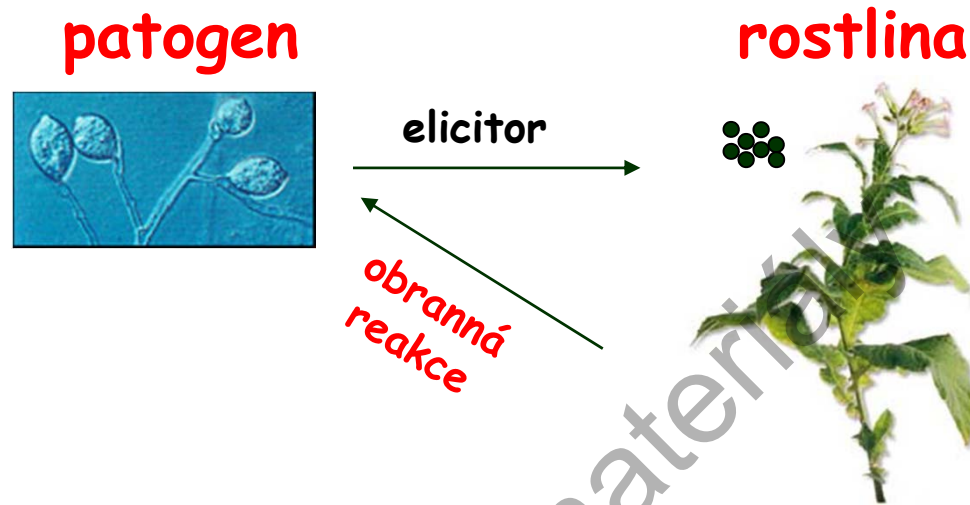


# Interakce rostlin s patogeny

Studijní materiály

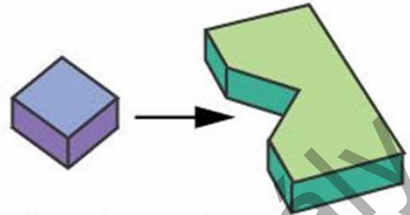
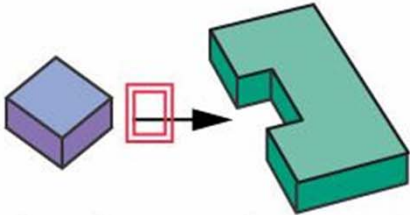
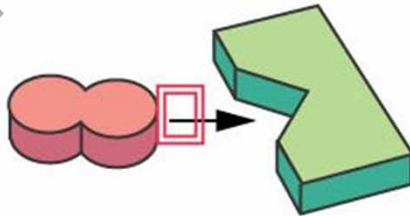
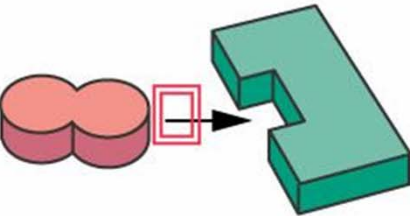
# Obranná reakce



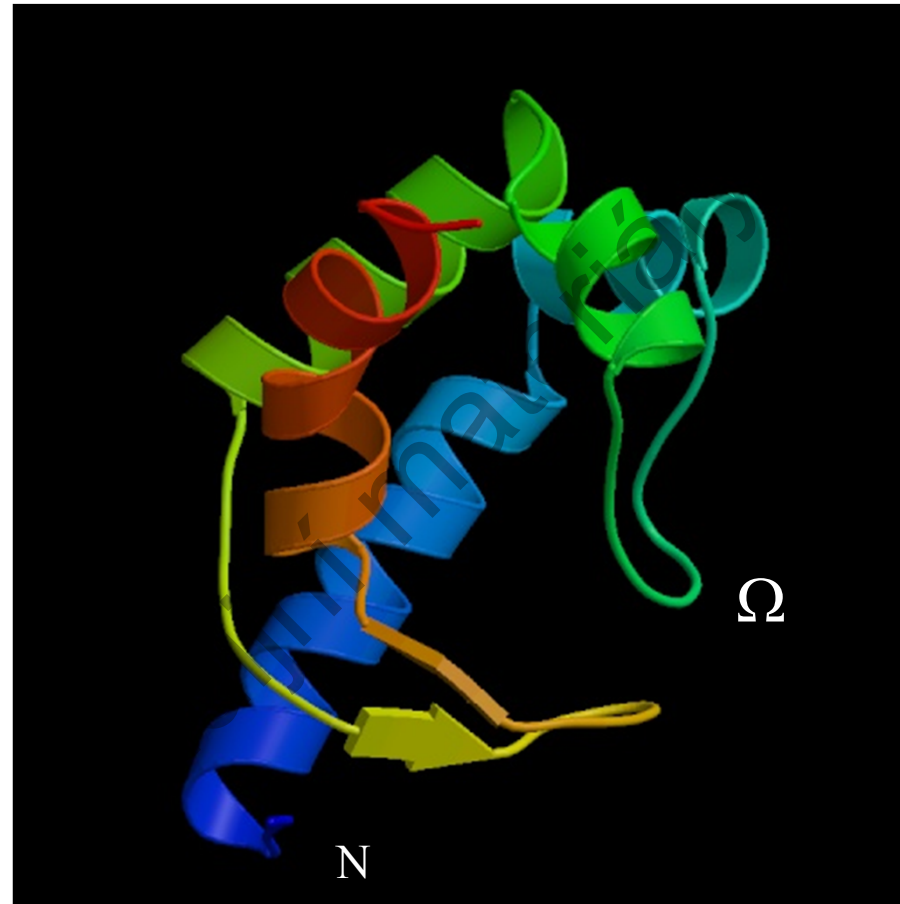
**Elicitory** – látky schopné vyvolat obrannou reakci u rostlin

- uvolňovány patogenem do okolí
- z chemického hlediska se jedná o celé spektrum látek
- glycoproteiny, chitinové fragmenty, proteiny, nízemolekulární látky, atd.

Model gen vs.gen  
 gen avirulence avr  
 parazita a gen  
 resistance rostliny R.  
 Jednotlivé  
 varianty,  
 kompatibilní  
 a nekomtatibilní  
 interakce

Pathogen genotype	Host plant genotype	
	<i>R1</i>	<i>r1</i>
<i>Avr1</i>	 <p>Avr1 R1 protein</p> <p>No disease            (Plant and pathogen are <b>incompatible</b>.)</p>	 <p>Avr1 r1 protein</p> <p>Disease            (Plant and pathogen are <b>compatible</b>.)</p>
<i>avr1</i>	 <p>avr1 R1 protein</p> <p>Disease            (Plant and pathogen are <b>compatible</b>.)</p>	 <p>avr1 r1 protein</p> <p>Disease            (Plant and pathogen are <b>compatible</b>.)</p>

# Bílkovinný elicitor



Produkt genu avirulence cryptogeinu, syntetizovaný houbou *Phytophthora cryptogea* startující nehostitelskou obrannou reakci u tabáku nesoucí gen resistance

# Protein engineering

F- Phe  
I- Ile  
M- Met  
W- Trp  
L- Leu  
R- Arg

---

M35F/M59W

---

M35W/M59W/I63F

---

M35W/M59W

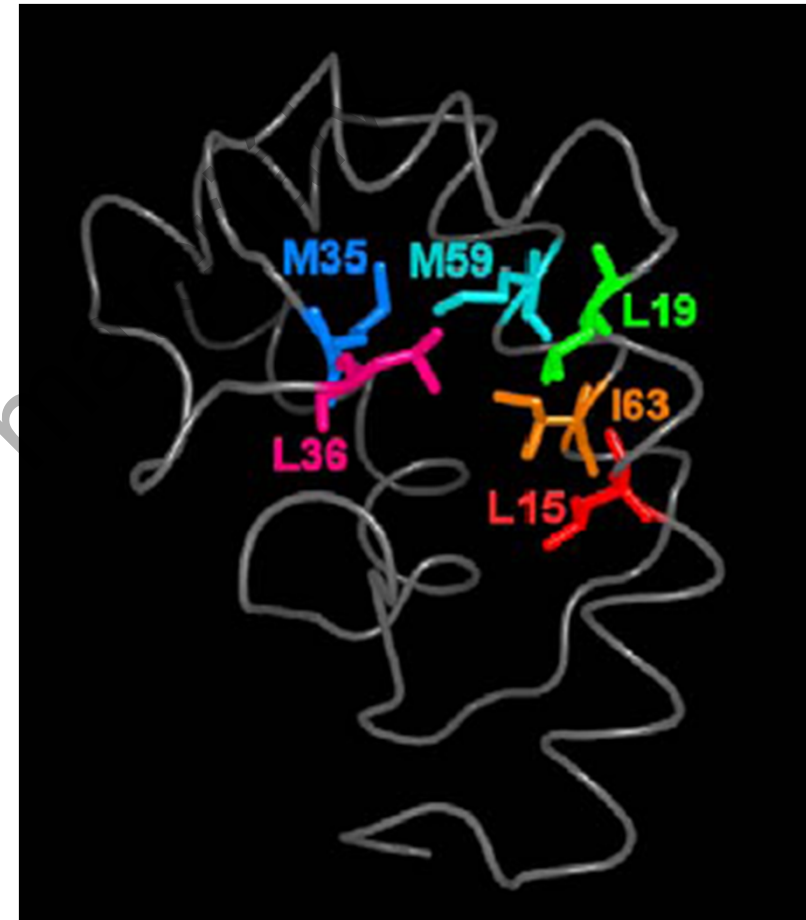
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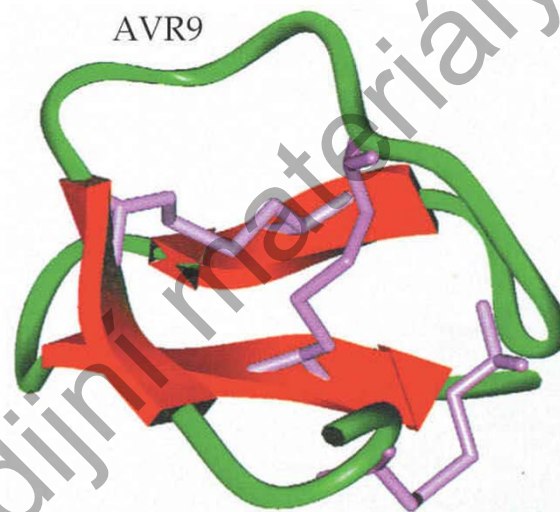
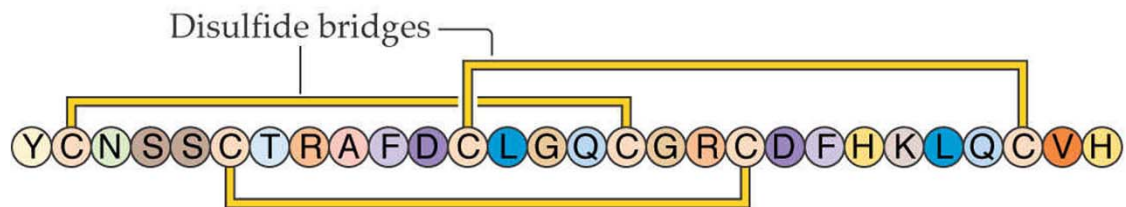
L19R

---

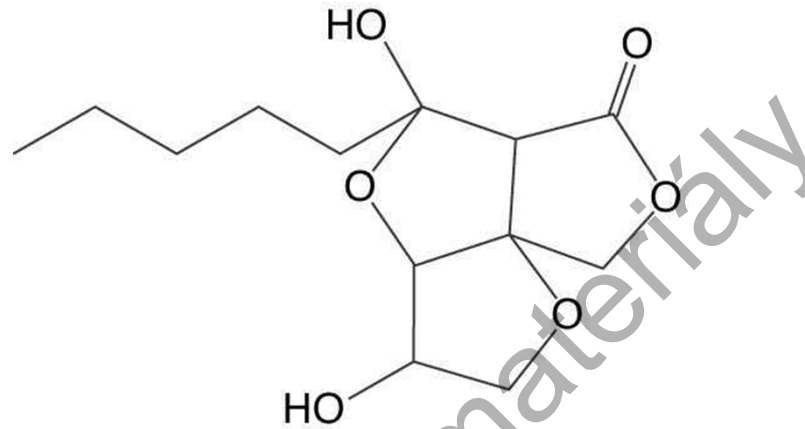
L15W/L36F

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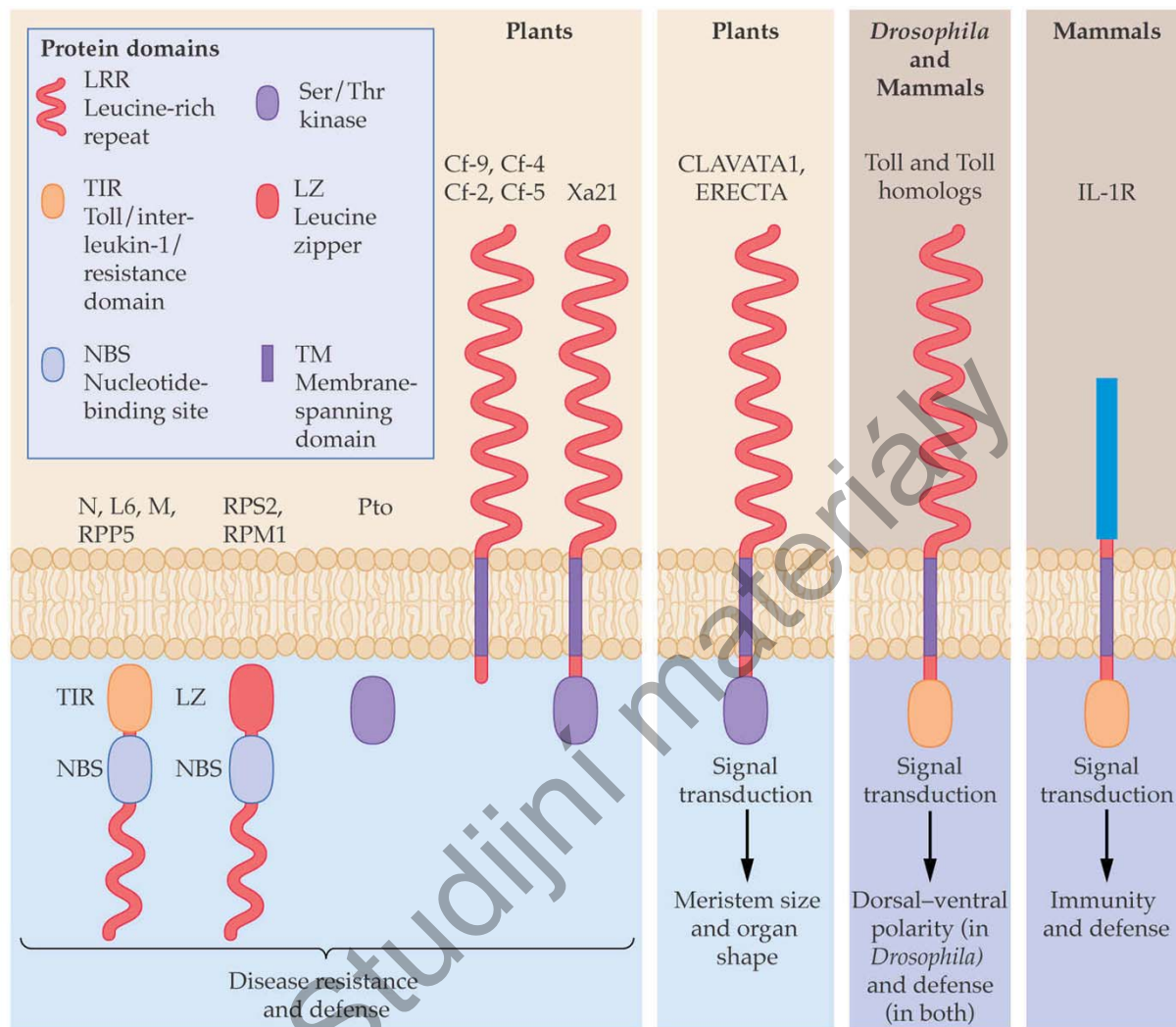




Struktura bílkoviny avirulence *Cladosporium fulvum* Avr9.

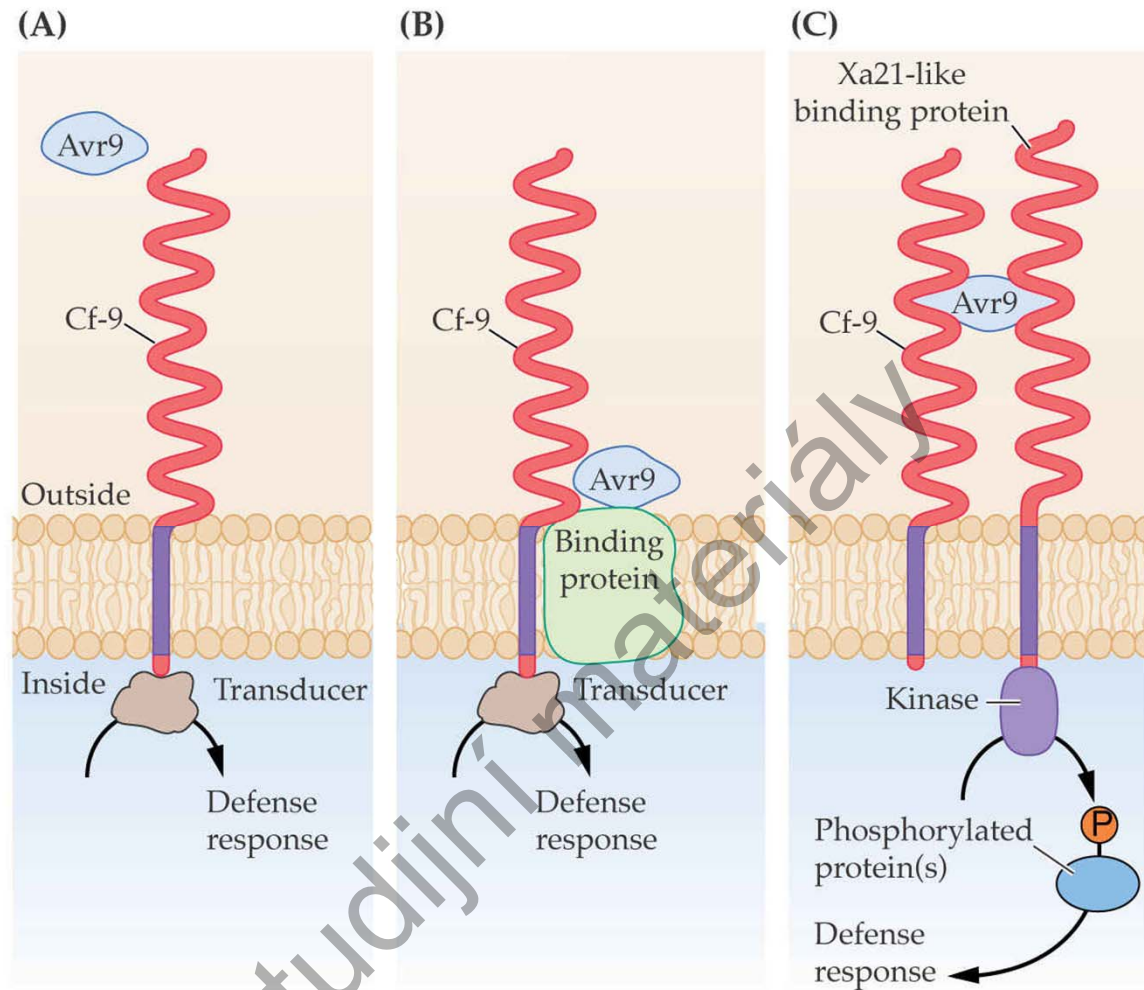


Syringolid, produkt genu avirulence *avrD* bakterie *Pseudomonas syringae* startuje obrannou reakci u soji nesoucí gen resistance *Rpg4*.

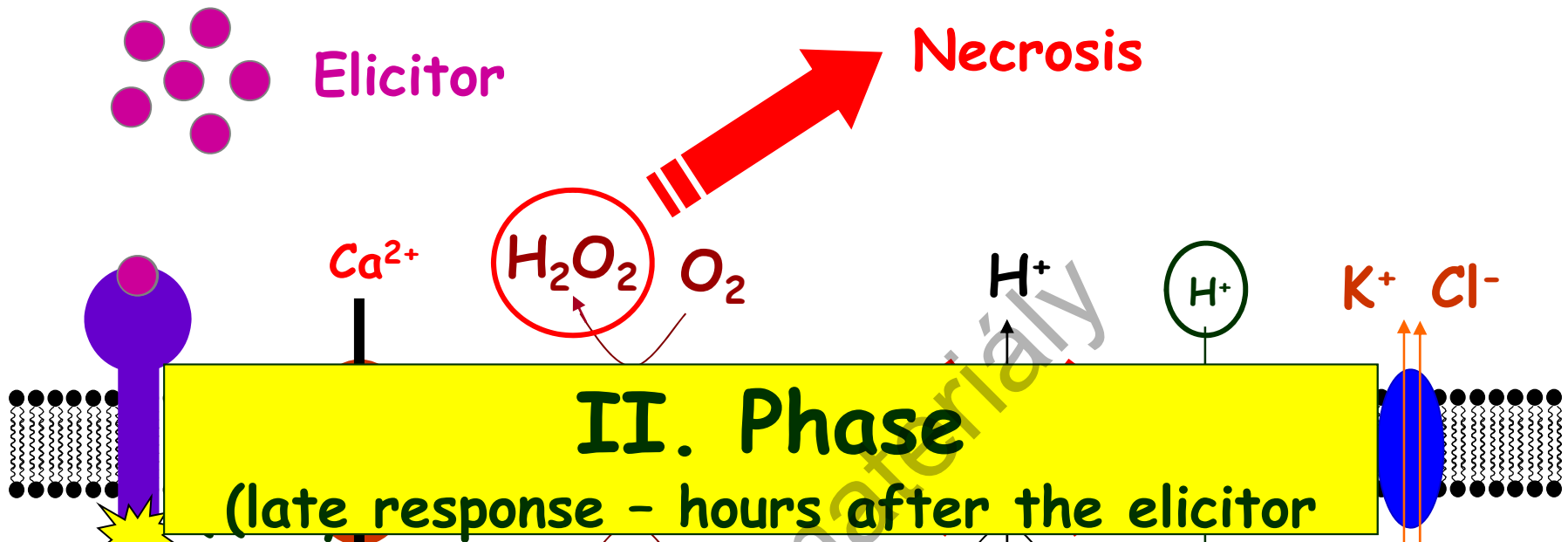


Schématický diagram struktury rostlinných receptorů (produkty genů rezistence) v srovnání s receptory živočichů





Možné mechanismy interakce Avr 9 s receptorem resistance Cf9. Avr9 interaguje s receptorem přímo nebo prostřednictvím vazebného proteinu. Jiná hypotéza předpokládá dimerizaci receptoru s kinasami.

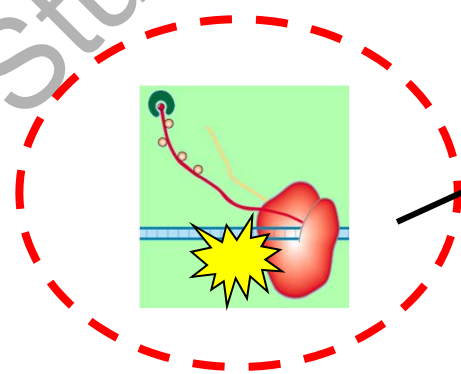
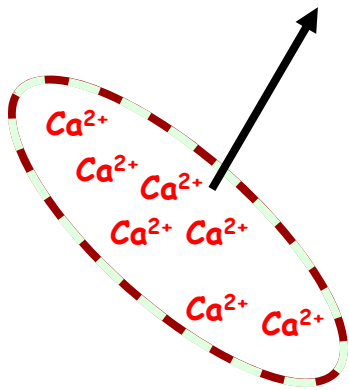


## II. Phase

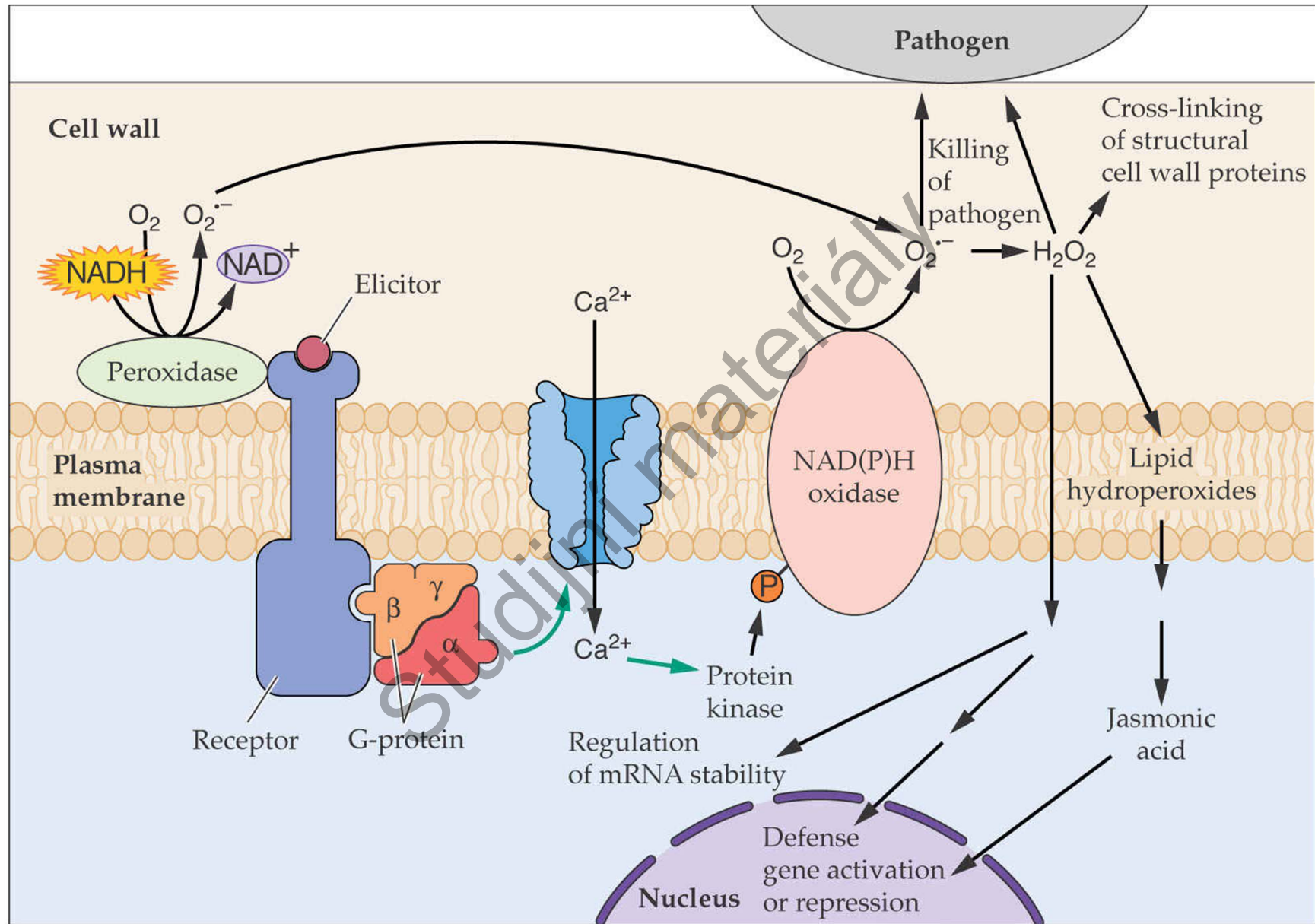
(late response - hours after the elicitor)

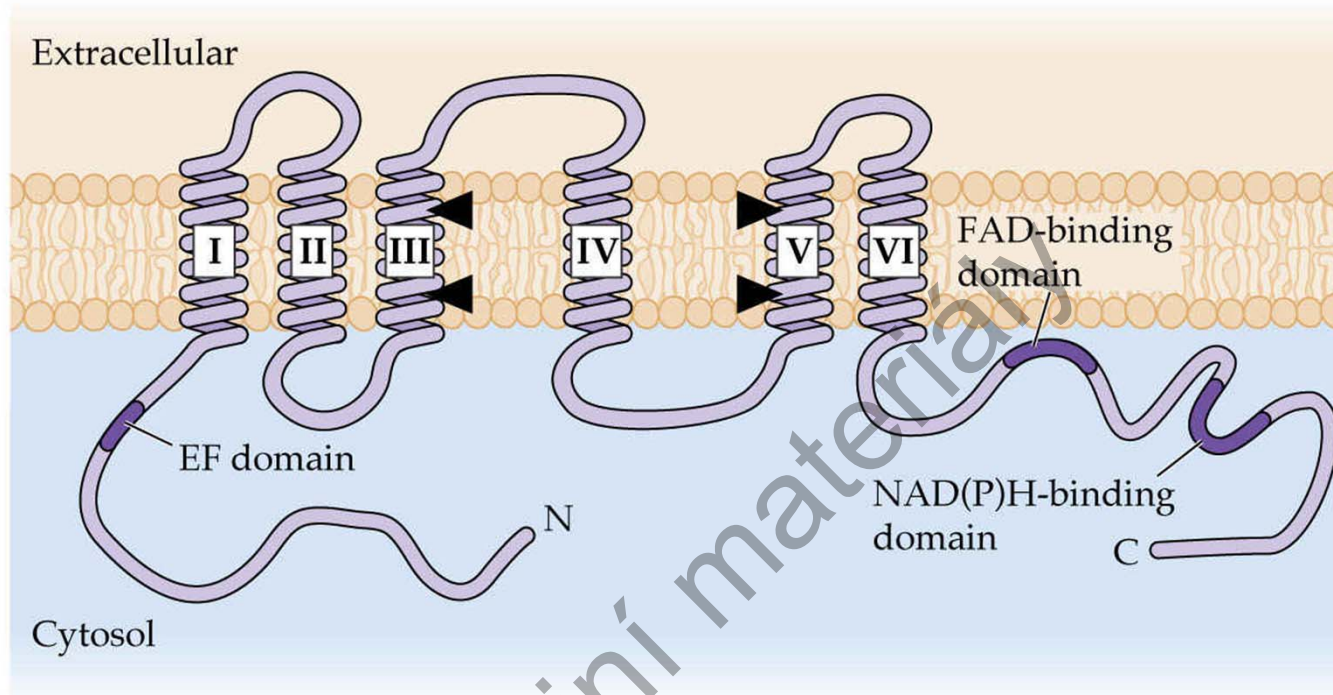
$Ca^{2+}$  uptake

$NAD(P)H$   $H^+$   $ADP+Pi$   $H^+$   $ATP$   $H^+$   $K^+$   $Cl^-$



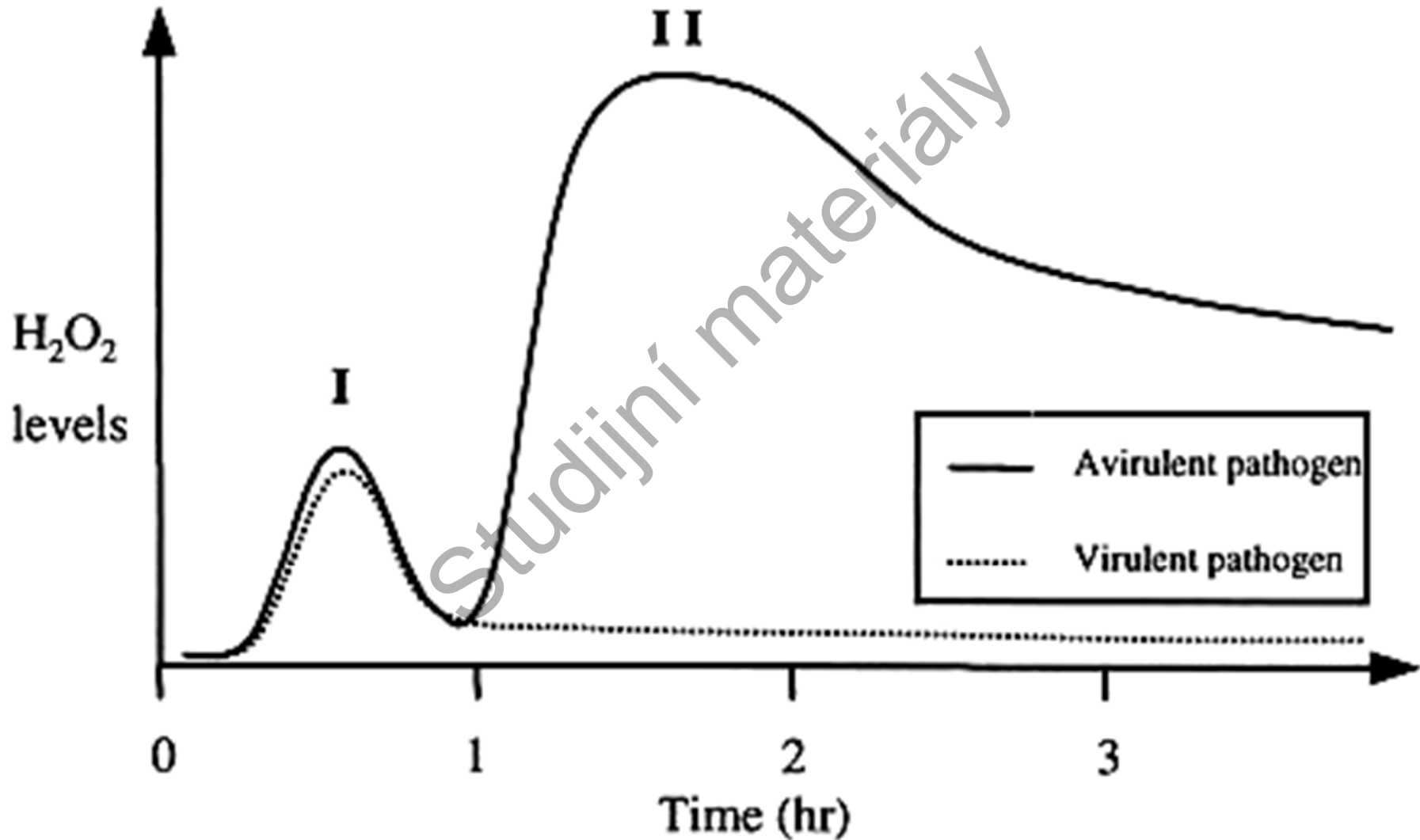
Expression of pathogenesis related proteins and enzymes involved in defense reaction

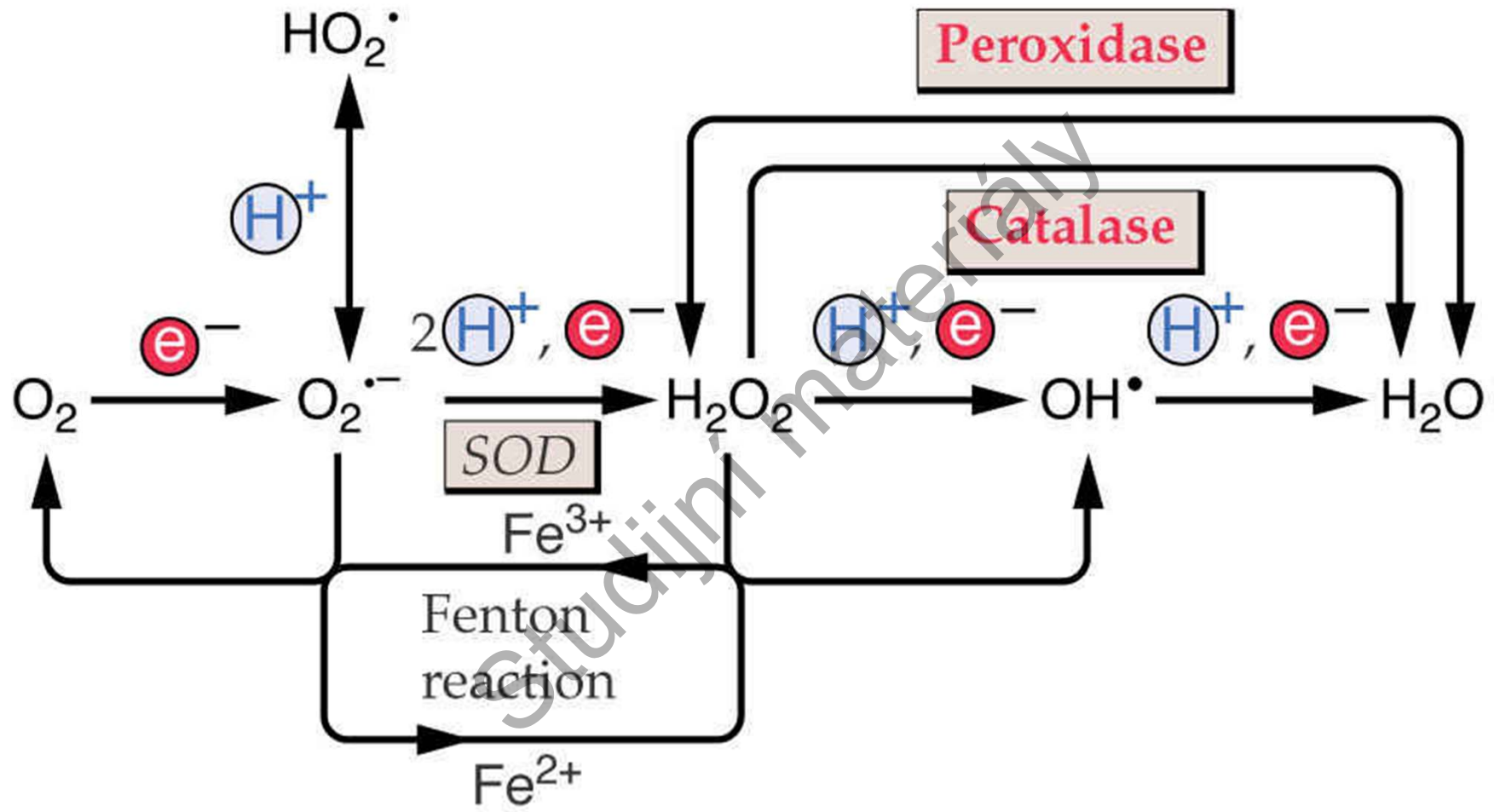




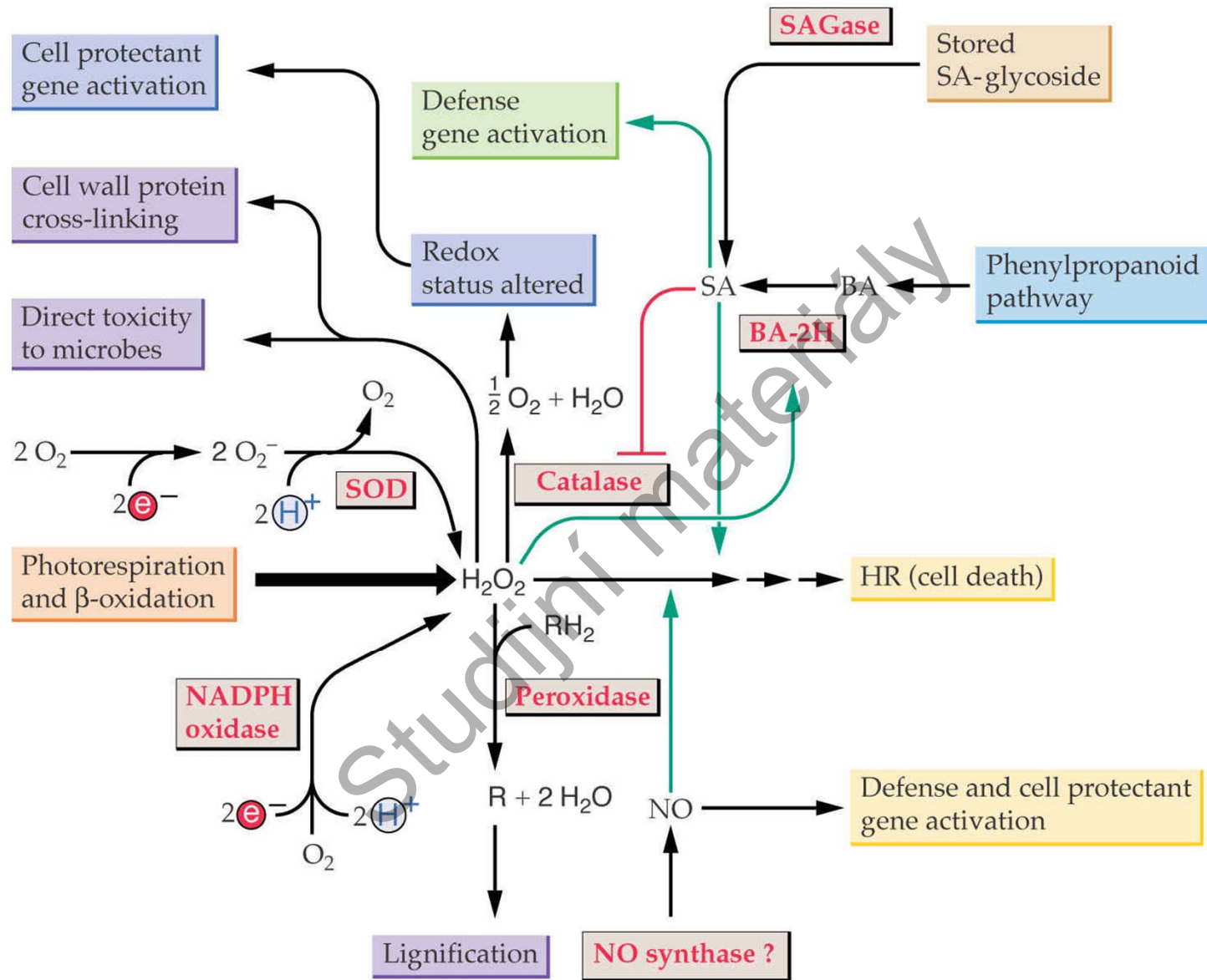
Topologie NADPH oxidasy z rostlin. 6 transmembránových domén, pravděpodobná poloha 2 hemů (trojúhelníky). EF motiv vázající vápník vedoucí k aktivaci.

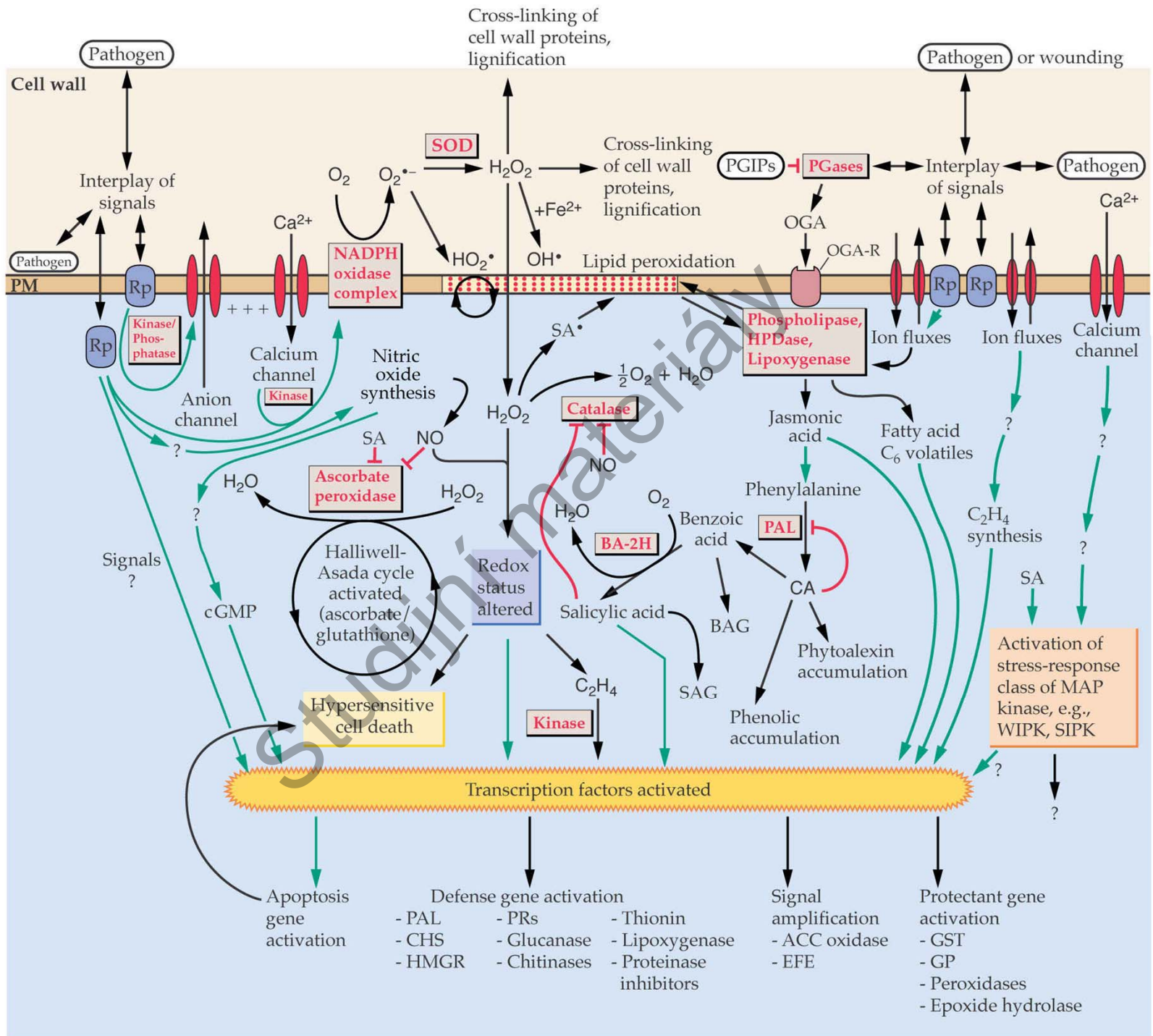
# Průběh produkce $H_2O_2$





(A)







# Enzymes Involved in Defense Reaction

PAL



Salicylic acid

LOX



Jasmonic acid

ACC synthase



Ethylen

Signalling molecules



STC



Phytoalexins

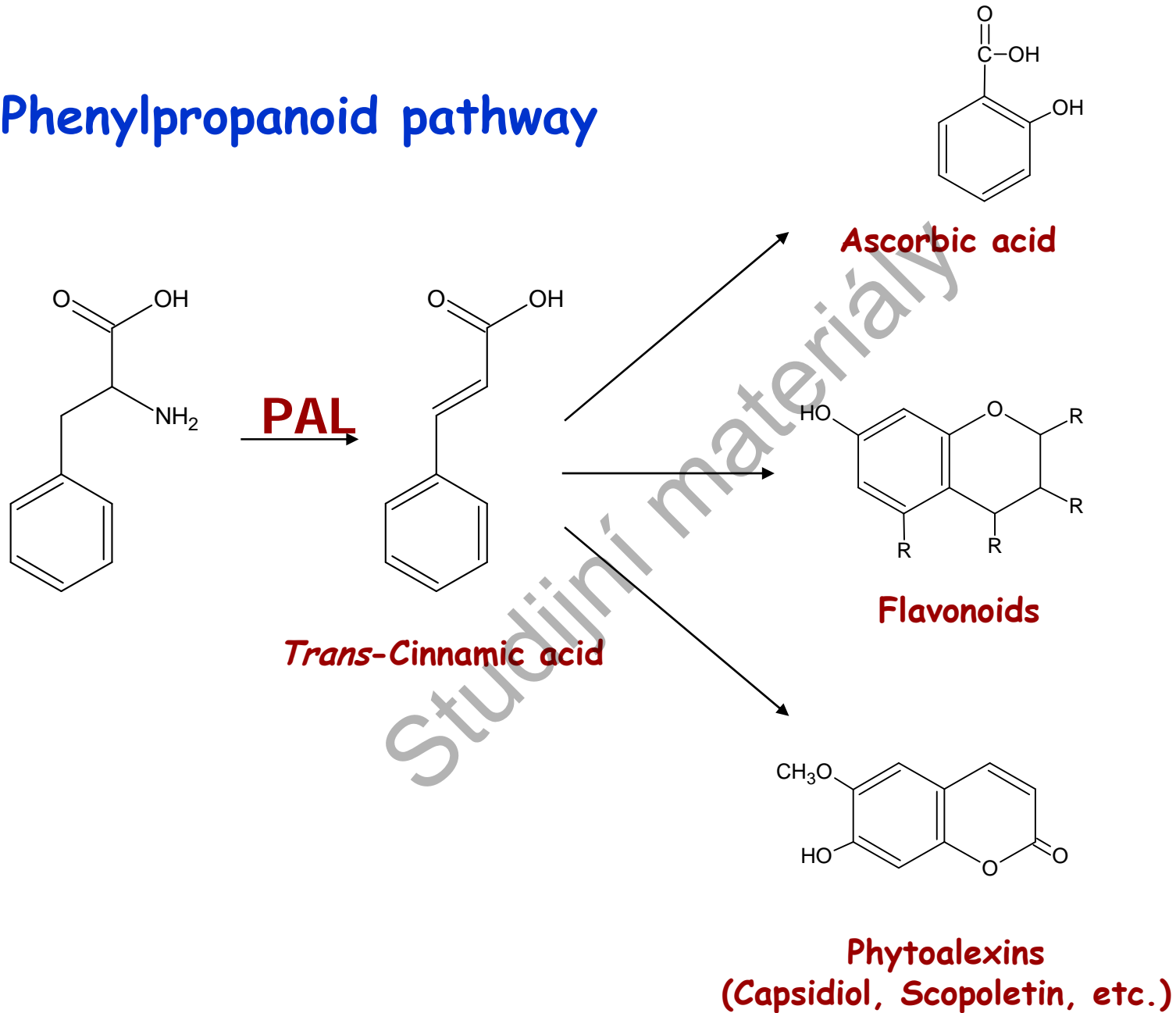
NADPH ox.

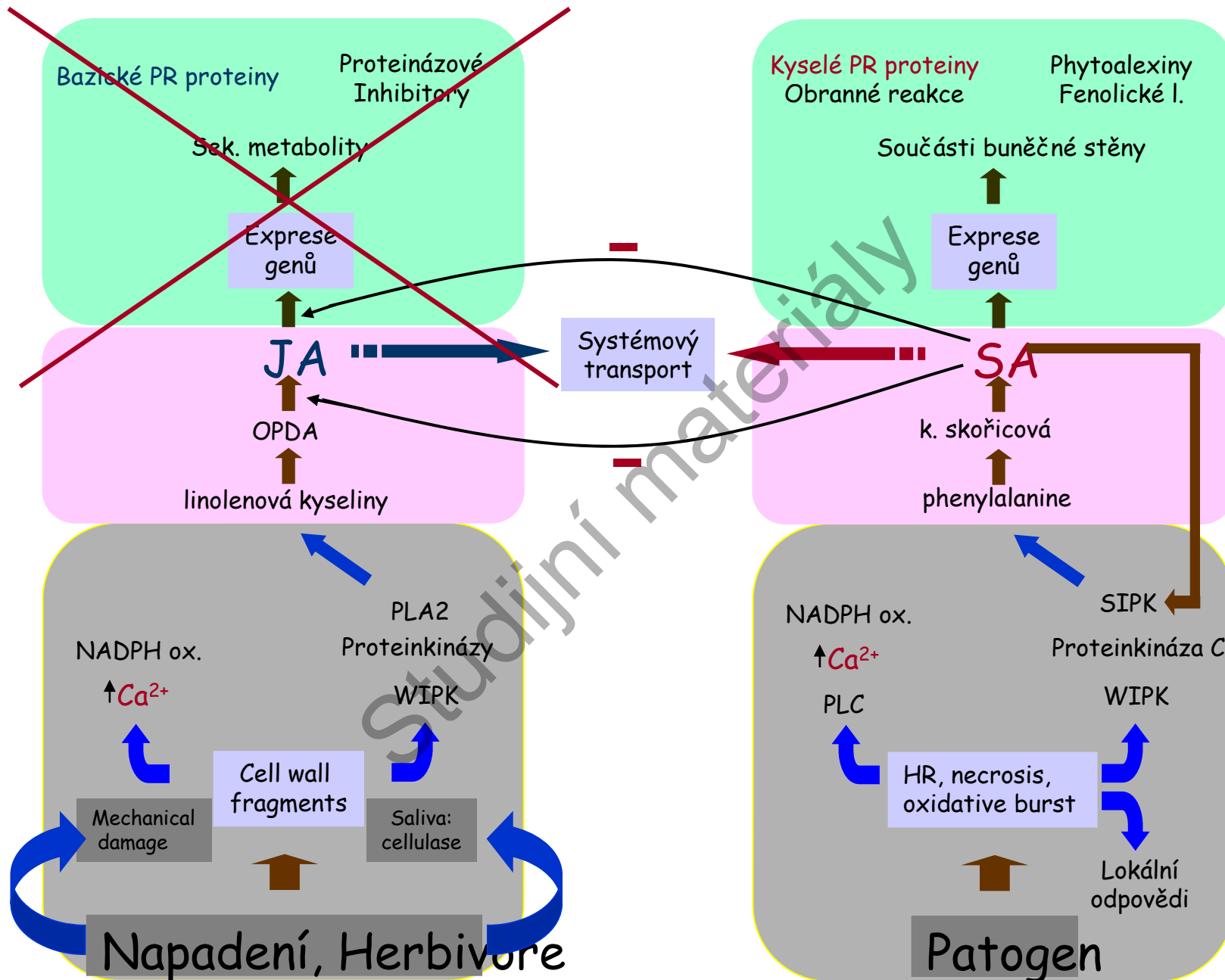


Superoxide radical

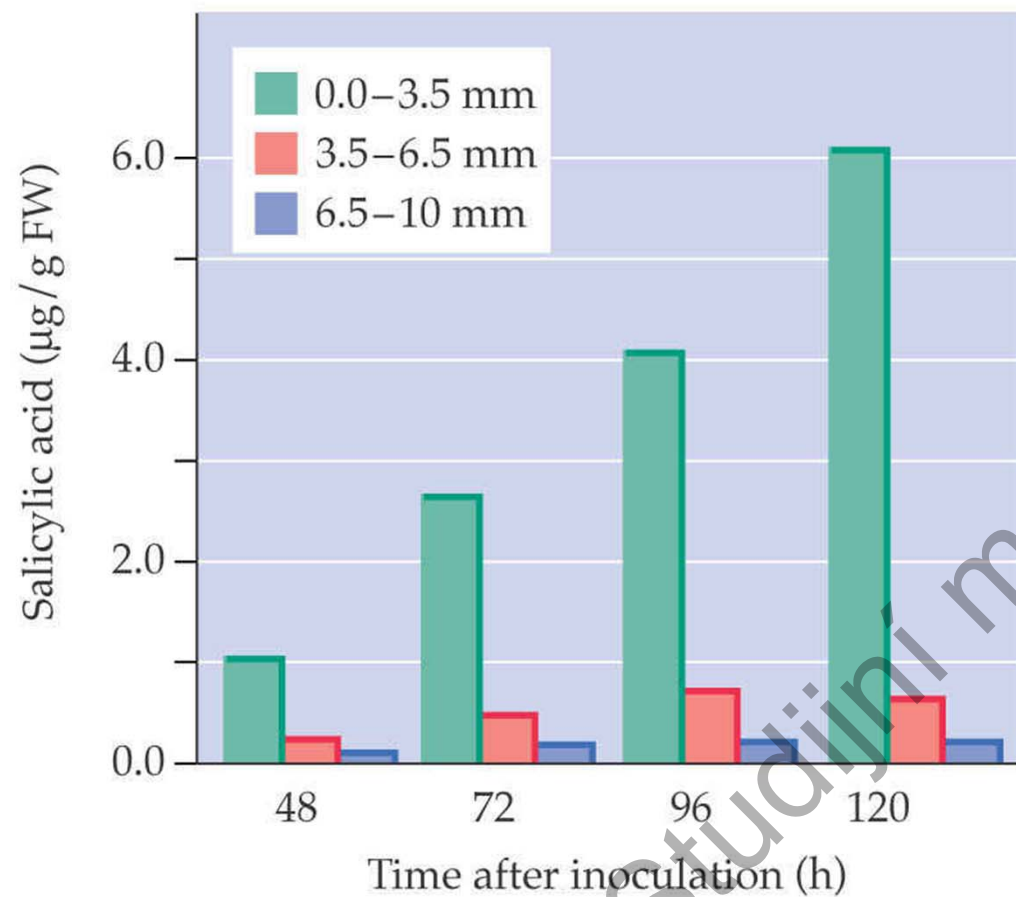
Study material

# Phenylpropanoid pathway





(A)



(B)

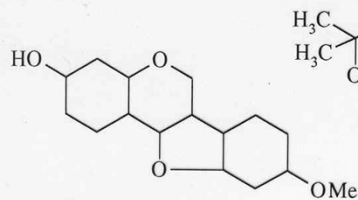


Obsah SA po napadení

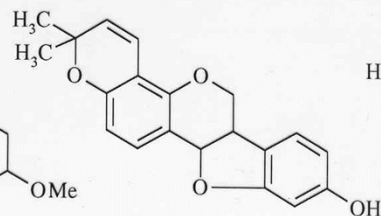
## PR-proteiny

Typ	vlastnosti
PR1a,b tabák	fungicidní
PR2 tabák	1-3 glukanasy
PR3 tabák	chitinasy
PR4 tabák	fungicidní
PR5 tabák	fungicidní
PR6 rajče	inhibitor proteinas
PR7 rajče	proteinas
PR8 okurka	chitinasa
P89 tabák	peroxidas
PR10 ječmen	typ ribonukleasy
PR11 tabák	chitinasa
PR12 defensiny	fungicidní
PR13 thioniny	fungicidní
PR14 lipid transfer prot.	fungicidní

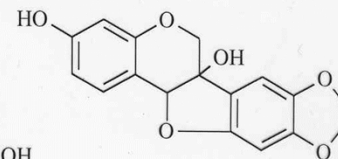
# Fytoalexiny



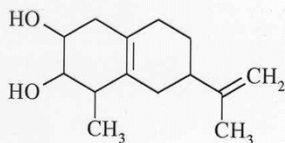
Medicarpin  
(vojtěška)



Glyceolin I  
(soja)

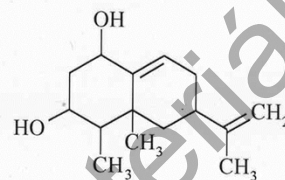


Pisatin  
(hrách)

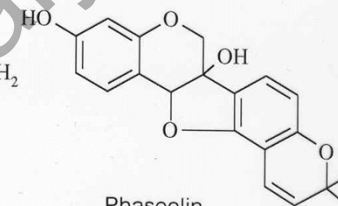


Rishitin  
(rajče, brambory)

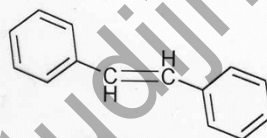
(Solanaceae)



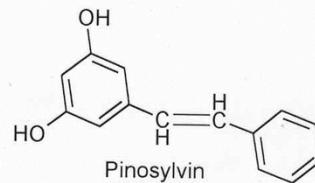
Kapsidiol  
(paprika)



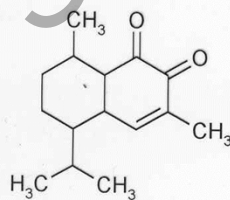
Phaseolin  
(fazole)



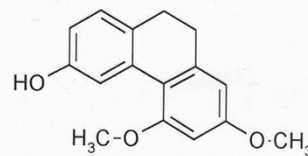
Resveratrol  
vinná réva



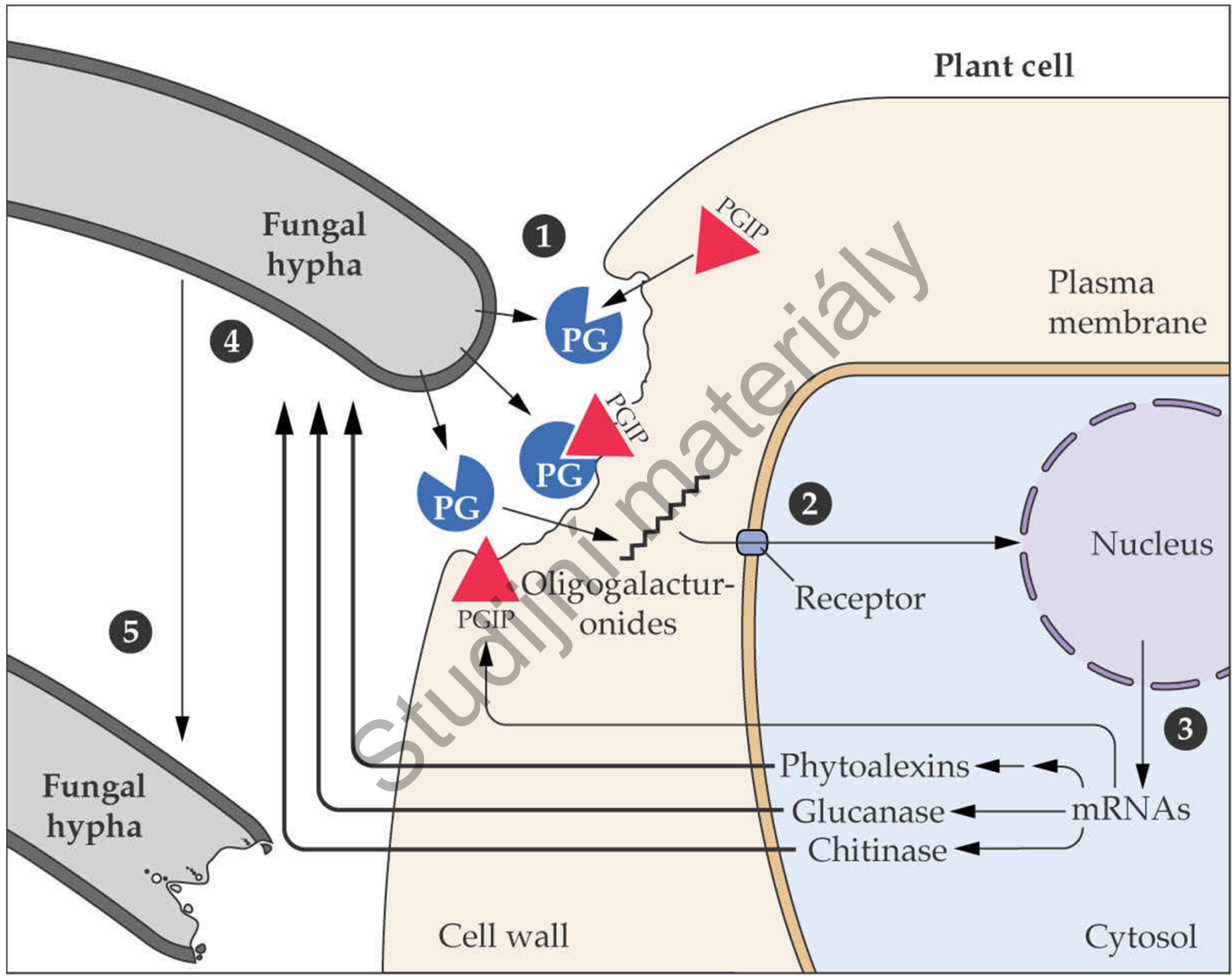
Pinosylvin  
(borovice)



Mansonon A  
(jilm)



Orchinol  
(orchidej)



# Časový sled aktivací při lokální a systémové rezistenci

## Immediate responses of invaded cells

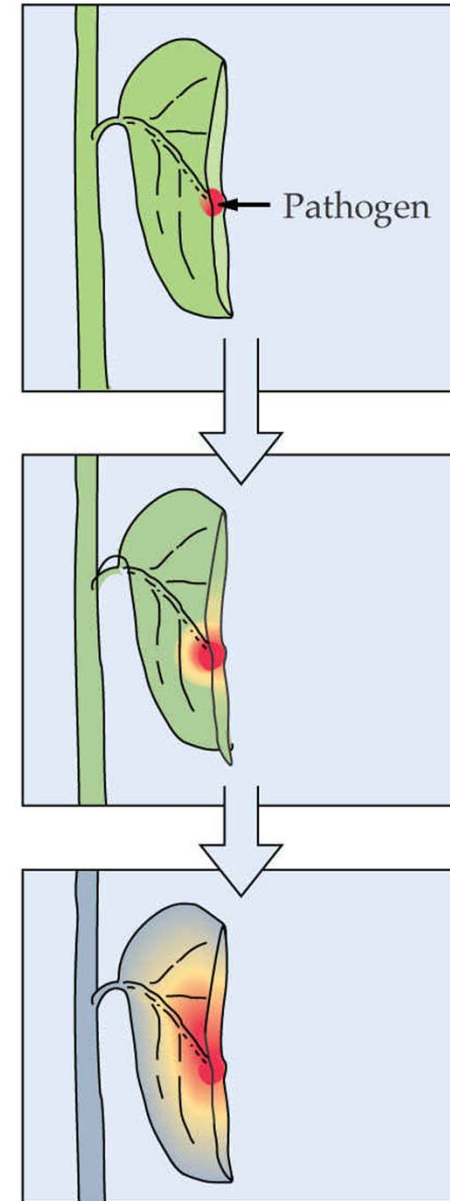
Generation of reactive oxygen species  
Nitric oxide synthesis  
Opening of ion channels  
Protein phosphorylation/ dephosphorylation  
Cytoskeletal rearrangements  
Hypersensitive cell death (HR)  
Gene induction

## Local responses and gene activation

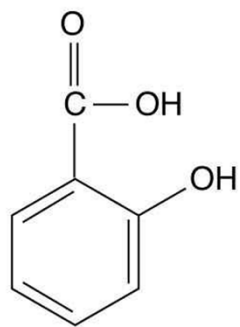
Alterations in secondary metabolic pathways  
Cessation of cell cycle  
Synthesis of pathogenesis-related (PR) proteins  
Accumulation of benzoic and salicylic acid  
Production of ethylene and jasmonic acid  
Fortification of cell walls (lignin, PGIPs, HRGPs)

## Systemic responses and gene activation

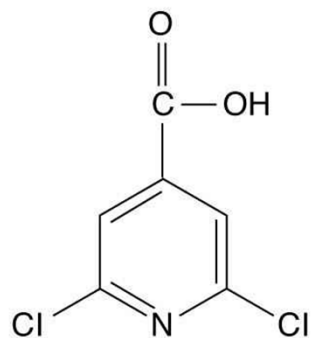
(1→3) $\beta$ -Glucanases  
Chitinases  
Peroxidases  
Synthesis of other PR proteins



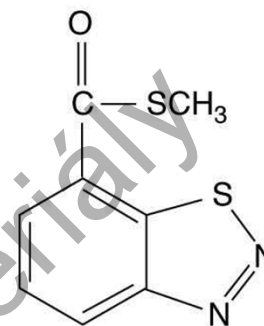




Salicylic acid  
(SA)



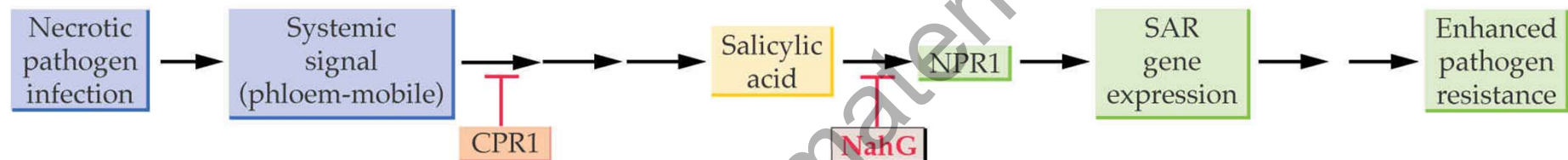
Dichloroisonicotinic acid  
(INA)



Benzo-(1,2,3)-thiadiazole-  
7-carbothionic acid  
S-methylester  
(BTH)

Syntetické látky schopné vyvolat systémovou rezistenci

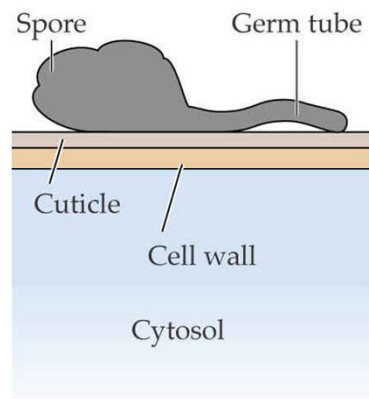
(A)



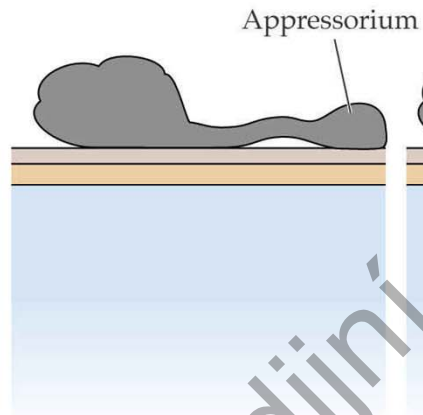
(B)



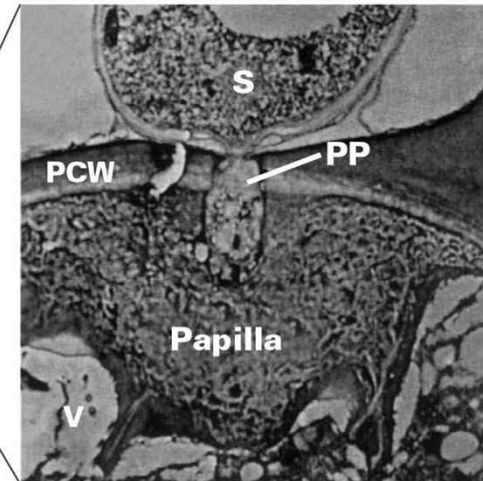
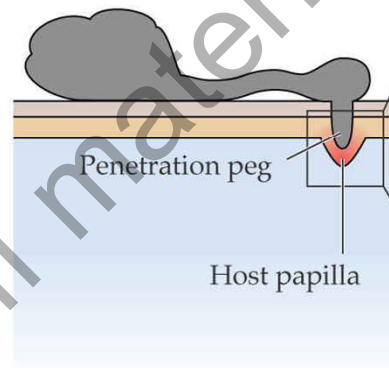
Spore germination



Appressorium formation



Formation of papilla below the penetration peg



Studijní materiály

