MUNI
SCI

C5730 Biochemie - seminář

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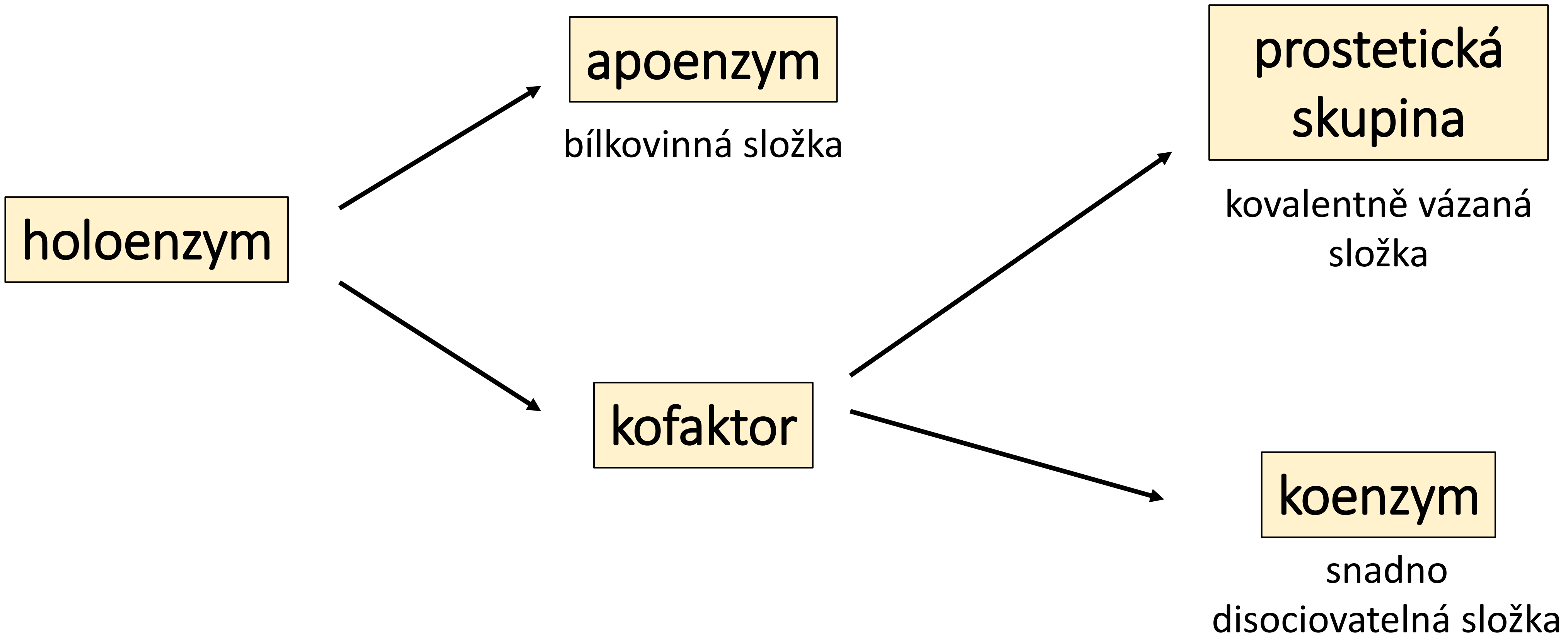
Enzymy

Charakteristika

- **biokatalyzátory**: urychlují biochemické reakce v živých soustavách
- zpravidla **bílkovinné** povahy



Rozdělení

Třída enzymu	Obecné schéma reakce
1. Oxidoreduktasy	$A_{red} + B_{ox} \leftrightarrows A_{ox} + B_{red}$
2. Transferasy	$A\text{-}B + C \rightarrow A + C\text{-}B$
3. Hydrolasy	$A\text{-}B + H_2O \rightarrow A\text{-}H + B\text{-}OH$
4. Lyasy	$A\text{-}B \leftrightarrows A + B$ (opačný směr: synthasy)
5. Isomerasy	$A\text{-}B\text{-}C \leftrightarrows A\text{-}C\text{-}B$
6. Ligasy (synthetasy)	$A + B + ATP \rightarrow A\text{-}B + ADP + P_i$

7. translokasy: umožňují přesun molekul či iontů přes biomembrány katalýzou přenosových reakcí

Vybrané kofaktory

TABLE 6–1	Some Inorganic Ions That Serve as Cofactors for Enzymes
Ions	**Enzymes**
Cu^{2+}	Cytochrome oxidase
Fe^{2+} or Fe^{3+}	Cytochrome oxidase, catalase, peroxidase
K^{+}	Pyruvate kinase
Mg^{2+}	Hexokinase, glucose 6-phosphatase, pyruvate kinase
Mn^{2+}	Arginase, ribonucleotide reductase
Mo	Dinitrogenase
Ni^{2+}	Urease
Se	Glutathione peroxidase
Zn^{2+}	Carbonic anhydrase, alcohol dehydrogenase, carboxypeptidases A and B

Table 6-1
Lehninger Principles of Biochemistry, Fifth Edition

TABLE 6–2 Some Coenzymes That Serve as Transient Carriers of Specific Atoms or Functional Groups		
Coenzyme	**Examples of chemical groups transferred**	**Dietary precursor in mammals**
Biocytin	CO_2	Biotin
Coenzyme A	Acyl groups	Pantothenic acid and other compounds
5′-Deoxyadenosylcobalamin (coenzyme B_{12})	H atoms and alkyl groups	Vitamin B_{12}
Flavin adenine dinucleotide	Electrons	Riboflavin (vitamin B_2)
Lipoate	Electrons and acyl groups	Not required in diet
Nicotinamide adenine dinucleotide	Hydride ion (:H^-)	Nicotinic acid (niacin)
Pyridoxal phosphate	Amino groups	Pyridoxine (vitamin B_6)
Tetrahydrofolate	One-carbon groups	Folate
Thiamine pyrophosphate	Aldehydes	Thiamine (vitamin B_1)

Note: The structures and modes of action of these coenzymes are described in Part II.

Table 6-2
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Reakční koordináta a vliv enzymu

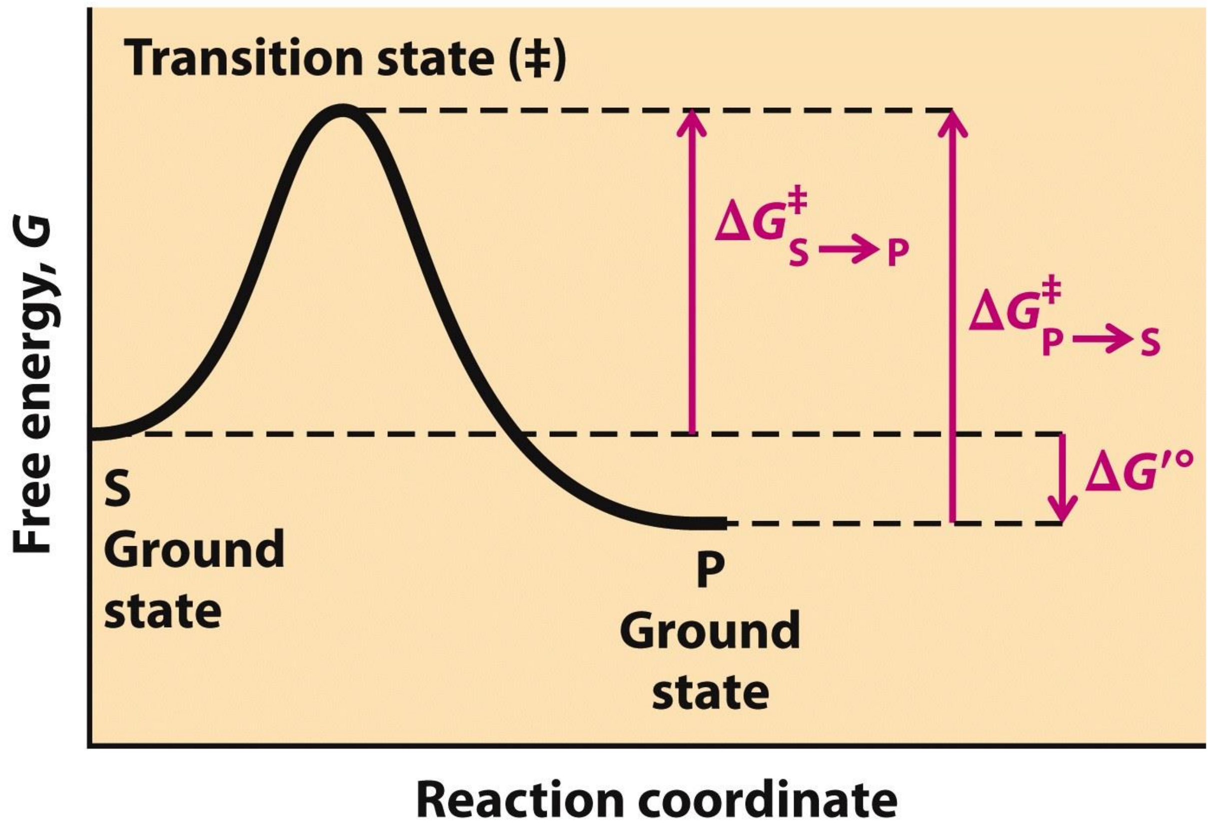

Figure 6-2
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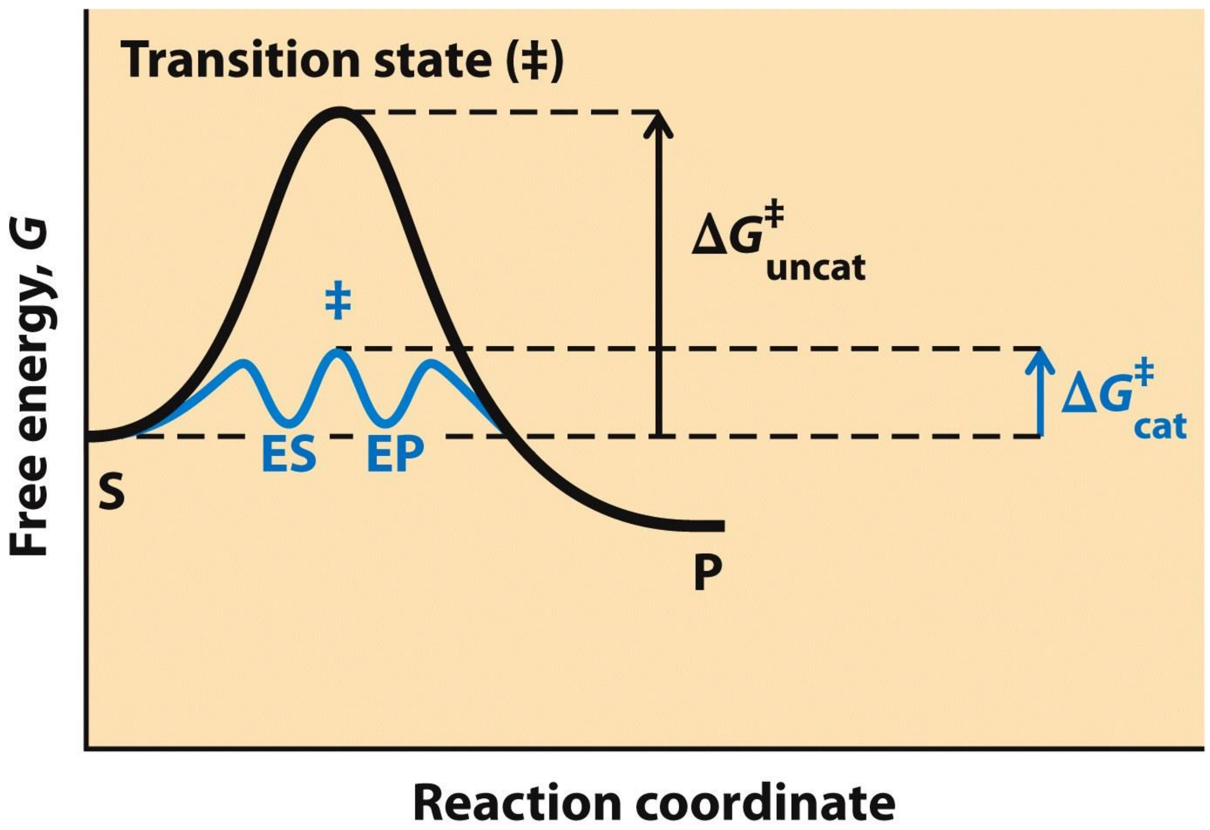

Figure 6-3
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Ukázka vlivu enzymu na rychlost vzniku produktu

TABLE 6–5	Some Rate Enhancements Produced by Enzymes
Cyclophilin	10^5
Carbonic anhydrase	10^7
Triose phosphate isomerase	10^9
Carboxypeptidase A	10^{11}
Phosphoglucomutase	10^{12}
Succinyl-CoA transferase	10^{13}
Urease	10^{14}
Orotidine monophosphate decarboxylase	10^{17}

Table 6-5
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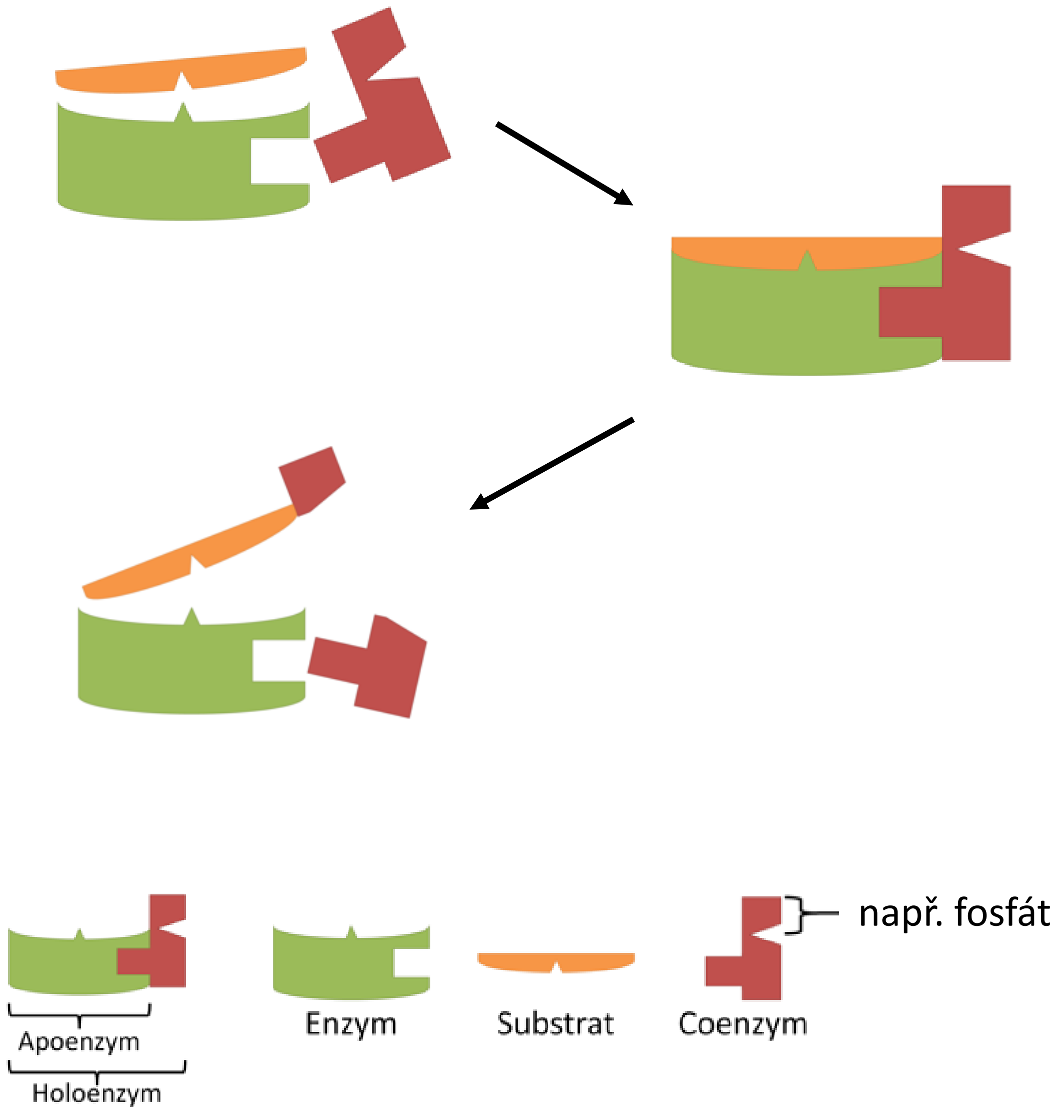
Jak dlouho by vznikalo množství produktu, které ureasa vytvoří za 1 s?

Princip enzymové reakce



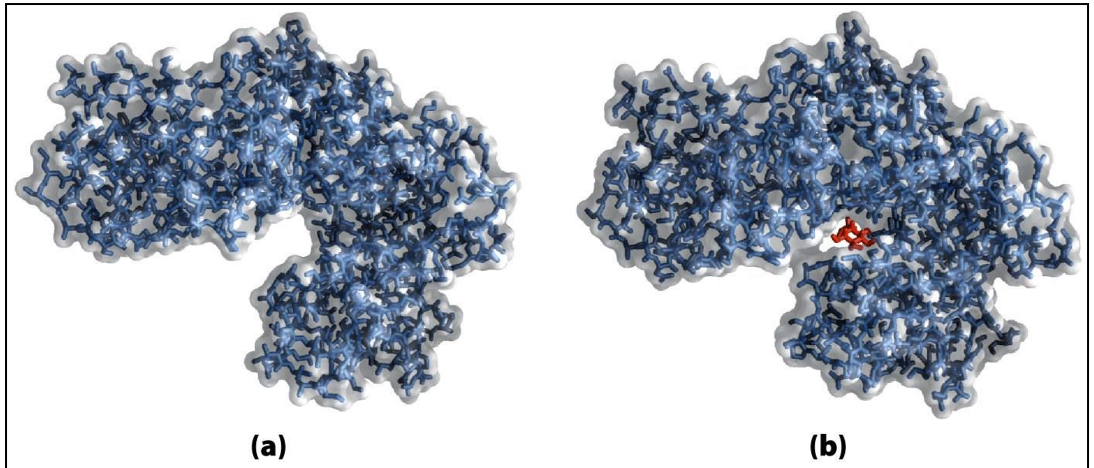


Figure 6-22
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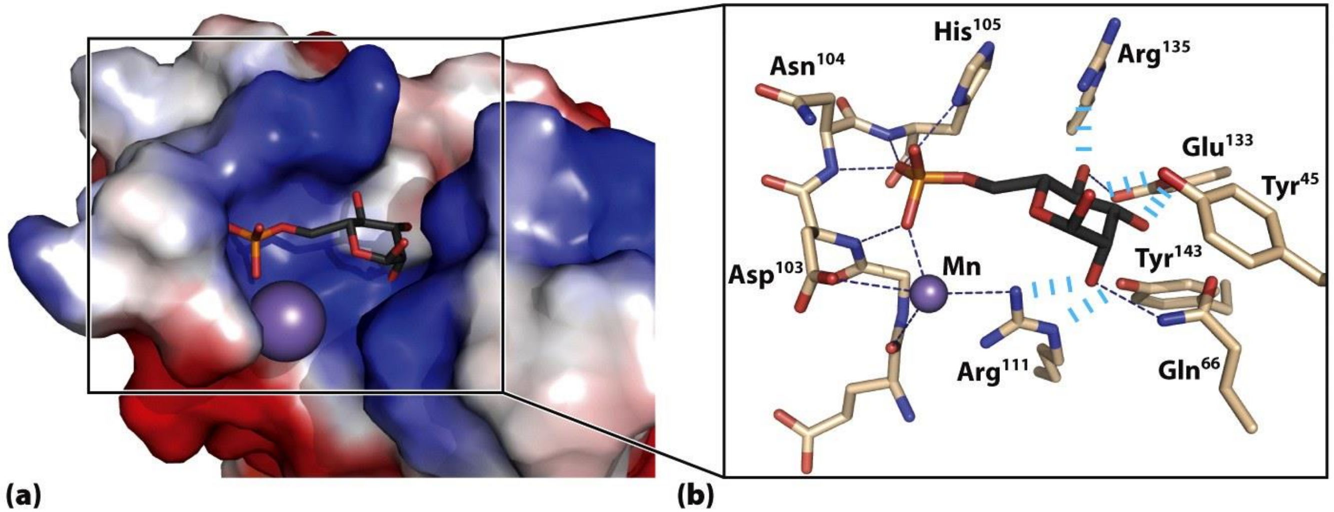

Figure 7-33
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Působení HIV proteasy

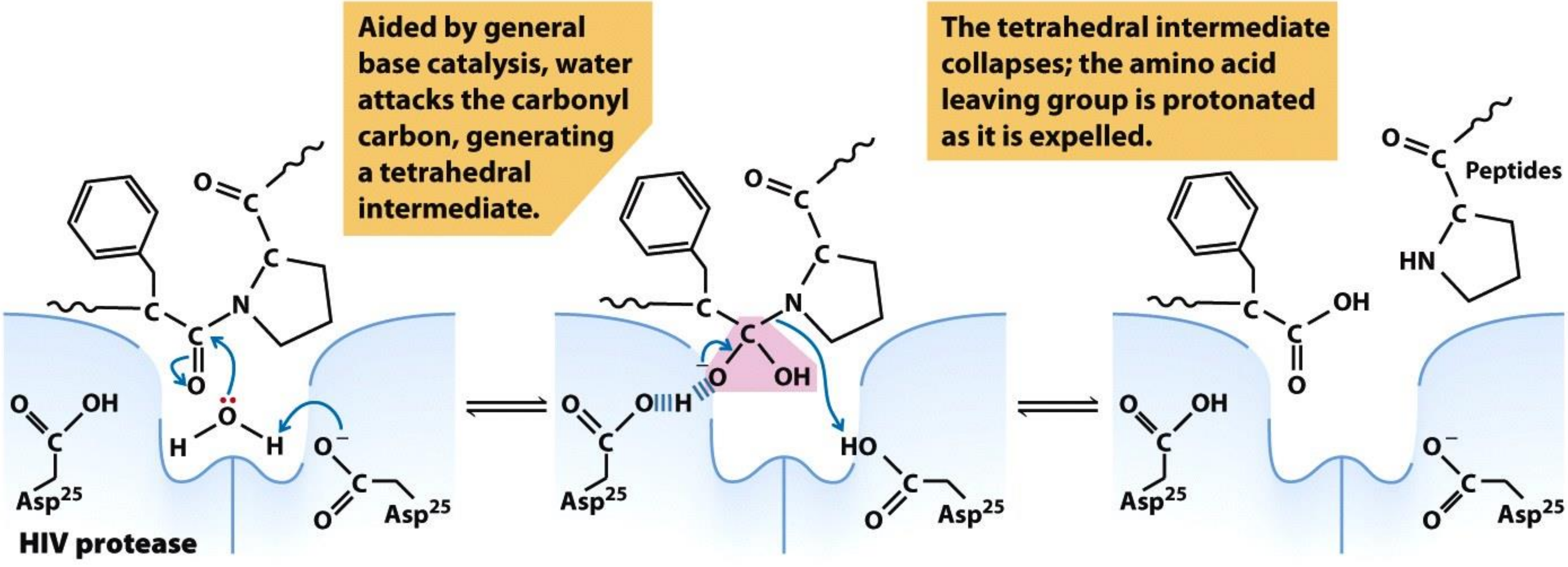

Figure 6-29
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Enzymová kinetika

- zkoumá rychlost biochemických reakcí katalyzovaných enzymy
- jednotky:
  - **katal** (kat; množství enzymu potřebné pro přeměnu 1 molu substrátu za 1 sekundu) mol/s
  - **enzymová jednotka** (U) µmol/min

Faktory ovlivňující rychlost enzymové reakce:

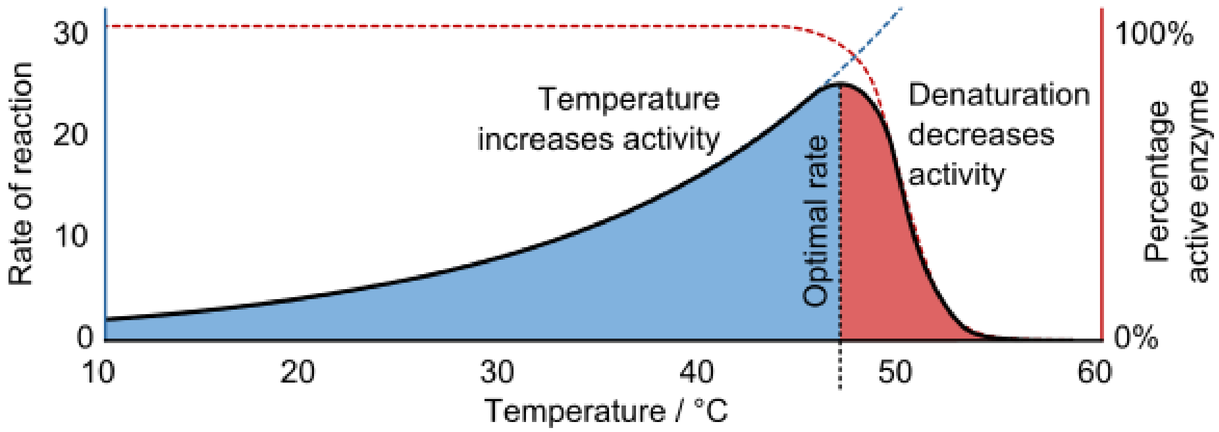
- teplota, pH
- množství enzymu, množství substrátu
- aktivátory a inhibitory

Vliv teploty a pH

- s rostoucí **teplotou** roste rychlost reakce (ale pouze do určité teploty, pak rychlost rapidně klesá)

- pro většinu enzymů klesá rychlost reakce v extrémně nízkém či vysokém pH

  - každý enzym má své **pH optimum**



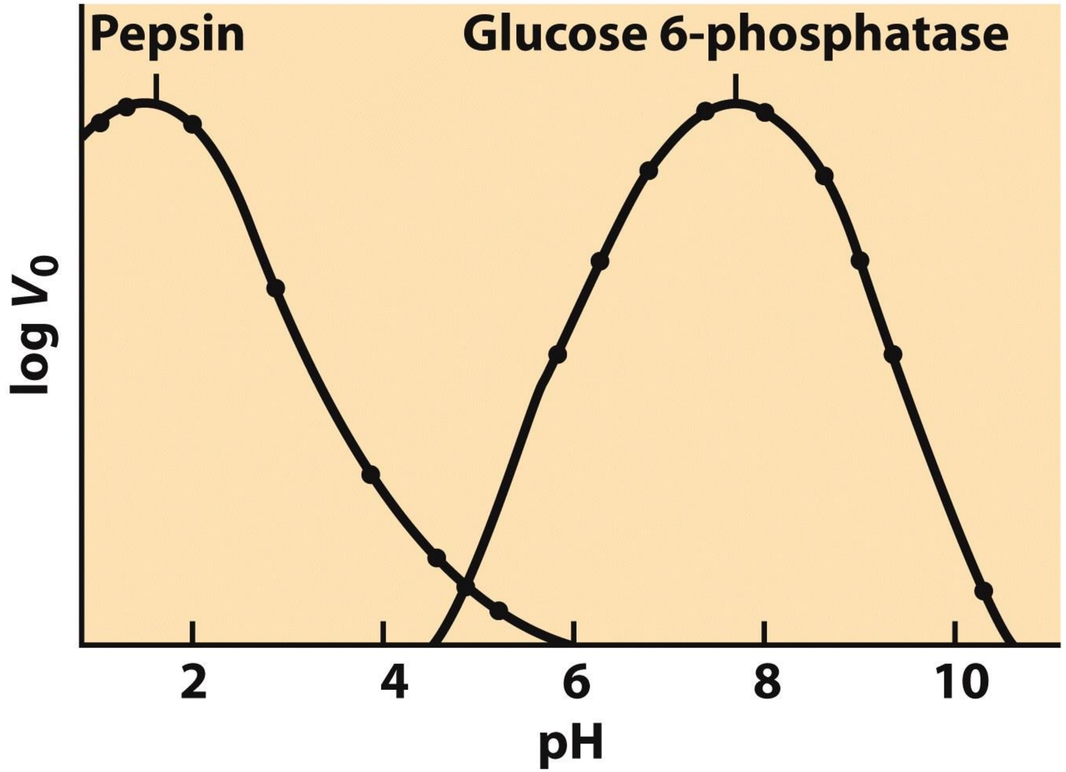


Figure 6-17
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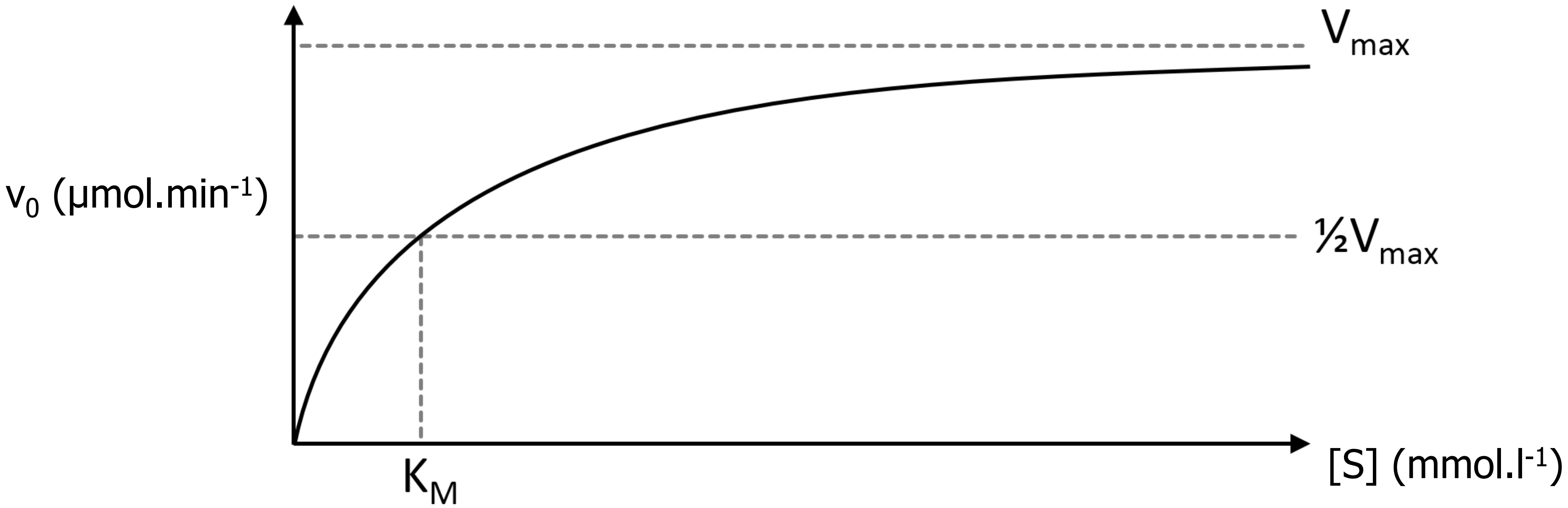
Rovnice Michaelise a Mentenové

$$V = V_{max} \frac{[S]}{[S] + K_M}$$


Leonor Michaelis
1875–1949
Maud Menten
1879–1960



Aktivace a inhibice

- **aktivace:** kovové ionty, kofaktory, přeměna neaktivní formy v aktivní (štěpení)
- **inhibice:** přeměna aktivní formy v neaktivní, přítomnost **inhibitorů**

Kompetitivní | Nekompetitivní

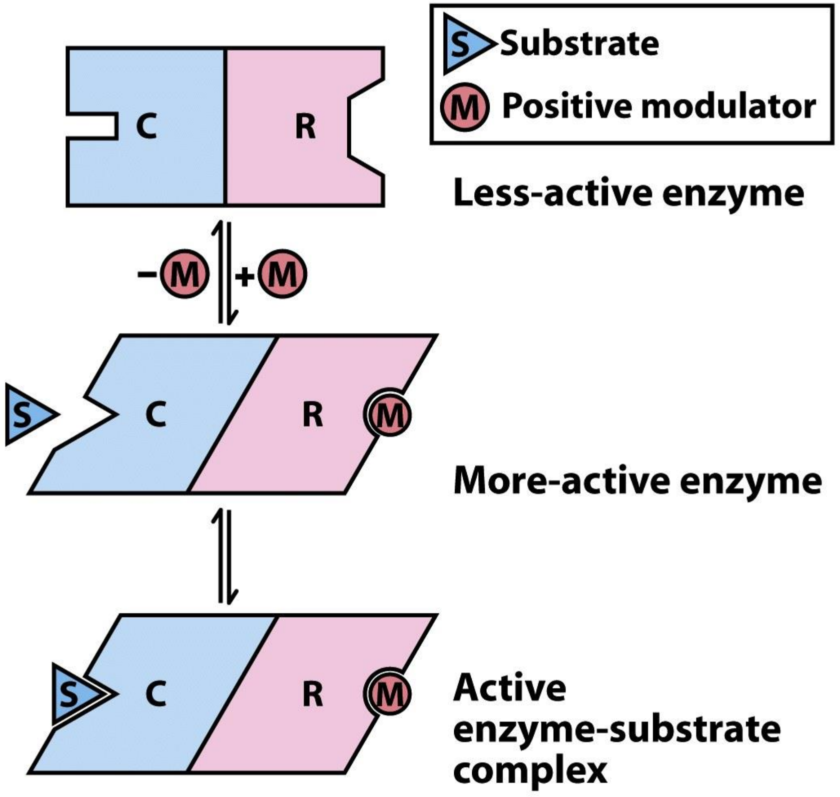


Figure 6-31
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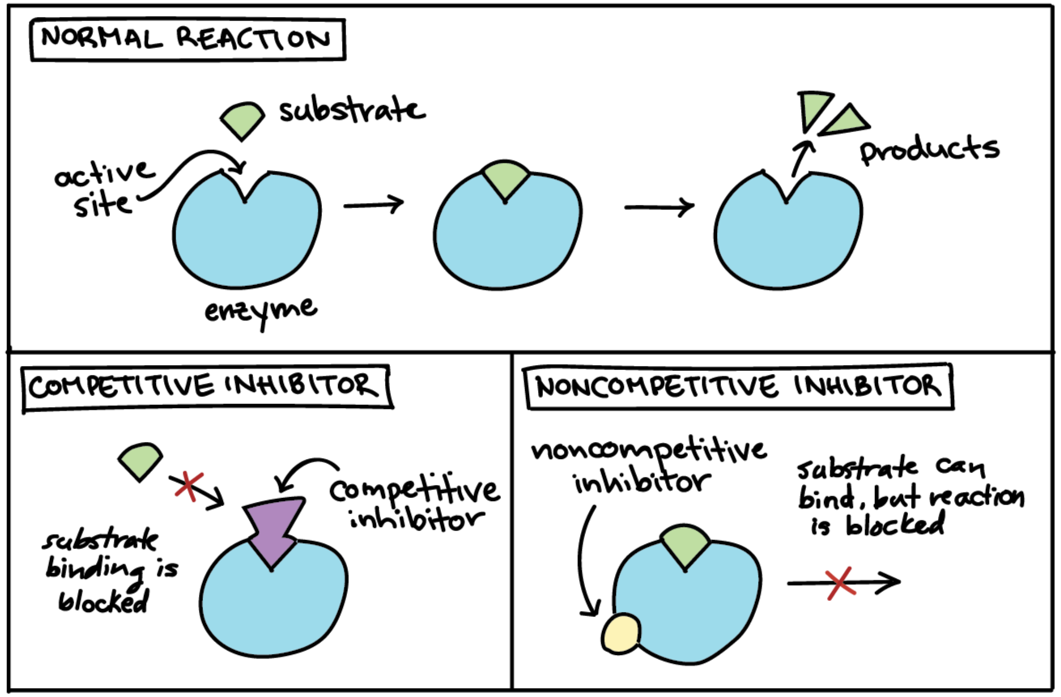
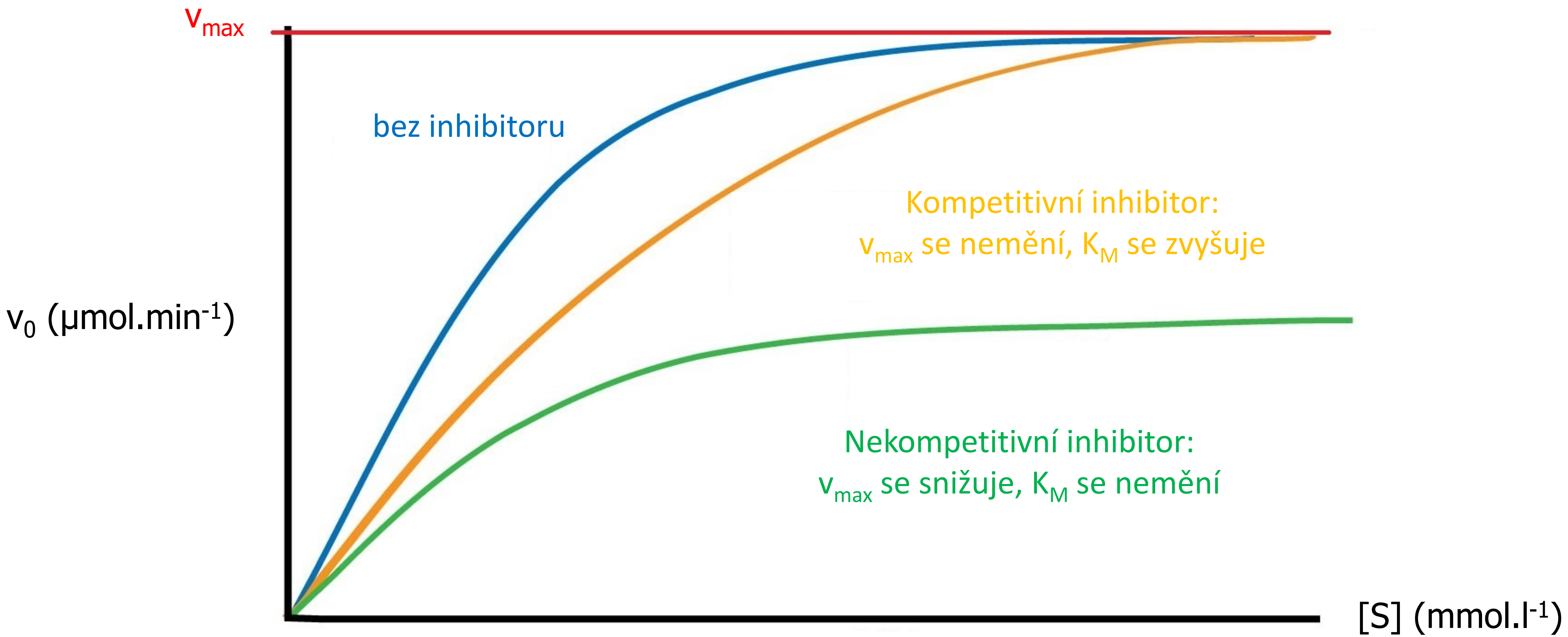
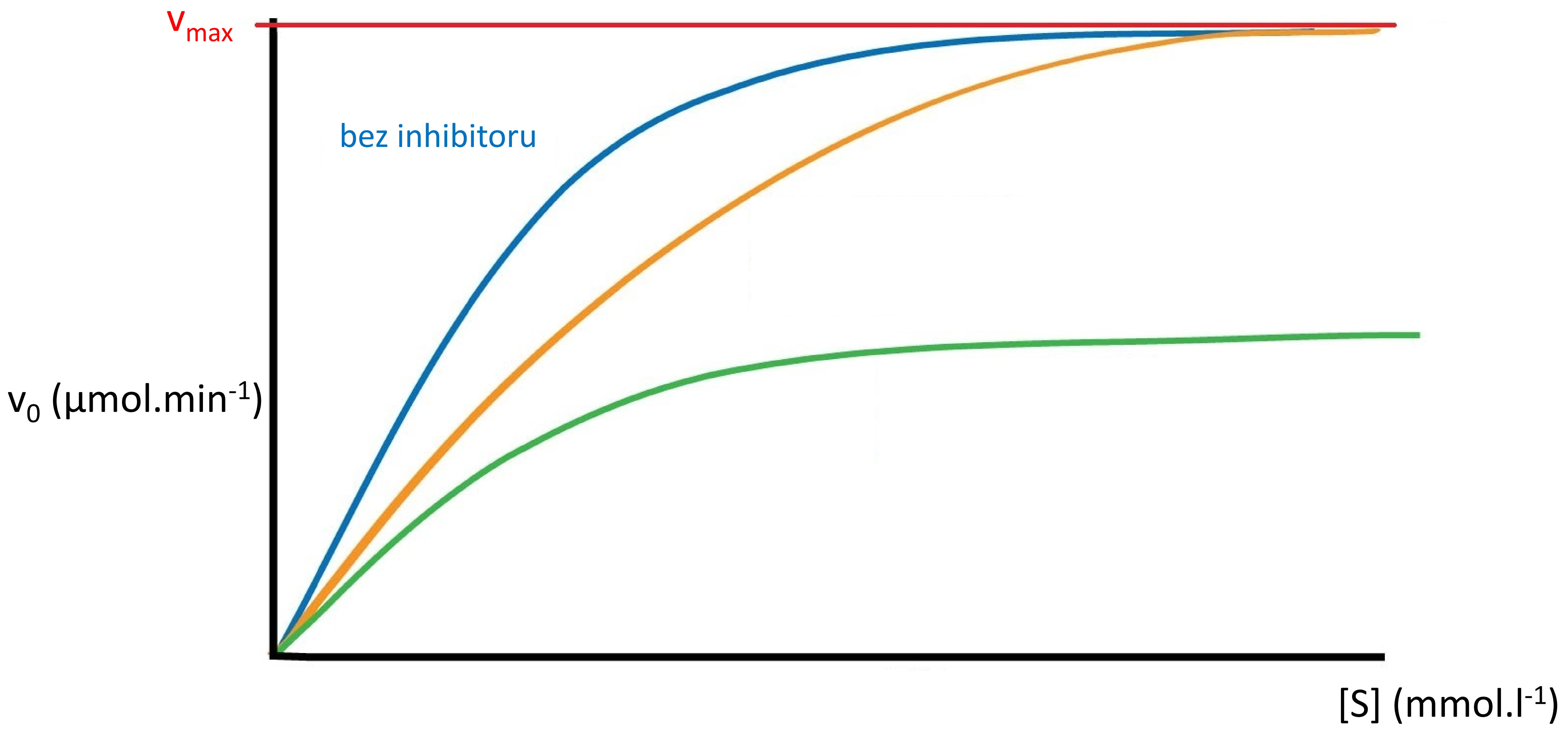


Khan Academy (online, 2023)

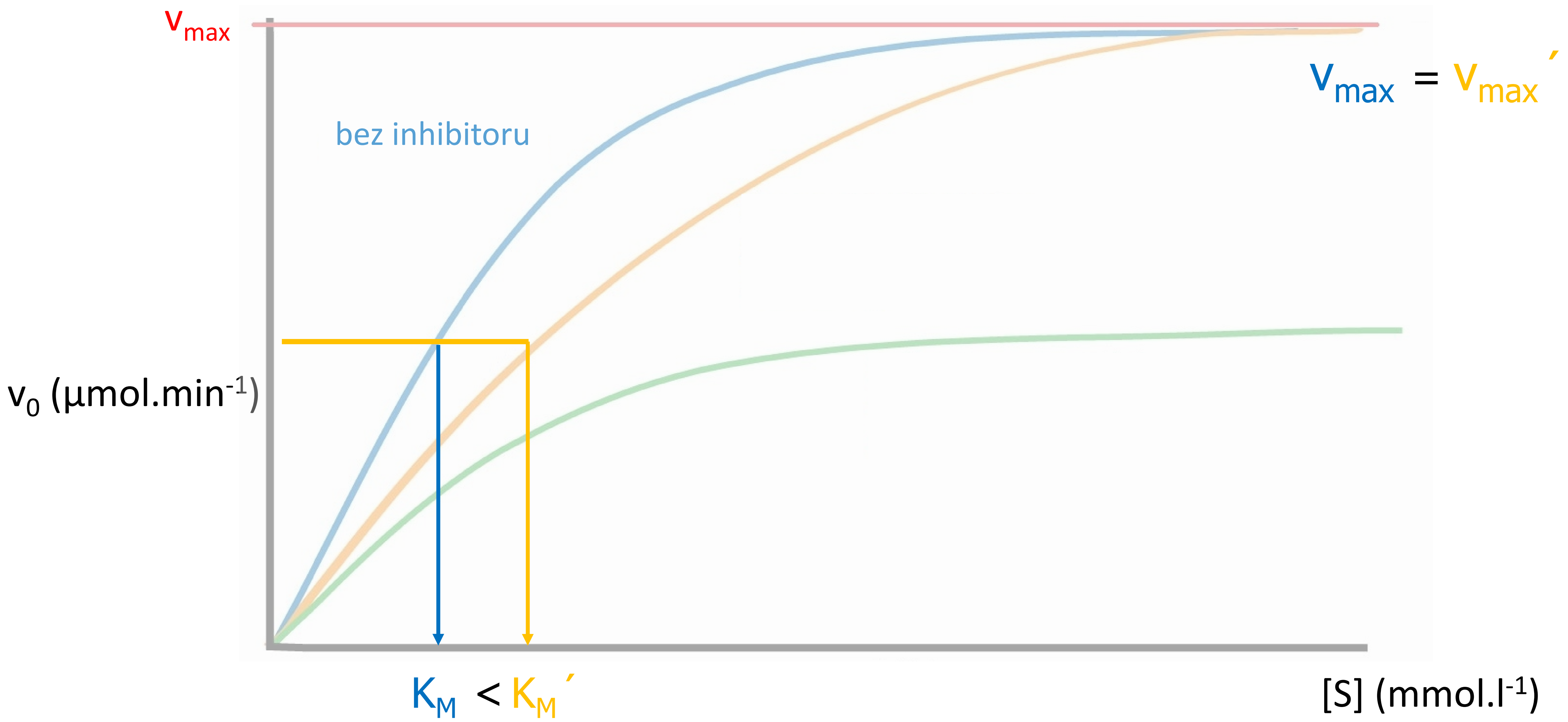
Vliv inhibitorů na K_M a v_{max}



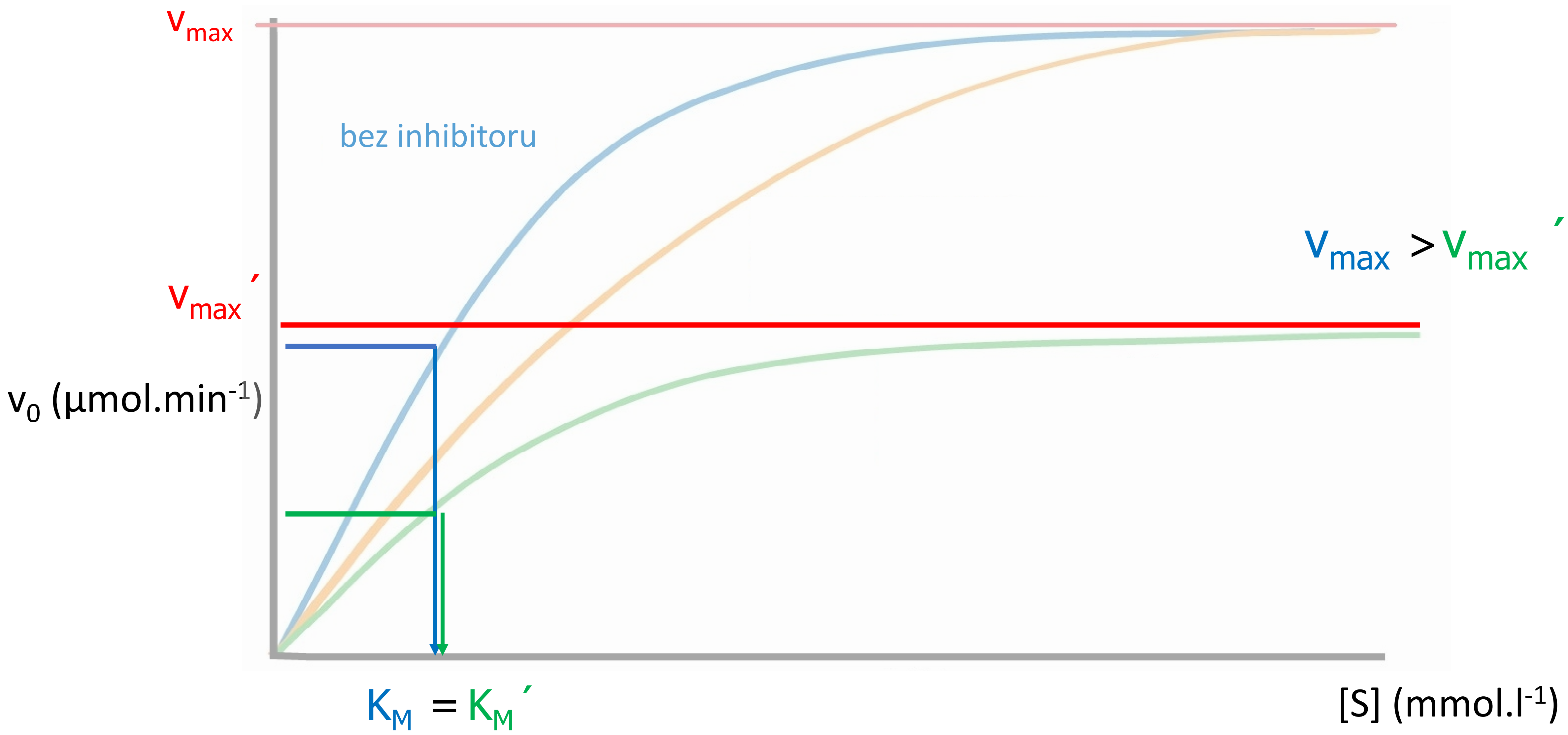


v_{max}
bez inhibitoru
v_0 (µmol.min^{-1})
[S] (mmol.l^{-1})

Kompetitivní inhibitor



Nekompetitivní inhibitor



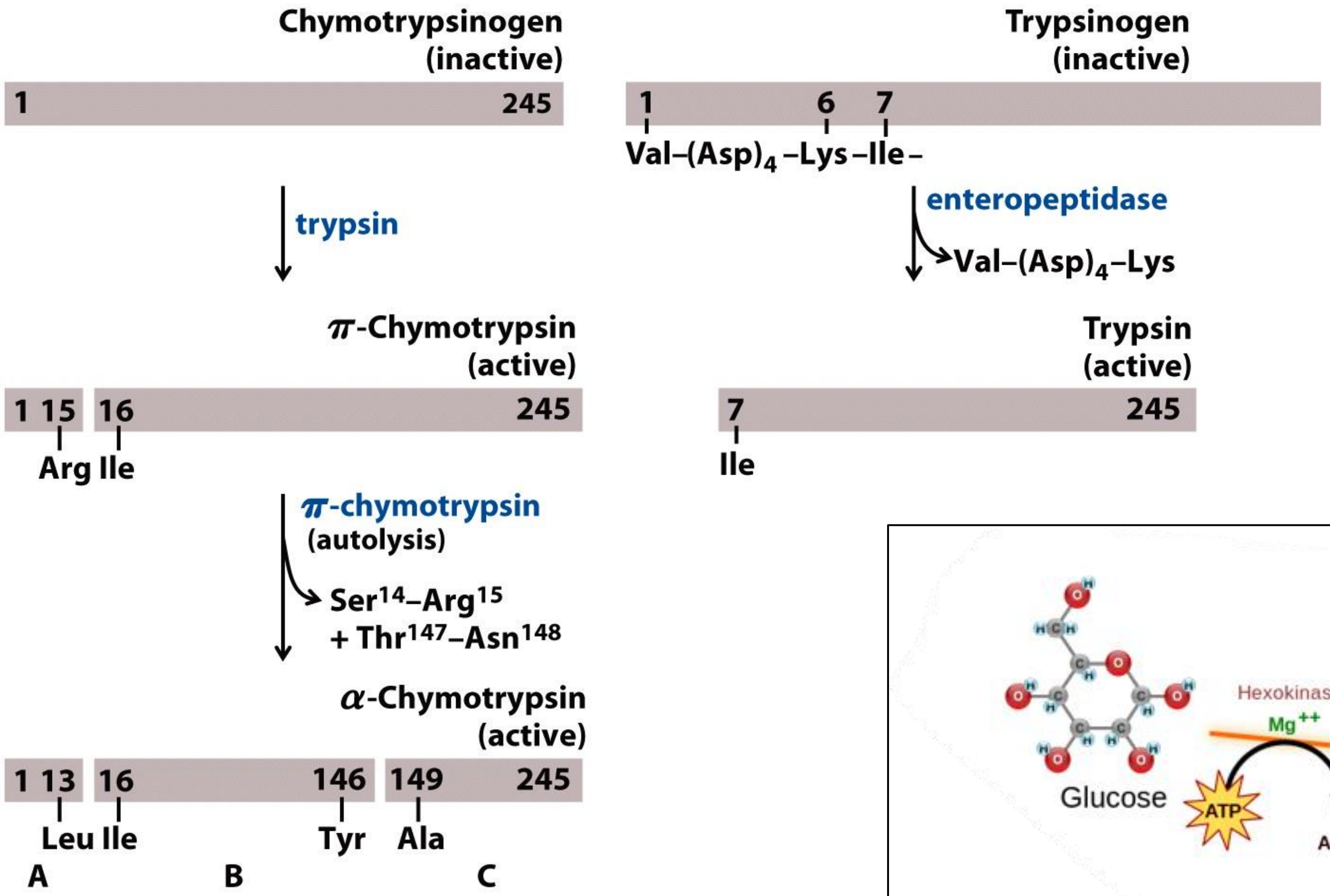


Figure 6-38
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Vybrané procesy, v nichž se uplatňují aktivace a inhibice enzymů