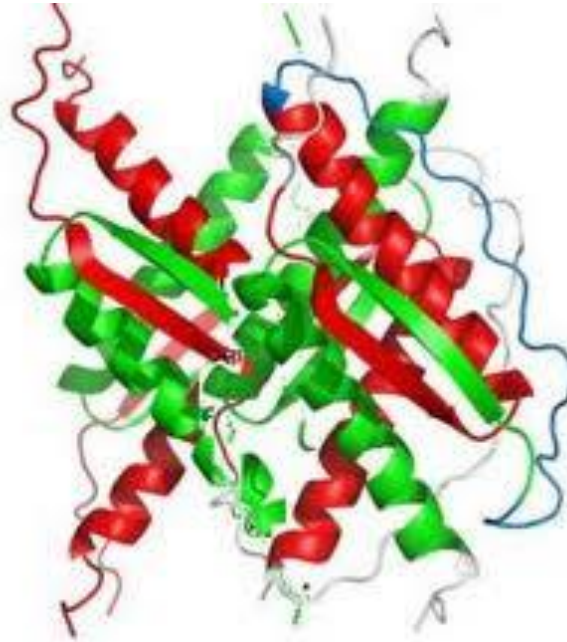
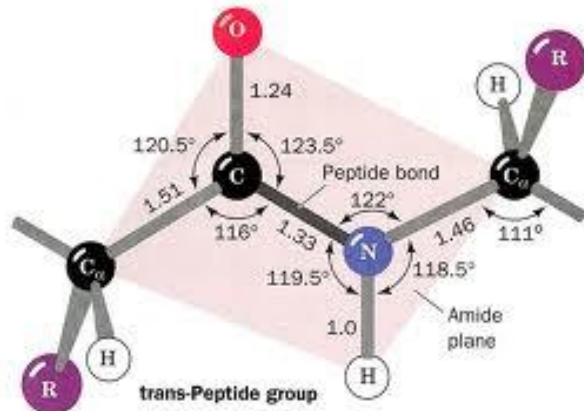
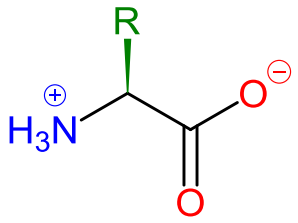
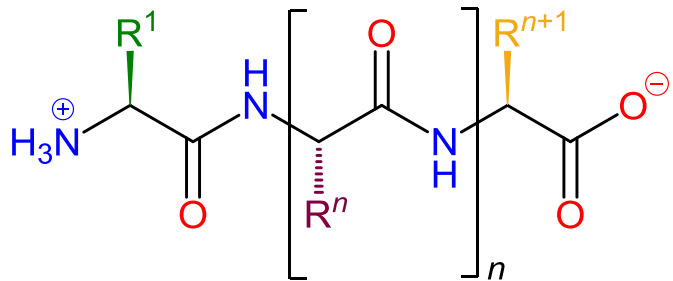
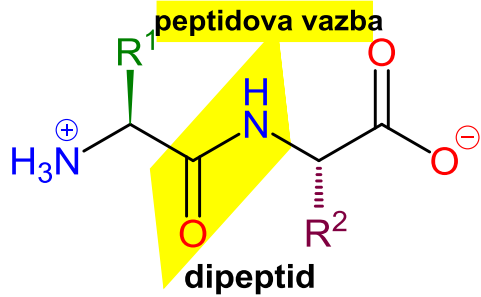


Aminokyseliny, peptidy a proteiny



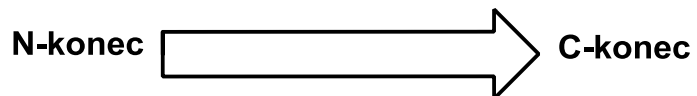


aminokyselina

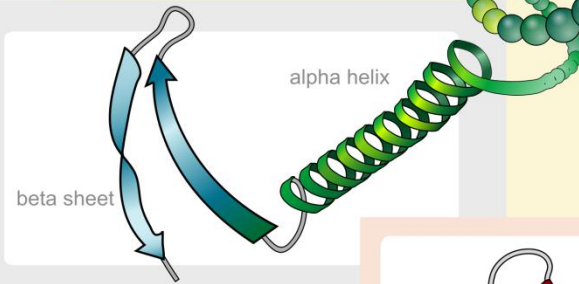
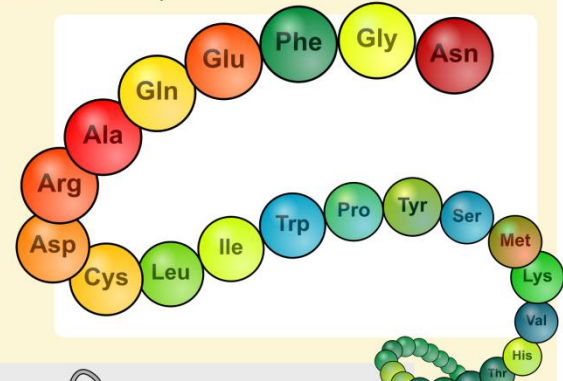


$n = 2-50$ peptid (oligopeptid)

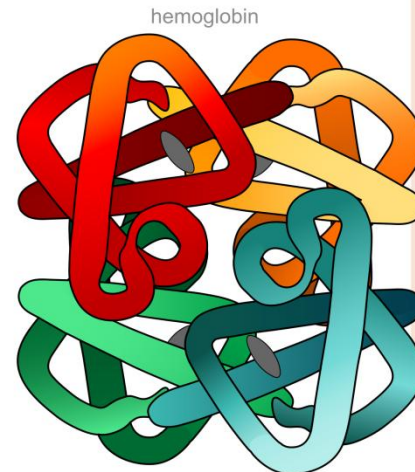
$n > 50$ protein (polypeptid)



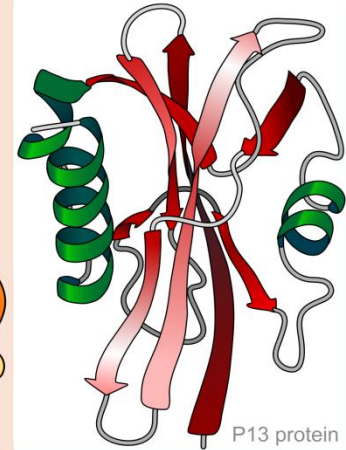
Primary structure
amino acid sequence



Secondary structure
regular sub-structures

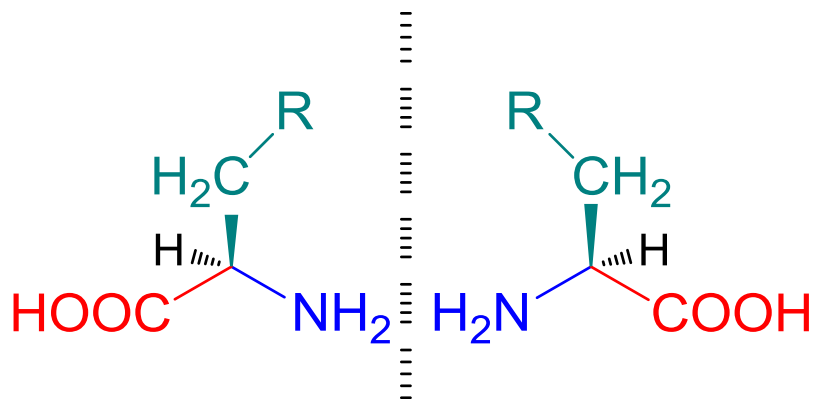


Quaternary structure
complex of protein molecules

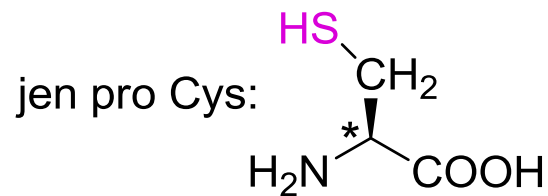
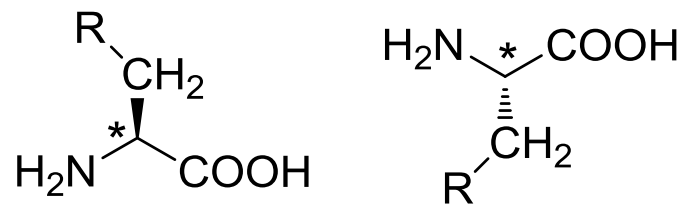


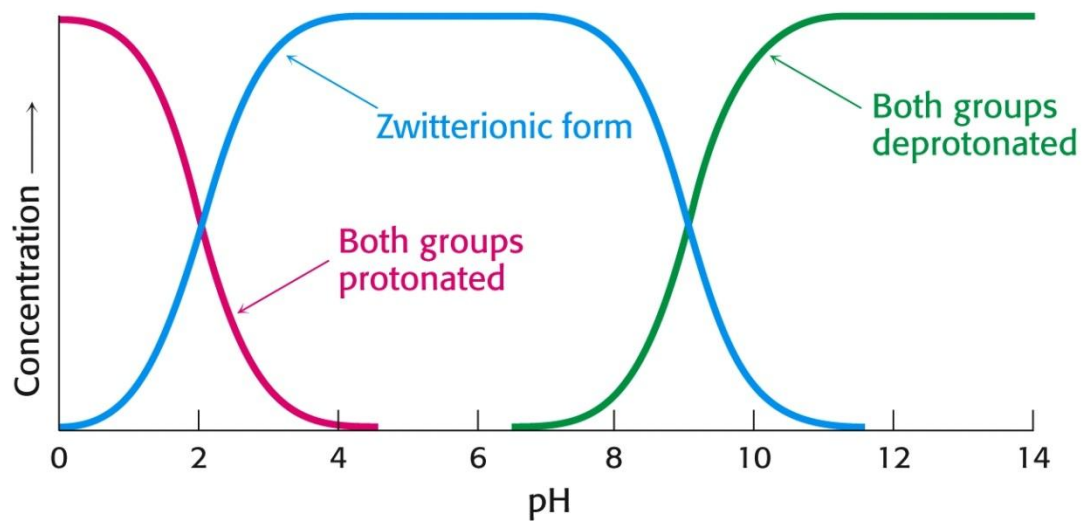
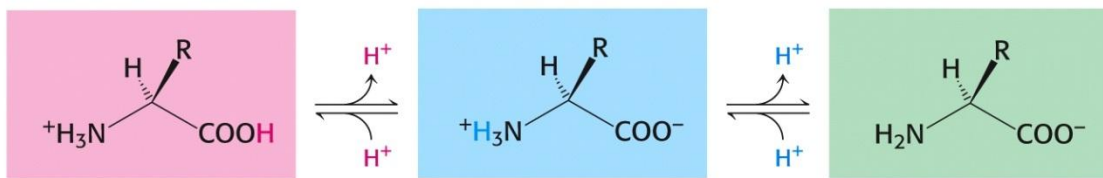
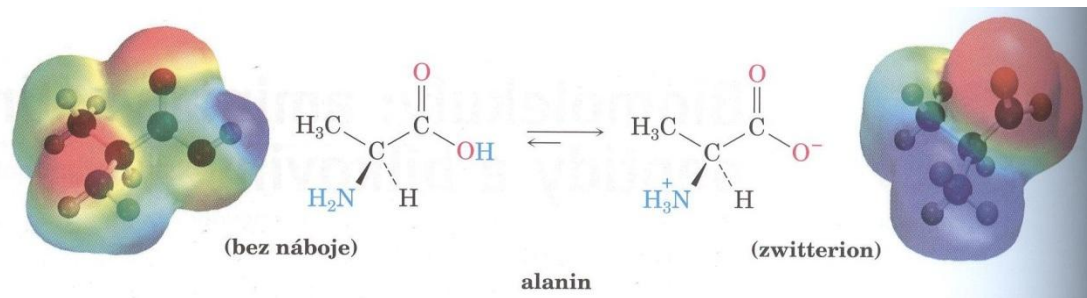
Tertiary structure
three-dimensional structure

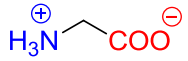
Chiralita aminokyselin:



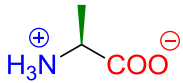
Nativní enantiomerie:



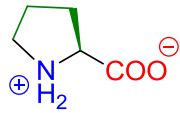


Small amino acids:

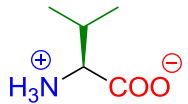
Glycine (Gly, G)



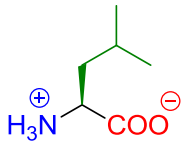
Alanine (Ala, A)



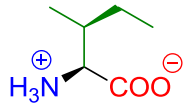
Proline (Pro, P)

Conformationally restrained amino acid:**Hydrophobic amino acids:**

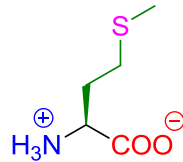
Valine (Val, V)



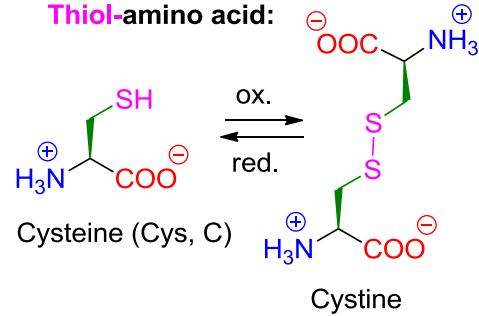
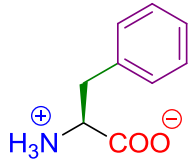
Leucine (Leu, L)



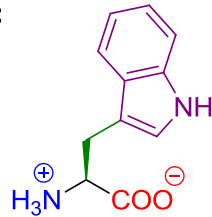
Isoleucine (Ile, I)



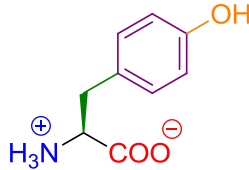
Methionine (Met, M)

Thiol-amino acid:**Aromatic amino acids:**

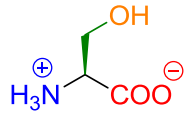
Phenylalanine (Phe, F)



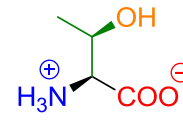
Tryptophan (Trp, W)



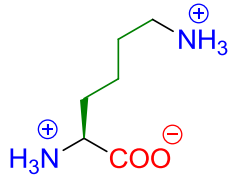
Tyrosine (Tyr, Y)

Hydroxy-amino acids:

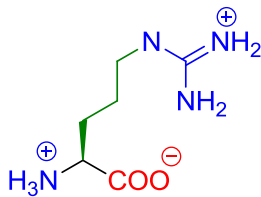
Serine (Ser, S)



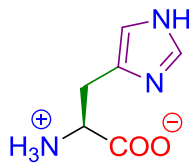
Threonine (Thr, T)

Basic amino acids:

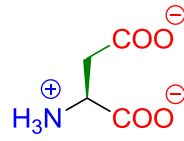
Lysine (Lys, K)



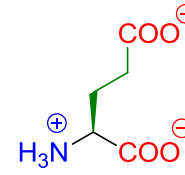
Arginine (Arg, R)



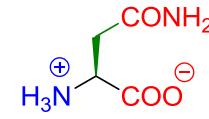
Histidine (His, H)

Acidic amino acids:

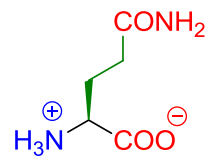
Aspartate (Asp, D)



Glutamate (Glu, E)

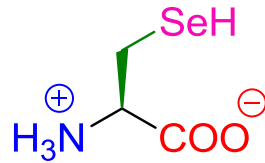


Asparagine (Asn, N)

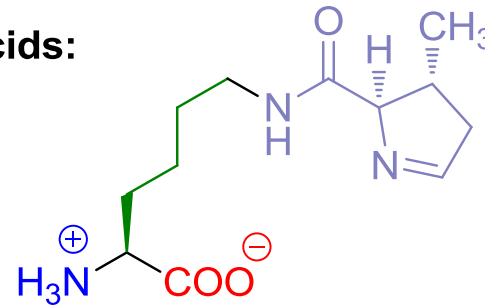


Glutamine (Gln, Q)

Rare genetically encoded amino acids:

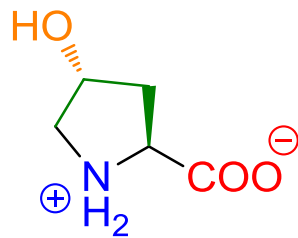


Selenocysteine (Sec, U)

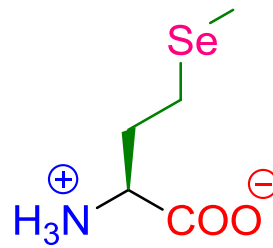


Pyrrolysine (Pyl, O)

non-genetically encoded amino acids occurring in proteins

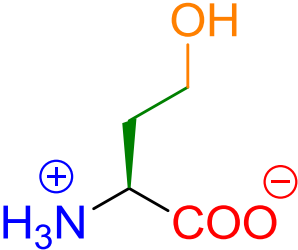


Hydroxyproline

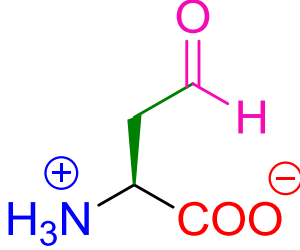


Selenomethionine

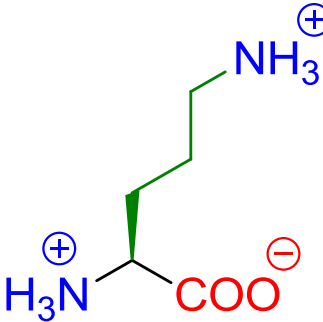
Structures of some non-proteinogenic biogenic amino acids



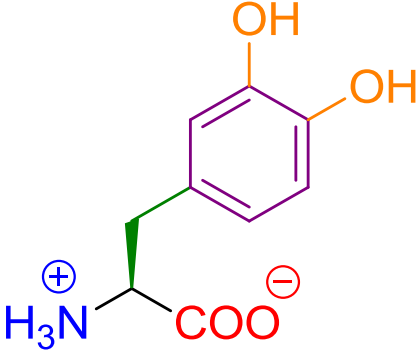
Homoserine



Aspartic semialdehyde

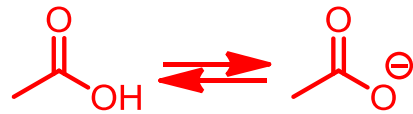


Ornithine



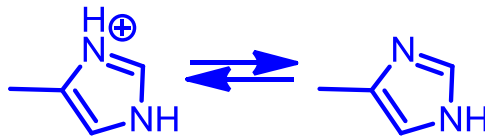
L-DOPA

pK_a



3.1 (koncová)

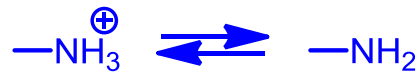
4.1 (postr. retezec Asp, Glu)



6.0 (His)

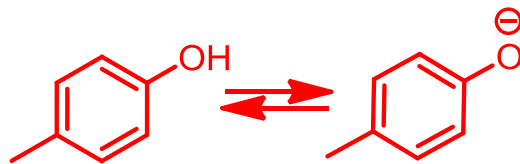


8.3 (Cys)

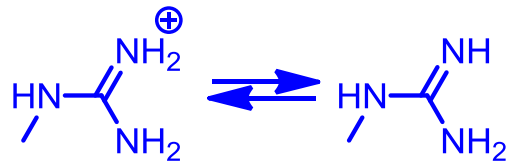


8.0 (koncová)

10.8 (postr. retezec Lys)



10.9 (Tyr)

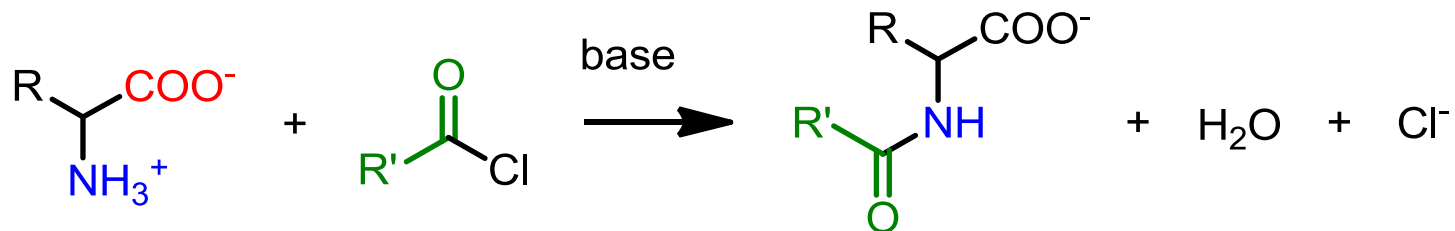
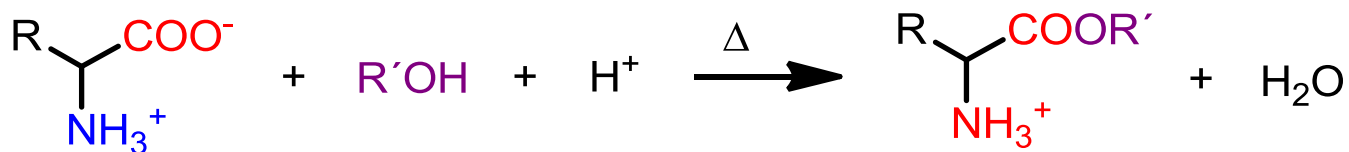


12.5 (Arg)

Reakce aminokyselin

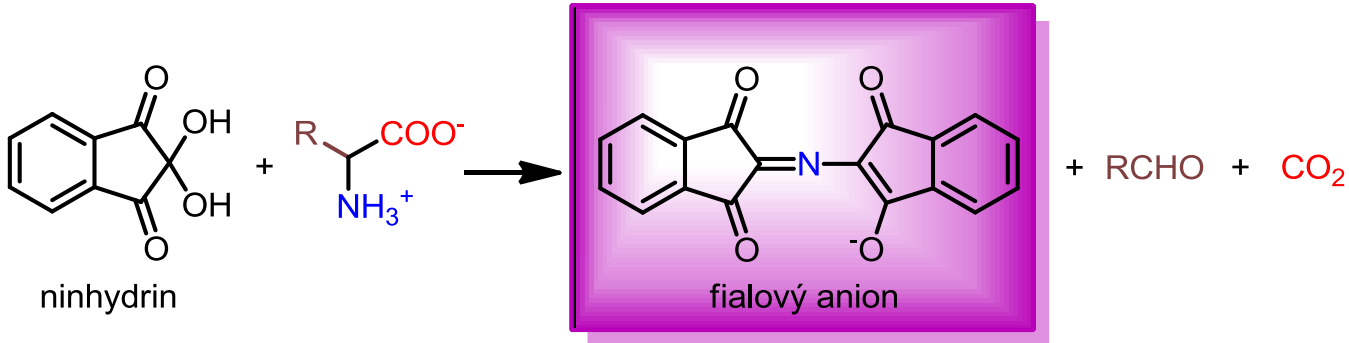
Aminokyseliny účastní reakcí typických pro karboxylové kyseliny a aminy.

Karboxylová skupina může být esterifikována a aminoskupina může být acylována.



Ninhydrinová reakce

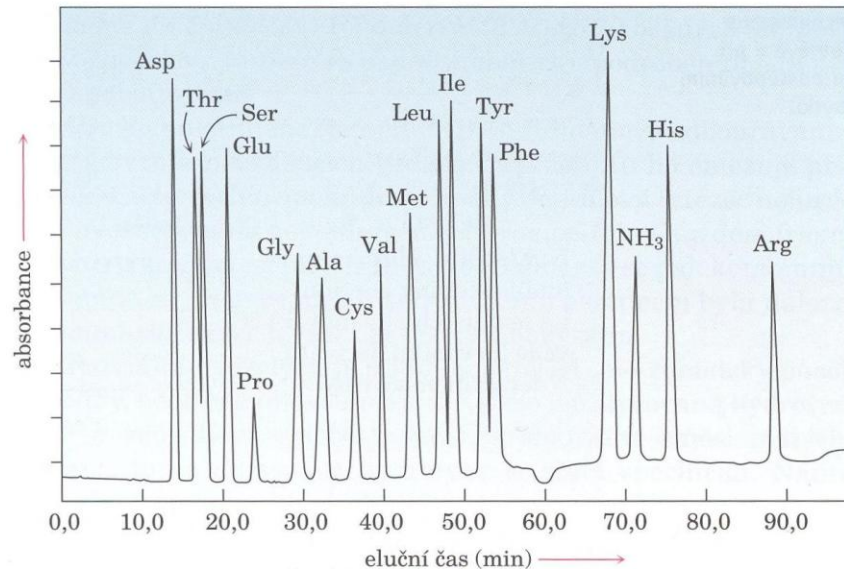
Ninhydrin je hydrát cyklického triketonu a při reakci s aminokyselinami dochází ke vzniku intenzivně fialového barviva



Pouze prolin, jež má sekundární aminoskupinu, nedává toto fialové barvivo.

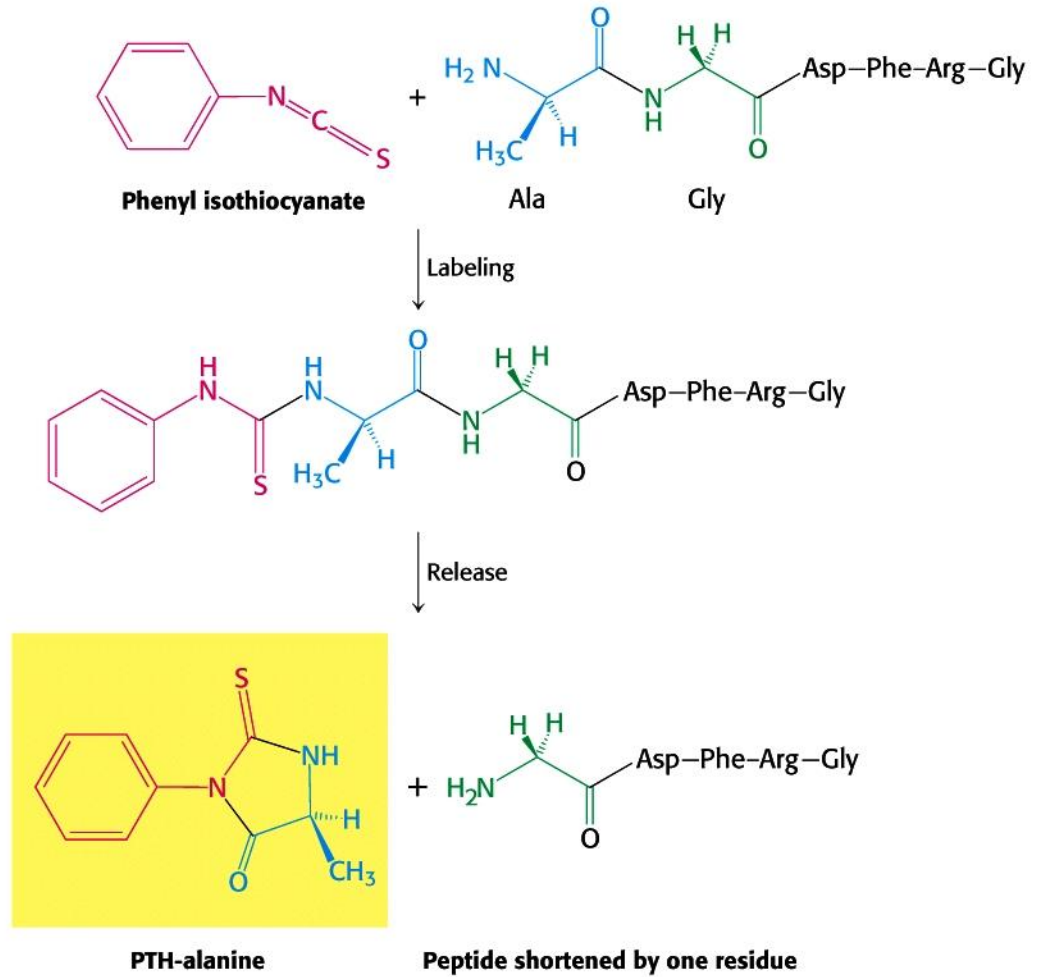
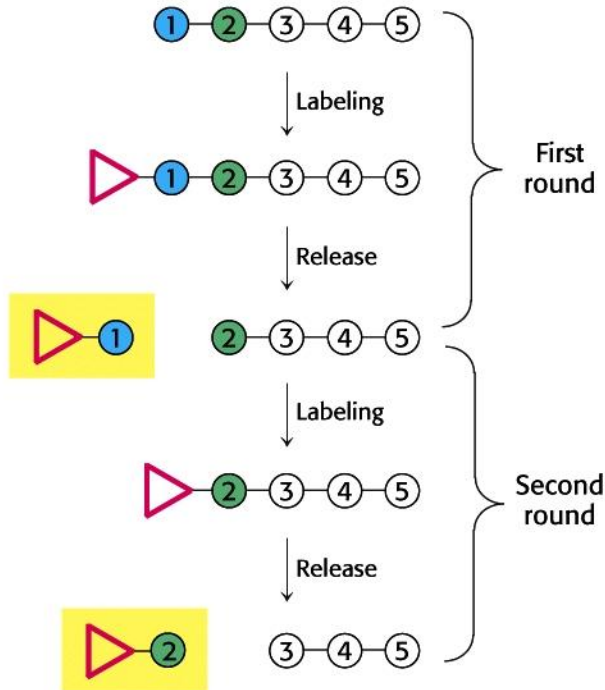
Aminokyselinová analýza

Protein/peptid je rozštěpen HCl, aminokyseliny separovány chromatografií a na výstupu dochází k reakcím aminokyselin s ninhydrinem - dle intenzity barvy (absorbance) lze stanovit počet aminokyselin



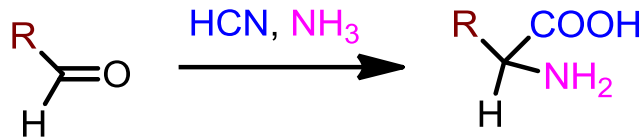
Sekvenování proteinu – Edmanovo odbourávání

EDMAN DEGRADATION

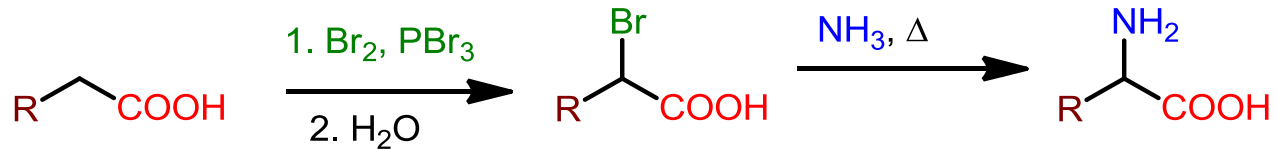


Syntéza aminokyselin

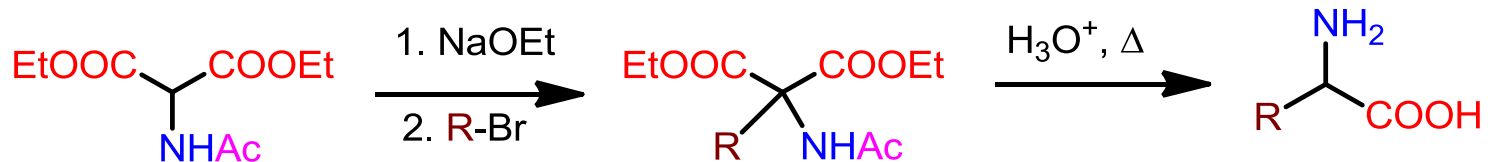
Streckerova syntéza



Syntéza nukleofilní substitucí α -bromokyselin

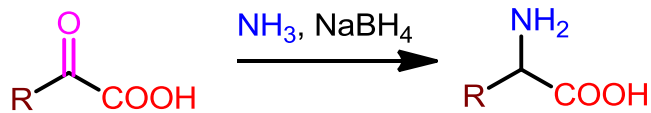


Acetamidomalonátová syntéza

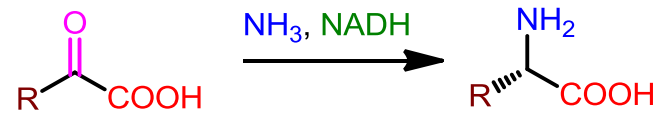


Reduktivní aminace

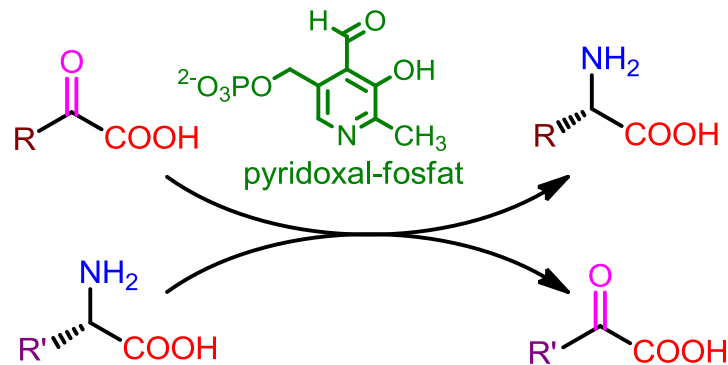
chemická



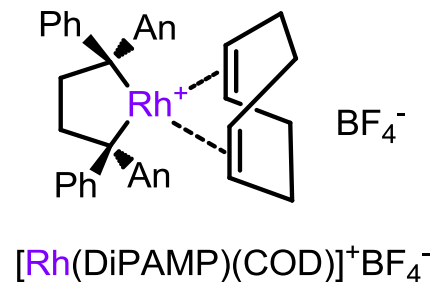
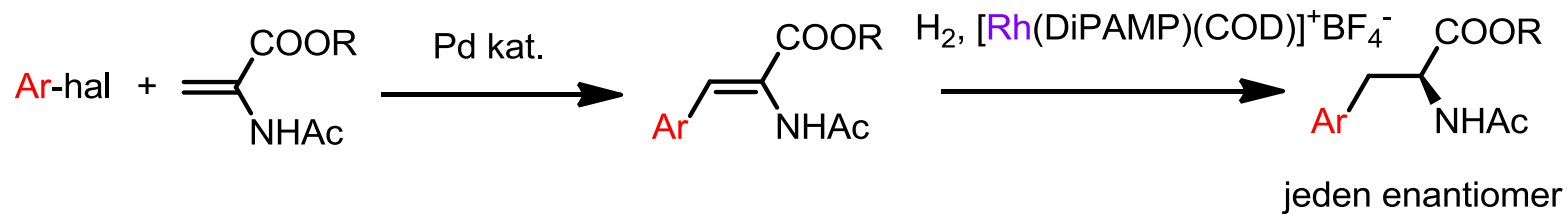
biochemická



Transaminace

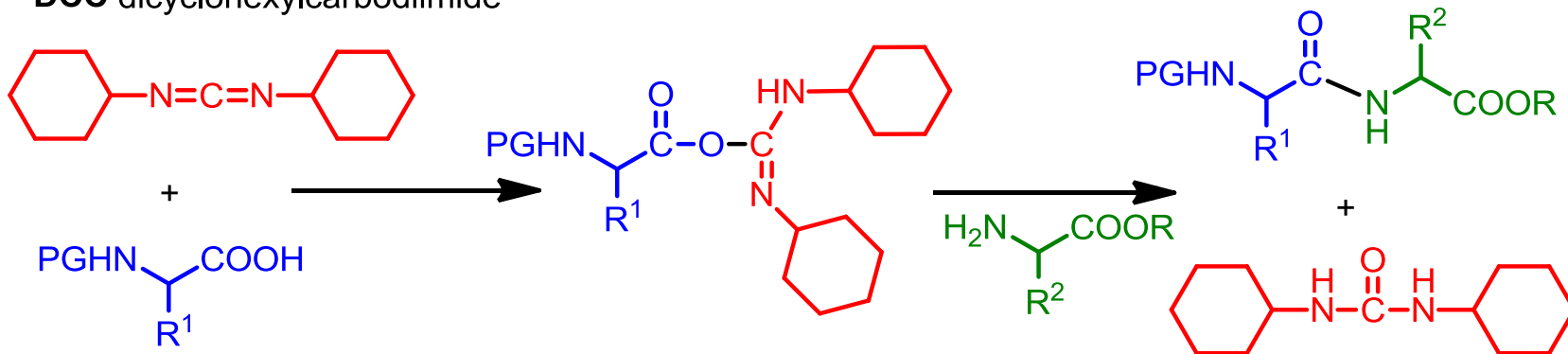


Heckova reakce + enantioselektivní katalytická hydrogenace

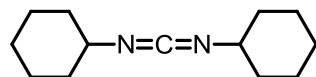


Mechanismus tvorby peptidové vazby – tvorba aktivních esterů

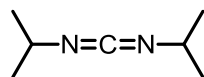
DCC dicyclohexylcarbodiimide



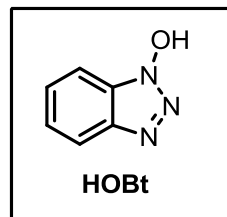
Příklady coupling reagentů



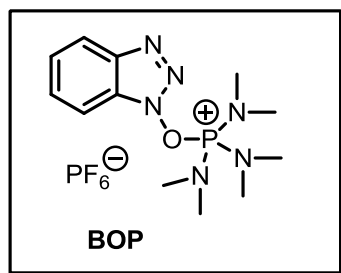
DCC



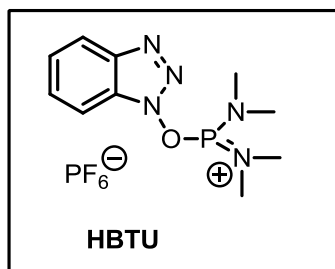
DIC



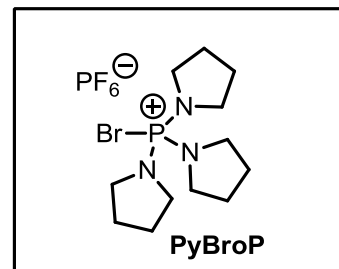
HOBt



BOP

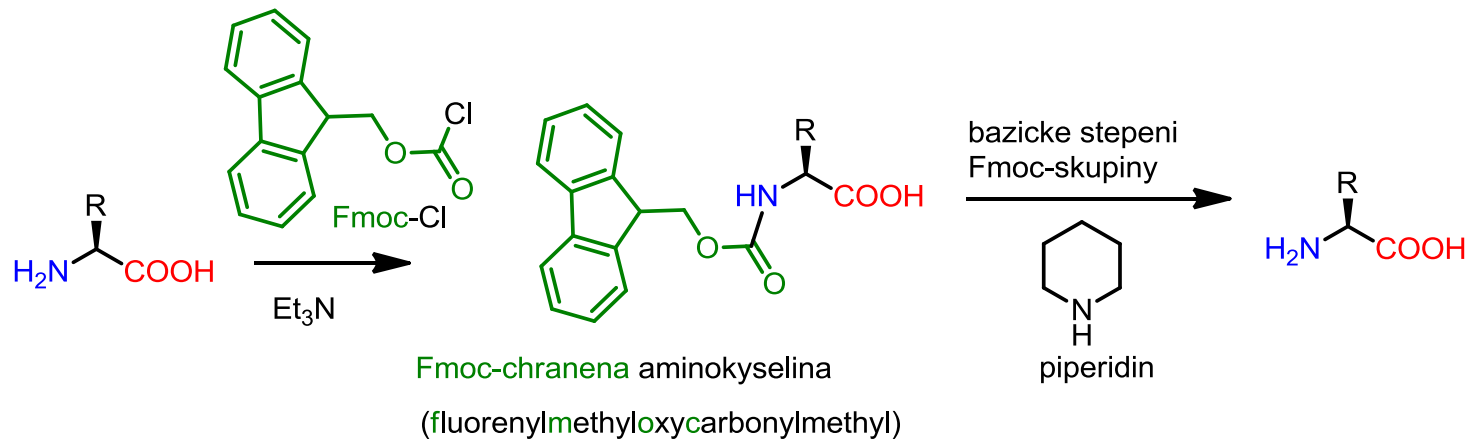
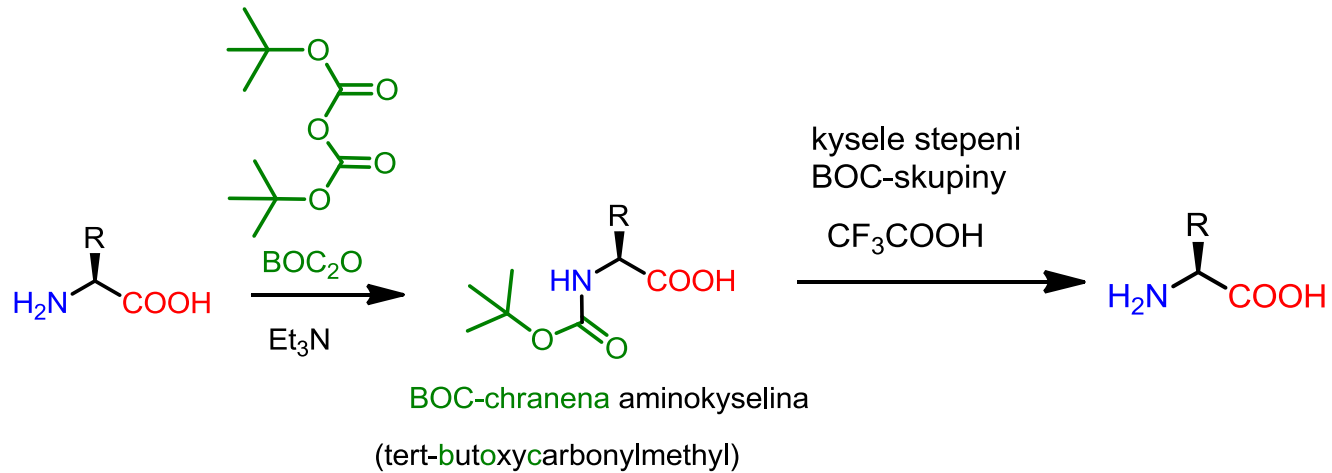


HBTU



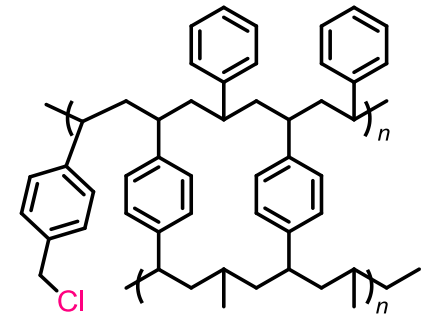
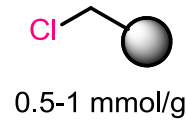
PyBroP

N-Chránící skupiny pro aminokyseliny

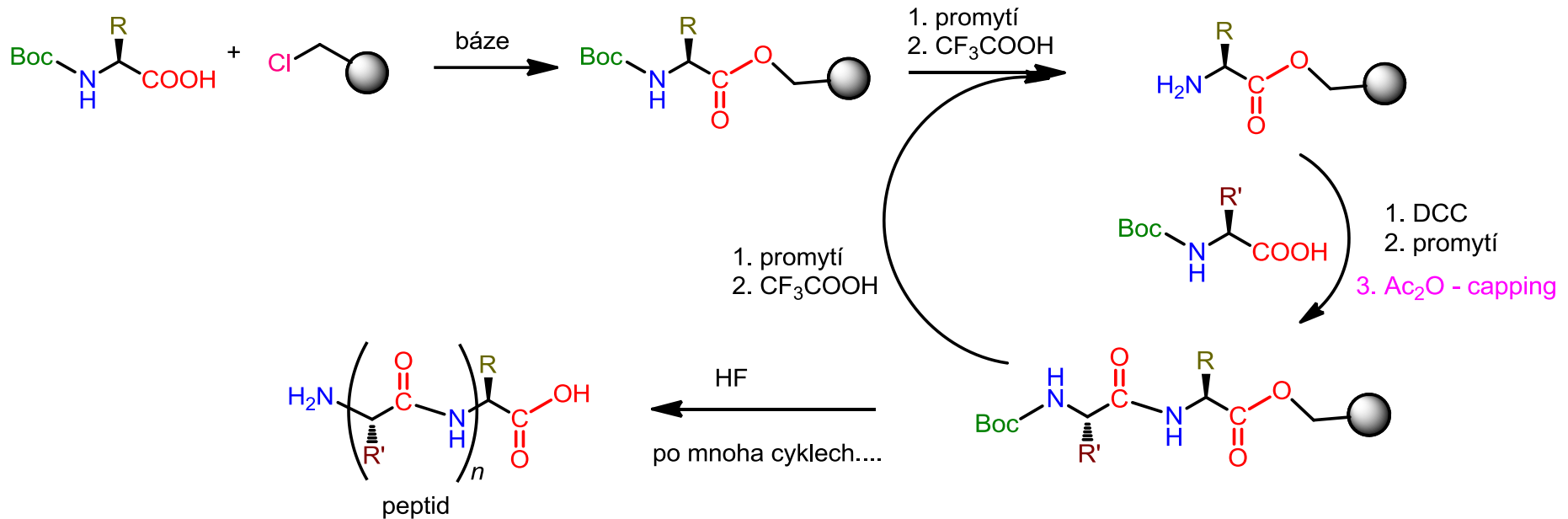


Syntéza peptidů – syntéza na pevné fázi

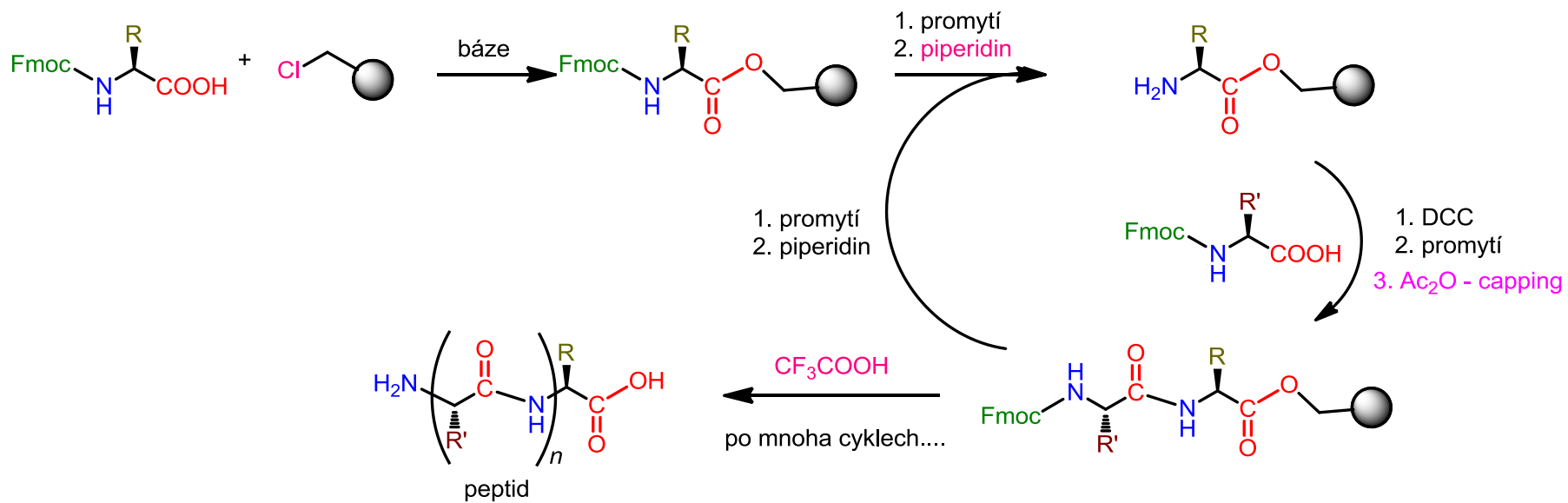
Merrifieldova pryskyřice



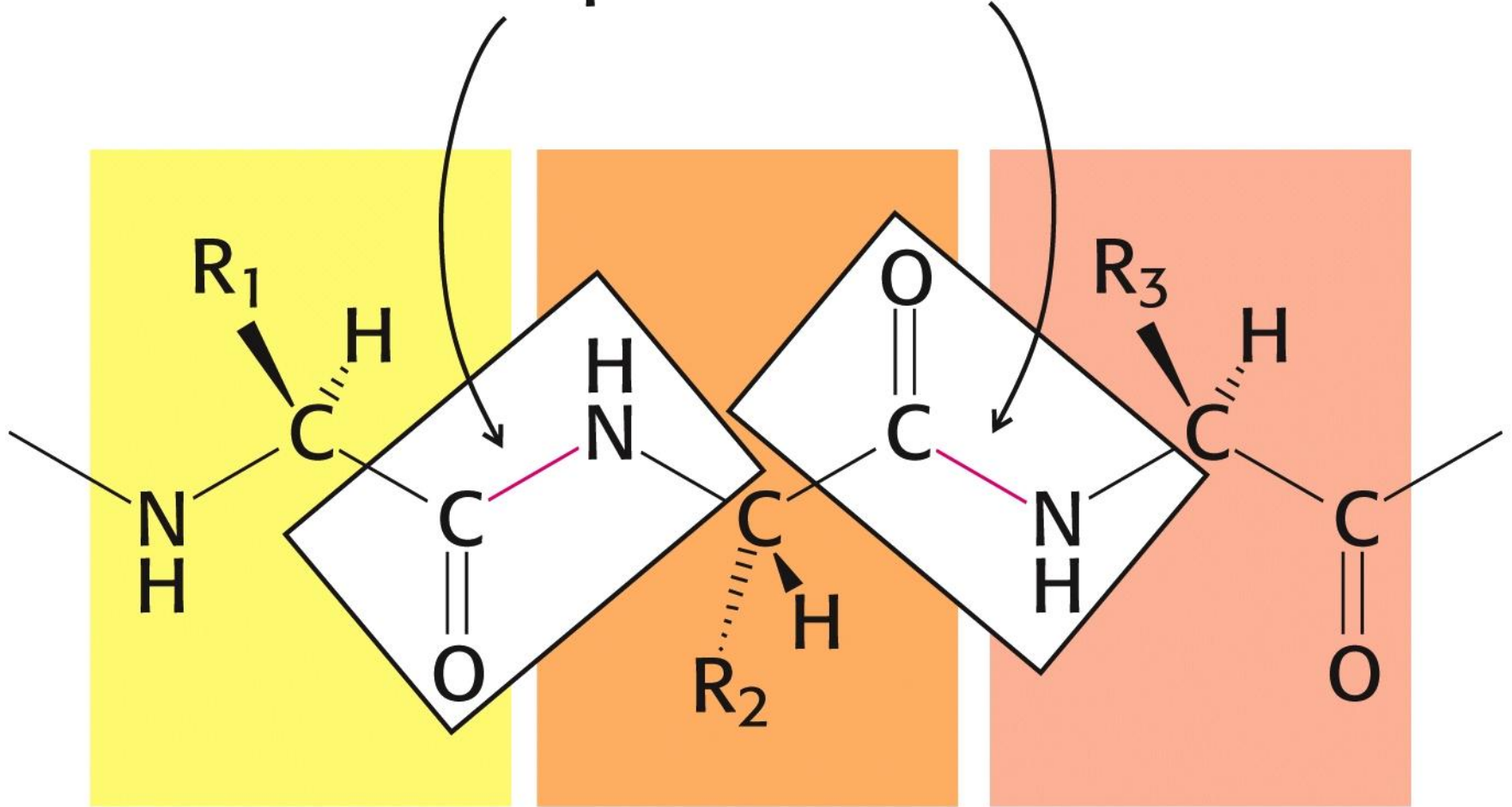
Boc-metoda



Fmoc-metoda



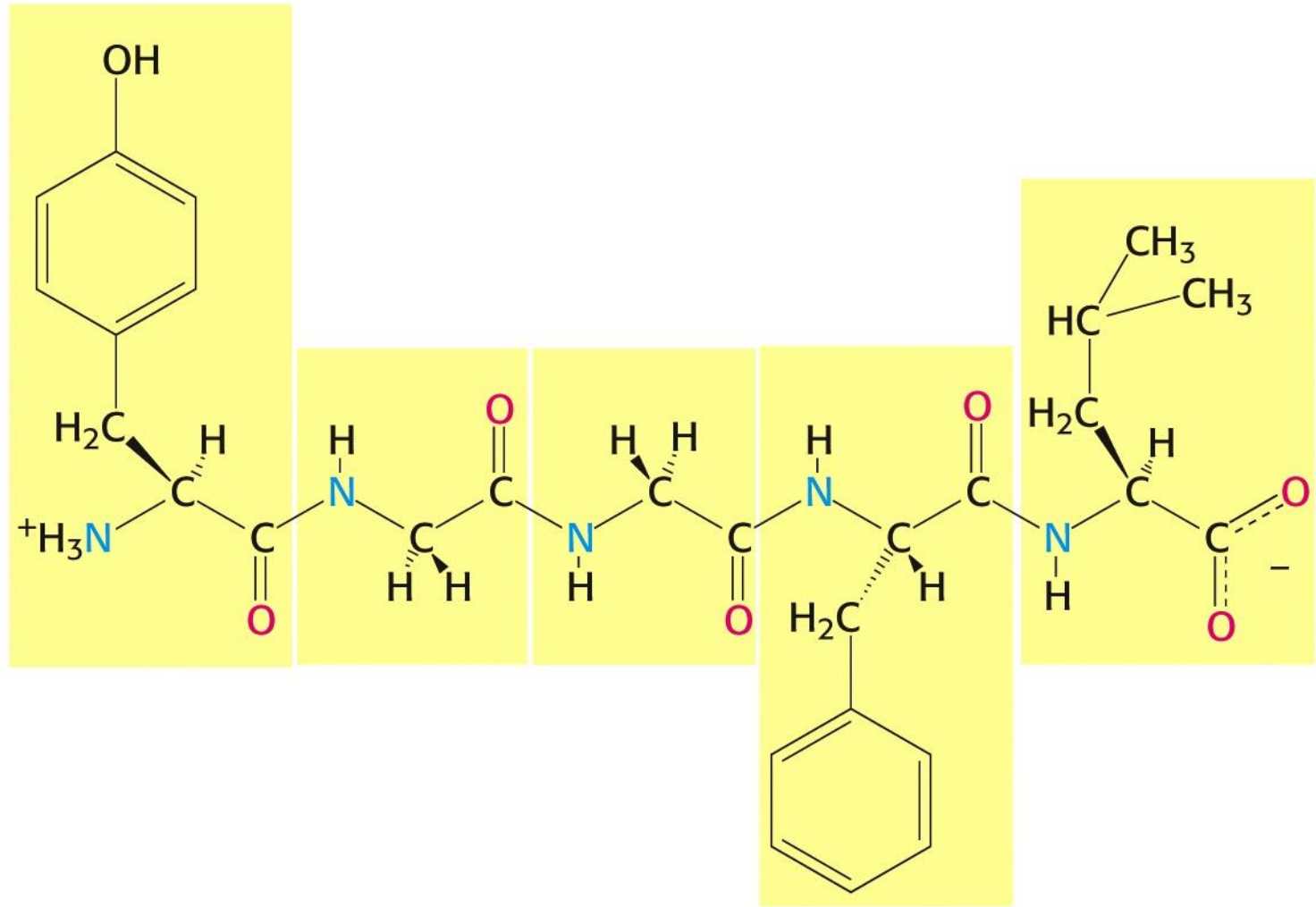
Peptide bonds



Amino
acid 1

Amino
acid 2

Amino
acid 3



Tyr

Gly

Gly

Phe

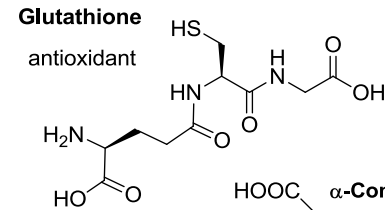
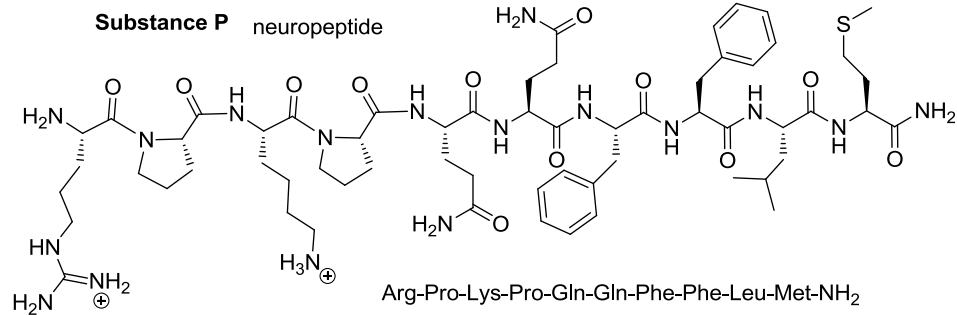
Leu

Amino
terminal residue

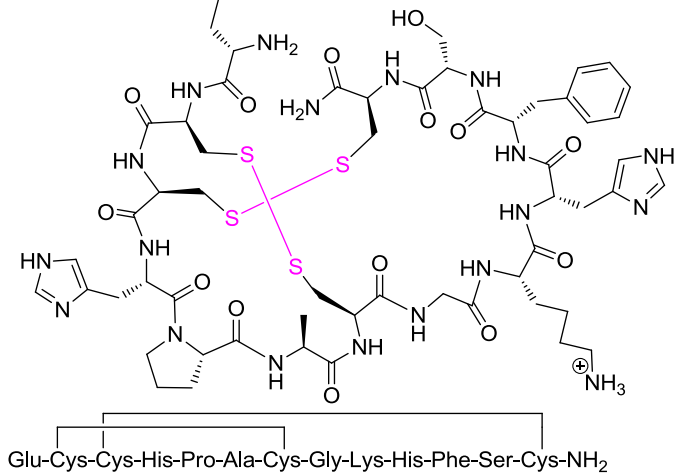


Carboxyl
terminal residue

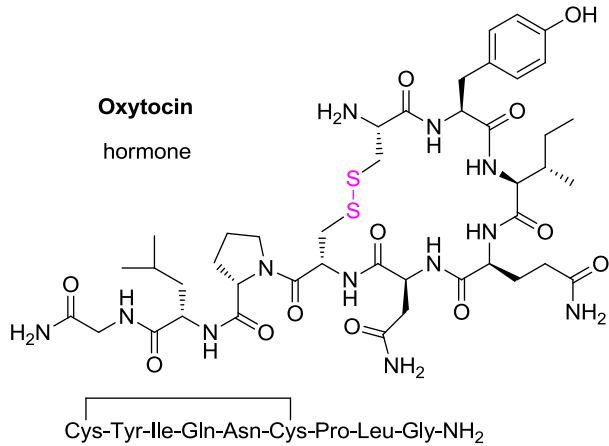
Peptidy v přírodě



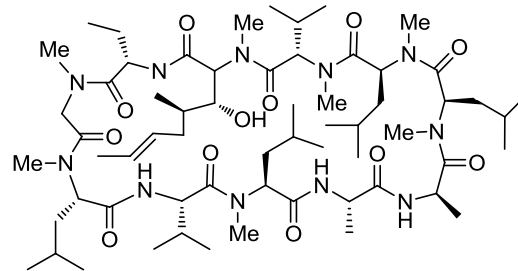
α-Conotoxin GII toxin from *Conus* snails



Oxytocin
hormone



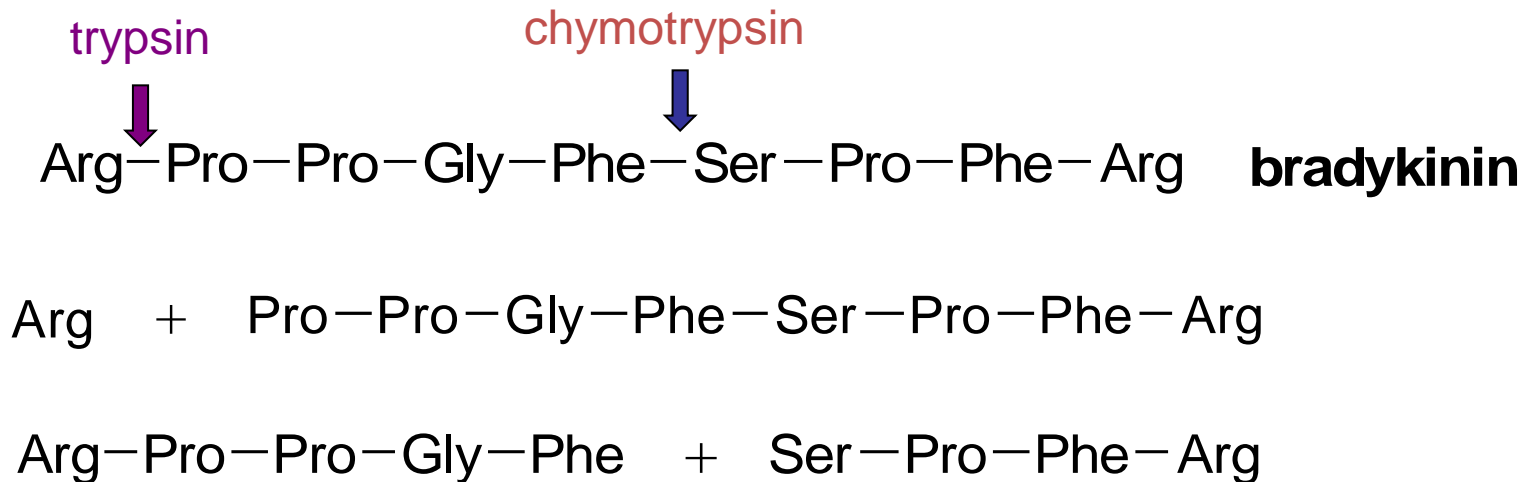
Cyclosporin antibiotic



Selektivní štěpení peptidových vazeb

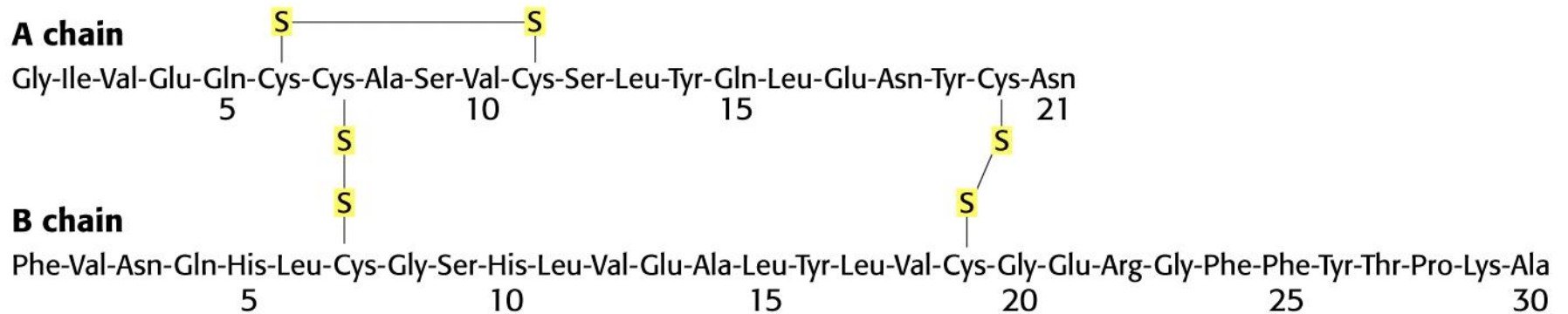
Tabulka 14.2. Činidla a enzymy pro štěpení specifických míst polypeptidů

Činidlo nebo enzym	Specifické místo
Trypsin	Karboxylová strana lysinu (Lys), argininu (Arg)
Chymotrypsin	Karboxylová strana fenylalaninu (Phe), tyrosinu (Tyr), tryptofanu (Trp)
Bromkyan (BrCN)	Karboxylová strana methioninu (Met)
karboxypeptidasa	C-koncová aminokyselina



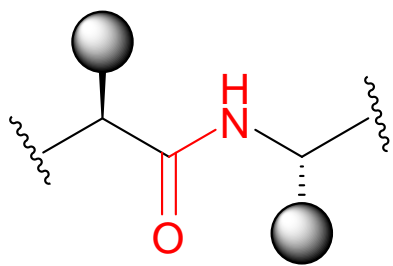
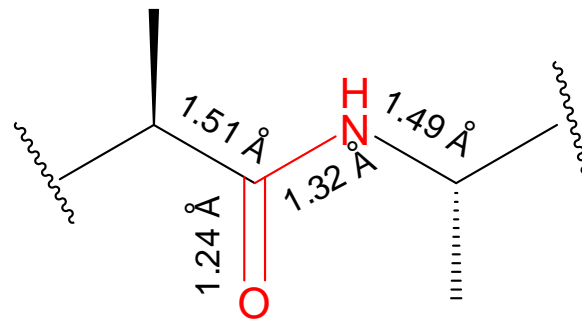
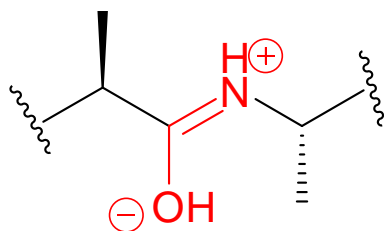
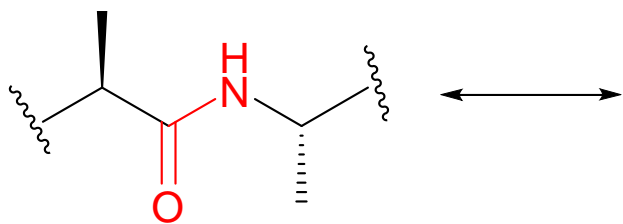
Primární struktura – aminokyselinová sekvence (zakódovaná v genech)

Hovězí inzulín

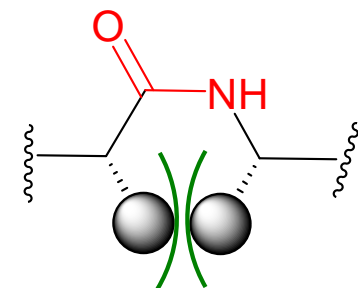


Sekundární struktura bílkovin

Geometrie peptidové vazby

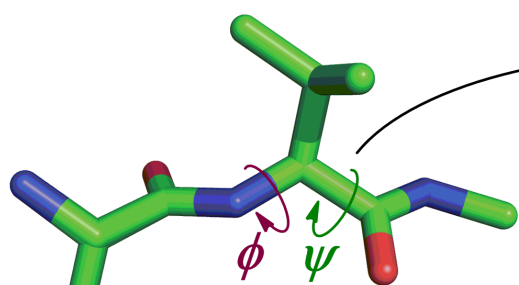
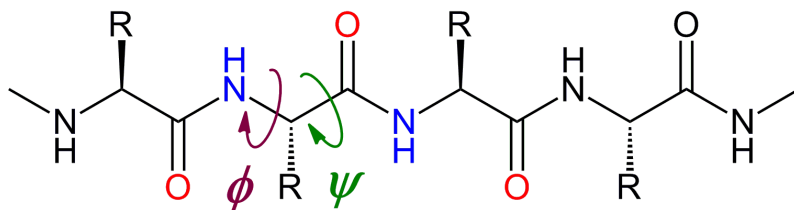


trans

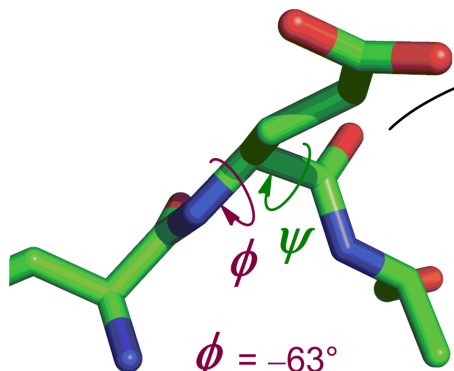


cis
steric clash

Geometrie polypeptidového řetězce

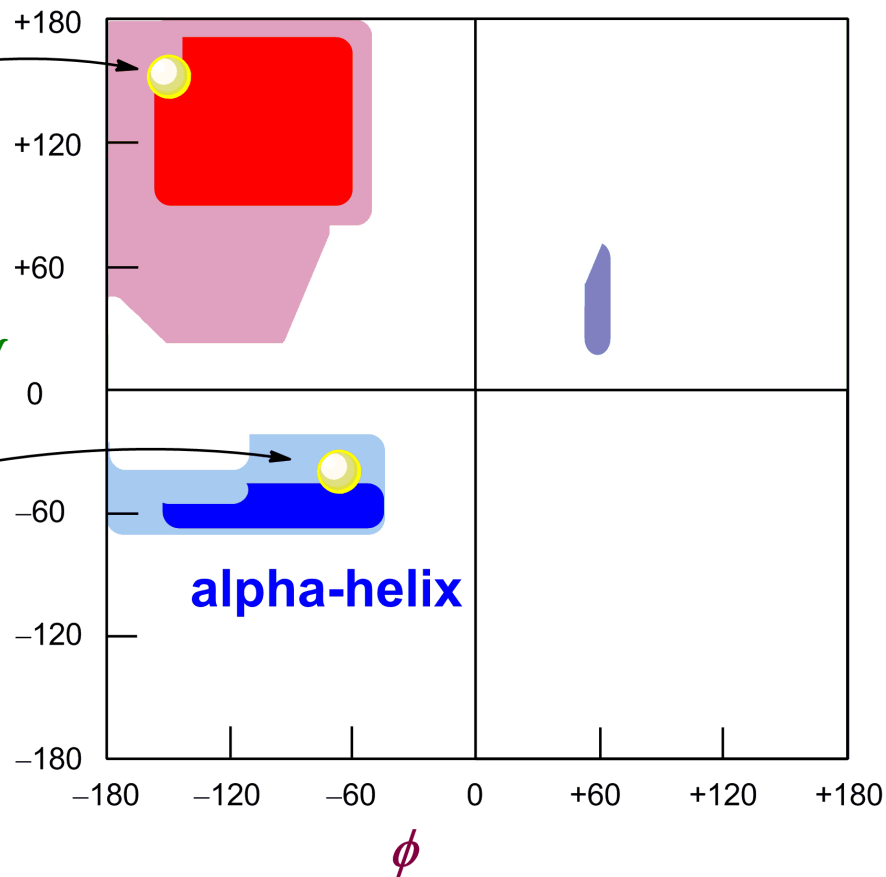


$$\phi = -141^\circ$$
$$\psi = +165^\circ$$

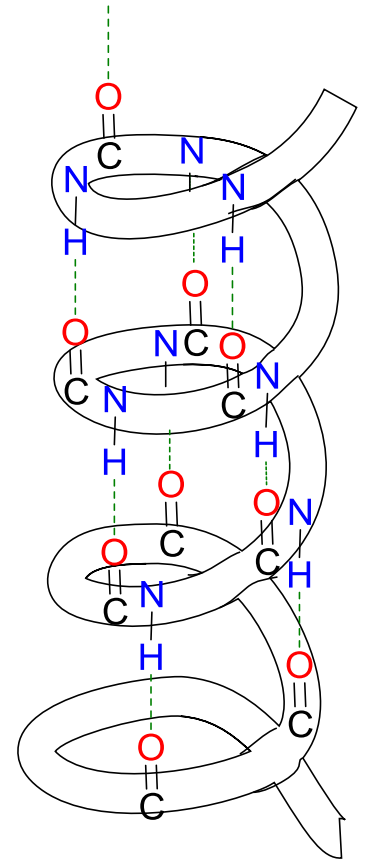
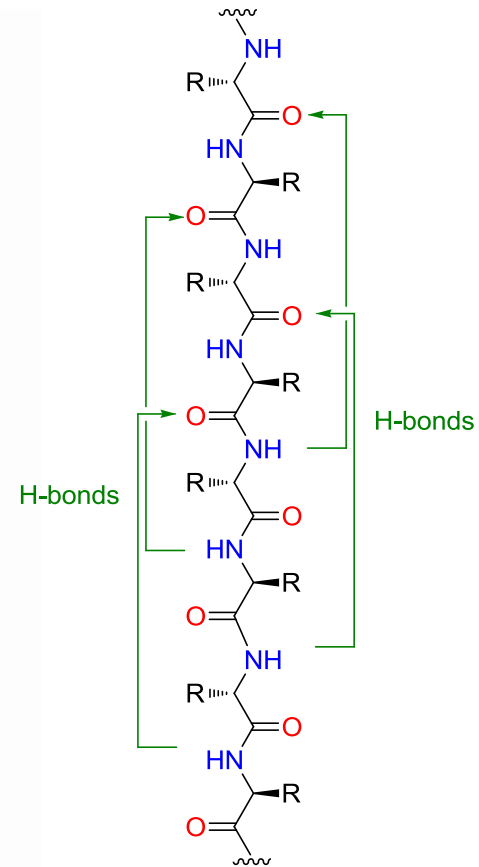
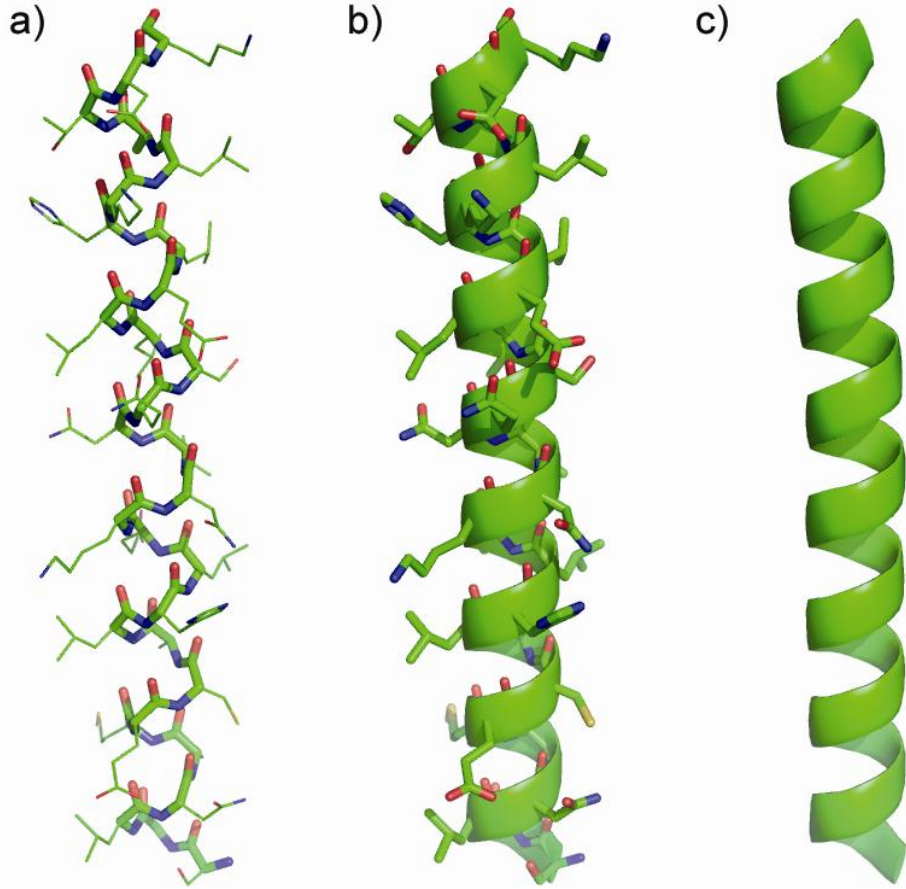


$$\phi = -63^\circ$$
$$\psi = -42^\circ$$

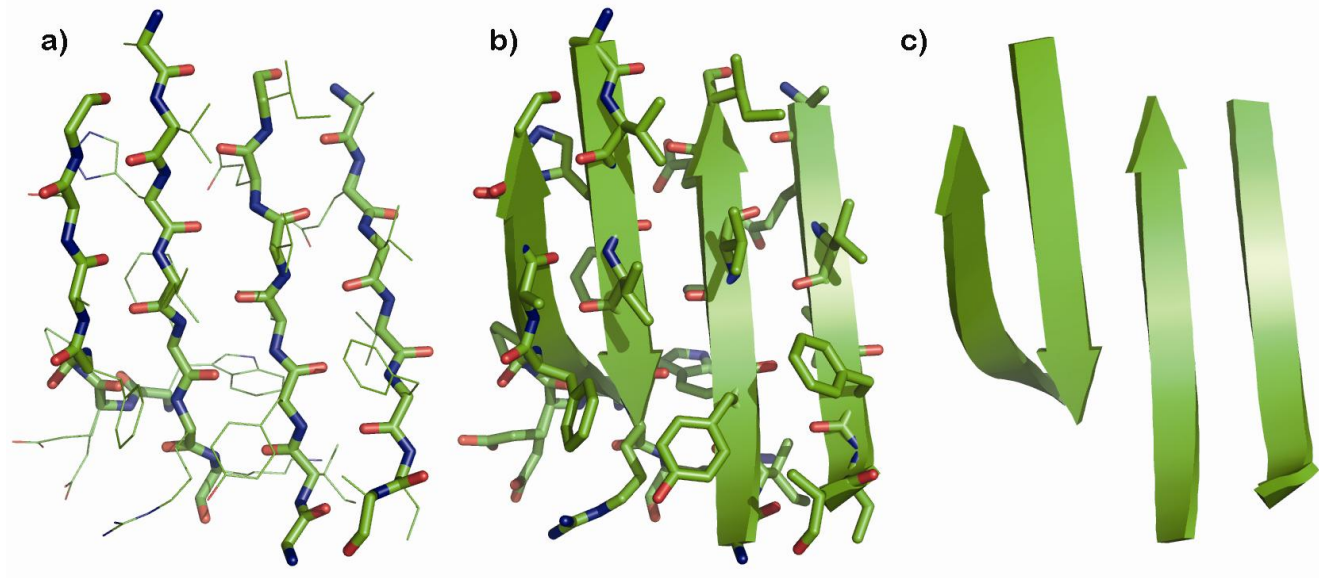
beta-sheet



α -Helix



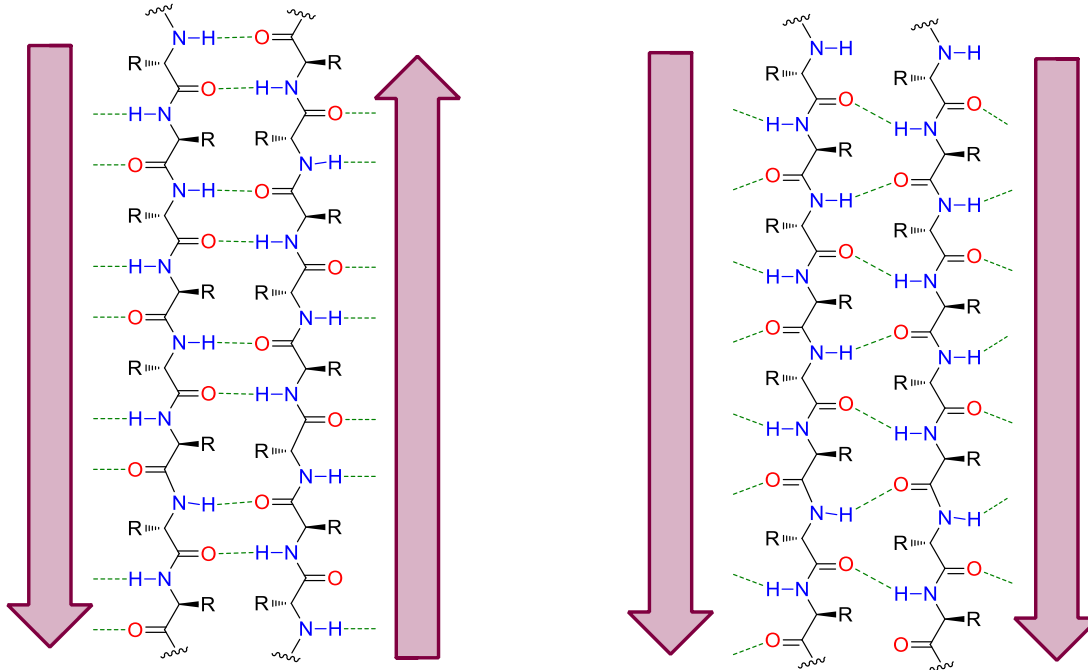
β -Skládaný list



Antiparalel

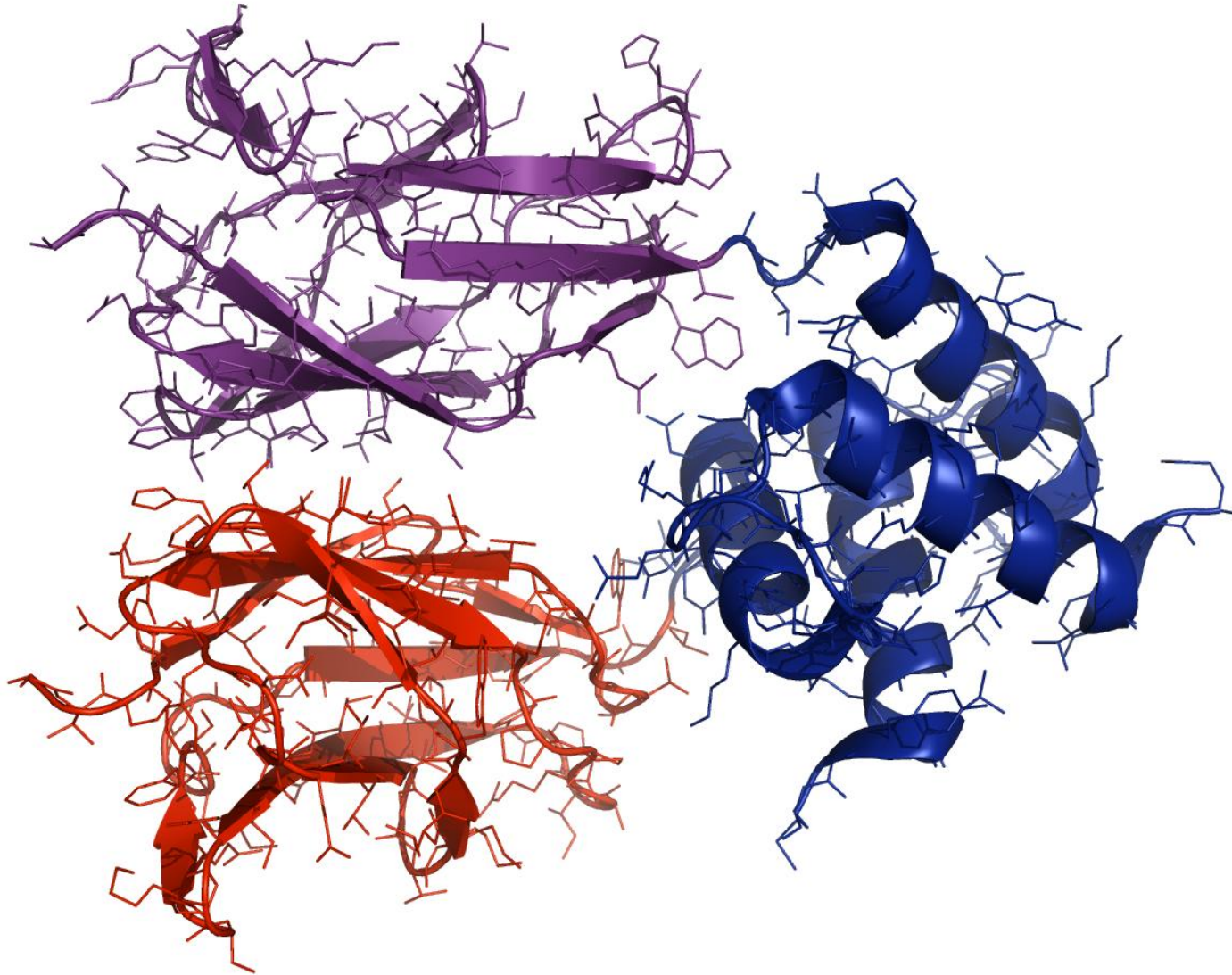
β -Sheet

Paralel



Terciární struktura

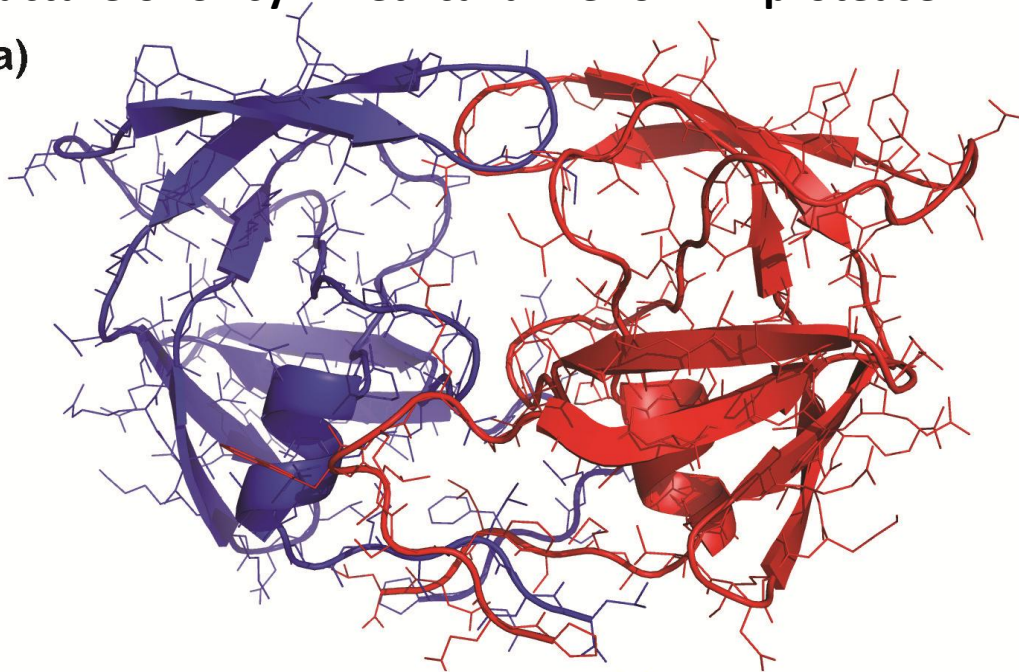
3 domény (fialová, modrá a červená) Early B-cell Factor proteinu



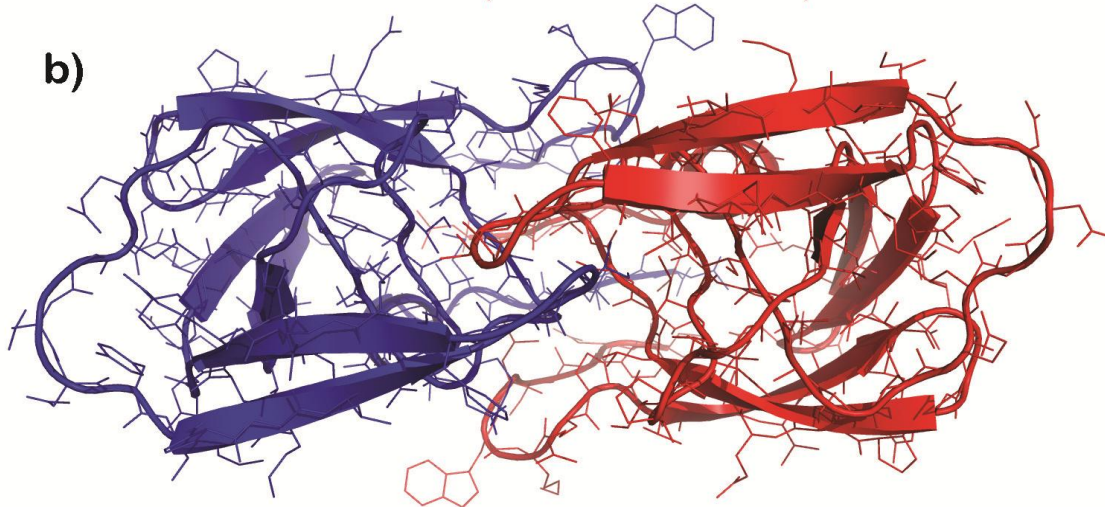
Kvartérní struktura

Quaternary structure of C_2 symmetrical dimer of HIV protease

a)



b)



Quaternary structure of chaperonin complex from *Thermus thermophilus*: a) side view (copies of the same protein unit are in different tints of either blue, red or green), b) side view (each protein unit in different color), c) top view, d) bottom view

It consists from 21 protein units of 3 different polypeptide chains where each storey is composed of $C7$ symmetrical ring of 7 copies of the same protein unit.

