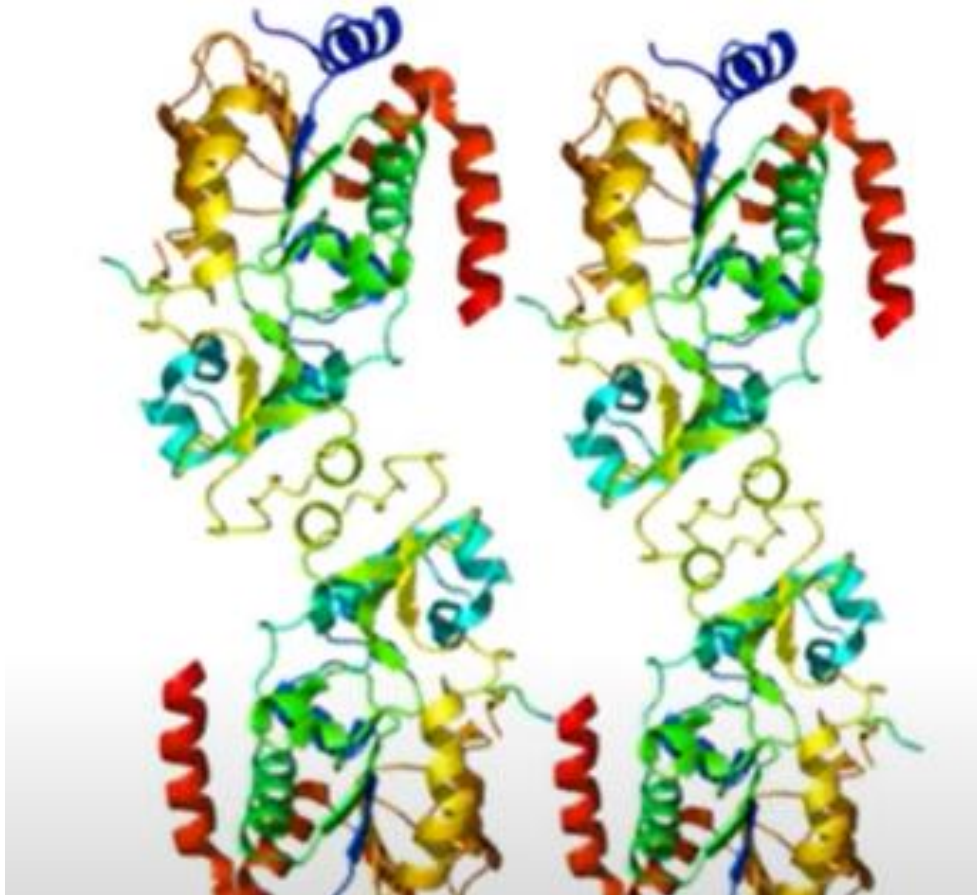
globular protein



fibrous protein

KVARTERNÍ STRUKTURA

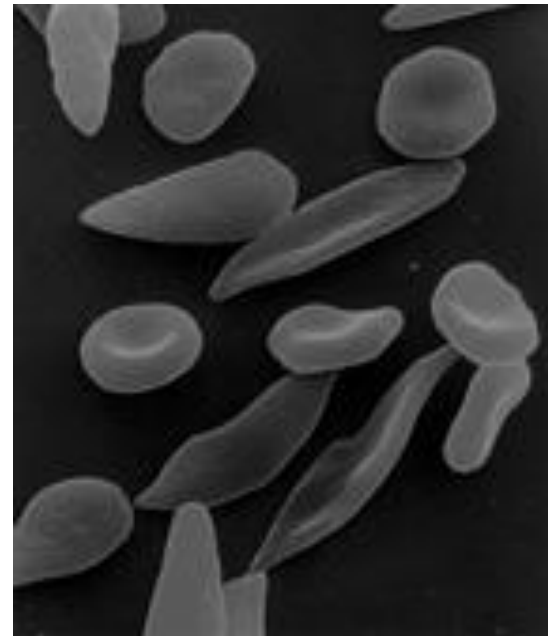
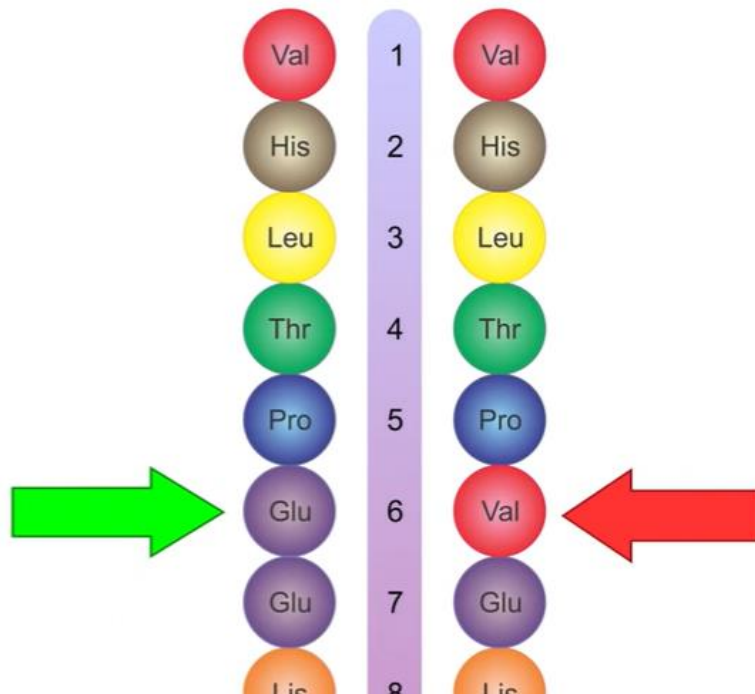
„ JAK SLOŽIT SPRAVNĚ SAMOSTATNÉ DOMENY“



NEMOCI

- Srpkovitá anémie – nemoc PRIMARNI STRUKT.

sickle cell disease



Jak zjišťujeme strukturu důležitých proteinů

(1) Z DATABÁZE

(2) Experimentálně – změří a to do té databáze zapíše

(ad 1) Dnes – z pohodlí domova z databáze na internetu

189915 Biological Macromolecular Structures Enabling Breakthroughs in Research and Education

PDB Archive

Advanced Search | Browse Annotations

Help

PDB-101 PDB EMDatResource Nucleic Acid Database Worldwide Protein Data Bank Foundation

Structure Summary **3D View** Annotations Experiment Sequence Genome Versions

7MKA

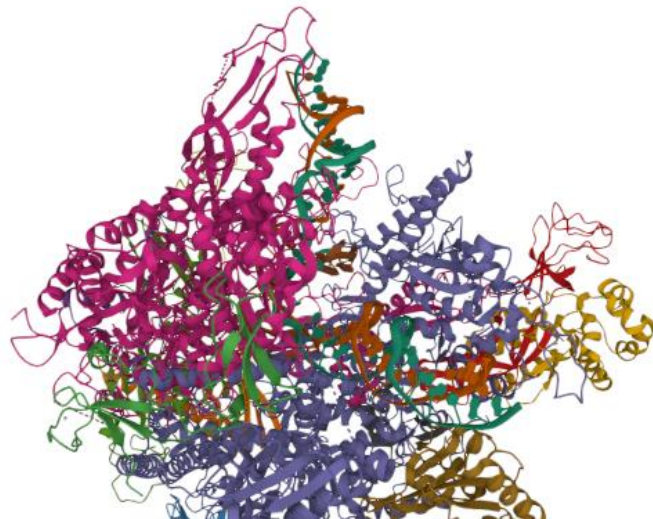
Structure of EC+EC (leading EC-focused)

Display Files Download Files

Help

Sequence of 7MKA | Struct... Chain 1: DNA (40-M... A [auth N]

```
27 37 47 57  
ACCAAAAAAAAAAATTCCTCCITCGAGTGCCTATCGGTAA
```



Structure

7MKA | Structure of EC+EC (leading ...

Type Assembly

Asm Id 1: Author Defined Asse...

Dynamic Bonds X Off

Nothing Focused

Measurements

Structure Motif Search

Components 7MKA

Preset + Add

Polymer Cartoon

Ion Ball & Stick

Density

Quality Assessment

Assembly Symmetry

Export Models

Export Animation

Export Geometry

(Ad 2) experimentálně

- Dvě základní metodiky:

RTG difrakce (na zkrystalovaném proteinu)

Strukturní nukleární magnetická rezonance (lze i na vodné směsi proteinu)

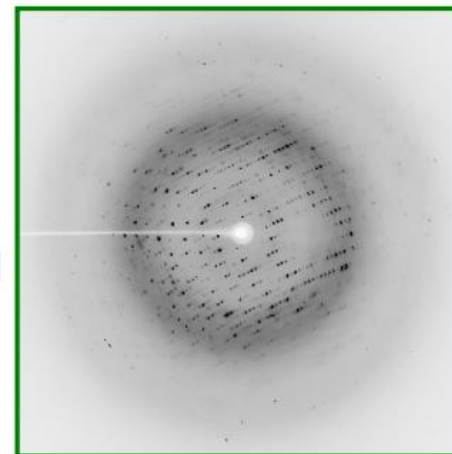
RTG difrakce a rekonstrukce



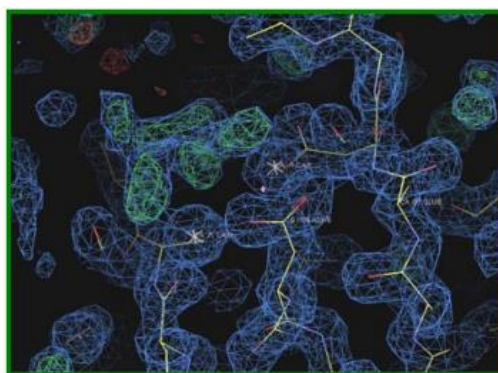
Krystaly



Difrakční experiment



Difrakce



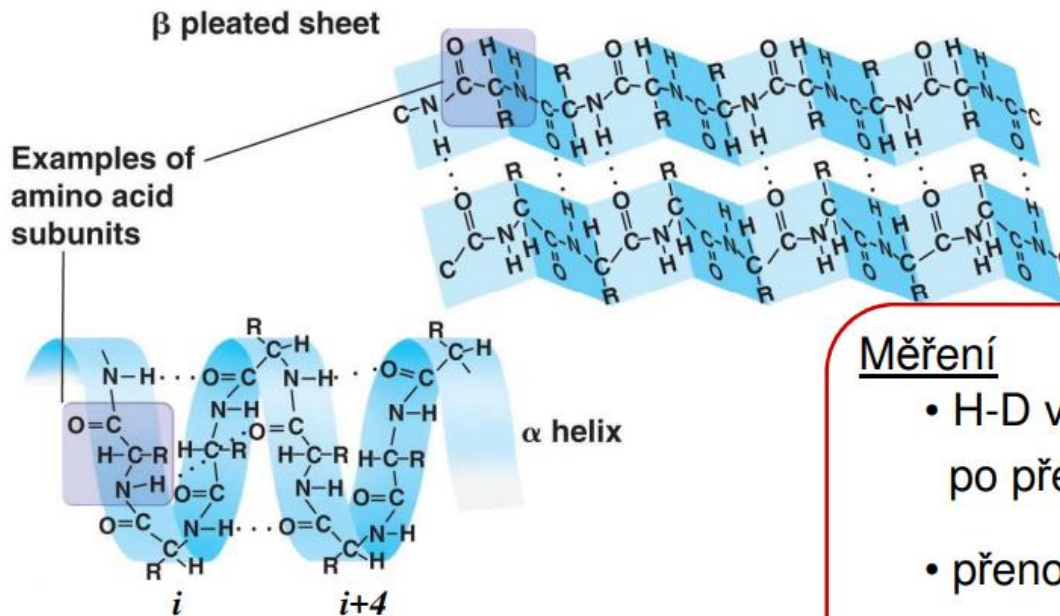
Elektronová hustota



Struktura

NMR analýza

Vodíkové vazby

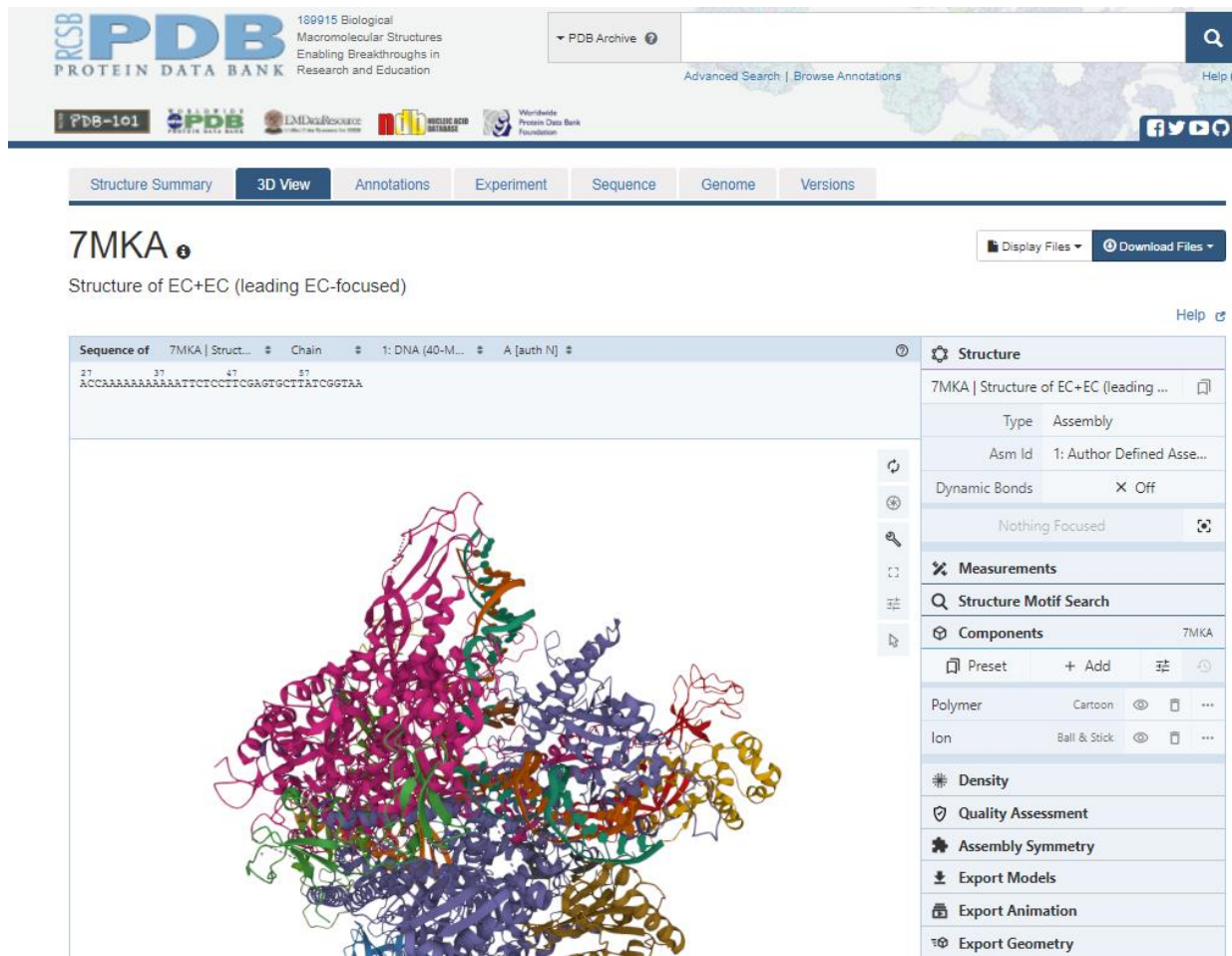


Měření

- H-D výměna – série ^{15}N , ^1H korelací po přenesení proteinu do D_2O
- přenos saturace – ze signálu vody
- teplotní závislost signálů

Co lze v databázi PDB.org v zápisu proteínu najít:

a) Podívat se na 3D strukturu proteínu



The screenshot displays the PDB.org website interface for protein 7MKA. At the top, the PDB logo and tagline "18915 Biological Macromolecular Structures Enabling Breakthroughs in Research and Education" are visible. A search bar and navigation links like "Advanced Search" and "Browse Annotations" are present. Below the header, a navigation bar includes tabs for "Structure Summary", "3D View", "Annotations", "Experiment", "Sequence", "Genome", and "Versions". The main content area shows the protein ID "7MKA" and its description "Structure of EC+EC (leading EC-focused)". A "Sequence of" section displays the amino acid sequence: ACCCAAAAAAAAAAATTCCTCTCGAGTGTCTTATCGGTAA. The central part of the page features a 3D ribbon diagram of the protein structure, colored in various shades of pink, purple, blue, and yellow. On the right side, a sidebar menu provides various options for viewing and interacting with the structure, including "Structure", "Measurements", "Structure Motif Search", "Components", "Density", "Quality Assessment", "Assembly Symmetry", "Export Models", "Export Animation", and "Export Geometry".

b) Najít si detail o nějaké aminokyselině (a tedy potažmo i o nějaké mutaci například v dané AK)

The screenshot shows the RCSB PDB website interface. At the top, there's a navigation bar with 'RCSB PDB' and 'MyPDB' button. Below it, a menu with options like 'Deposit', 'Search', 'Visualize', 'Analyze', 'Download', 'Learn', 'About', 'Documentation', 'Careers', and 'COVID-19'. A secondary menu has tabs for 'Structure Summary', '3D View', 'Annotations', 'Experiment', 'Sequence', 'Genome', 'Ligands', and 'Versions'. The main content area shows the entry '5VEU' for 'Human Cytochrome P450 3A5 (CYP3A5)'. There are buttons for 'Display Files' and 'Download Files'. A 'Help' link is visible in the top right.

The 'Sequence of' section shows the amino acid sequence for Chain 1: Cytochrome... A. The sequence is displayed in a grid with residue numbers 32, 42, 52, 62, 72, 82, 92, 102, 112, 122, 132, 142, 152, 162, 172, 182, 192, 202, 212, 222, 232, 242, 252, 262, 272. The sequence is: MALYGTRTHGLFKRLGIPGPTPLPLLGNVLSYRQGLWKFDTCEYKKGKMWGTYEGQLPVLAITDPDVIRTVLVKECYSVFTNRR SLGPPVGFMKSAISLAEDEEWKIRIRSLSPFTFTSGKLEKEMFPIIAQYGDVLRNLRREAEKGPVTLKDI FGAYSMDVITGTSFGV NIDSLNLPQDFPVVESTKFKFLKFGFLDPLFLSIIILFPFLTVPVFEALNVSLFPKDTINFLSKSVNRMKKSRNLNDKQKHRDLDFLQIMI. A yellow arrow points to the '252' position in the sequence, which corresponds to the amino acid 'SER' at position 231 in the protein structure.

Annotations below the sequence include: 'například si chceme najít 252 aminokyselinu vw strktuře P450 314 proteinu' and '...ejhke je to SER'. The 'Structure' panel on the right shows details for '5VEU | Human Cytochrome P450 3A5...'. It includes a table with columns 'Type' and 'Assembly'. The 'SER 231 [auth 252] | A' entry is circled in yellow.

Type	Assembly
Asm Id	1: Author Defined Asse...
Dynamic Bonds	× Off
SER 231 [auth 252] A	⊗ 🔍