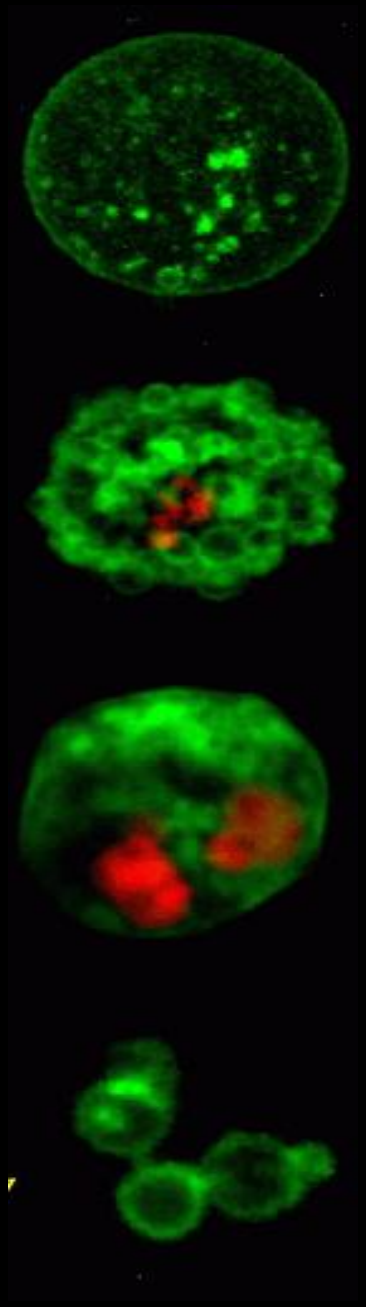
MORTE CELULAR
28/05/2020

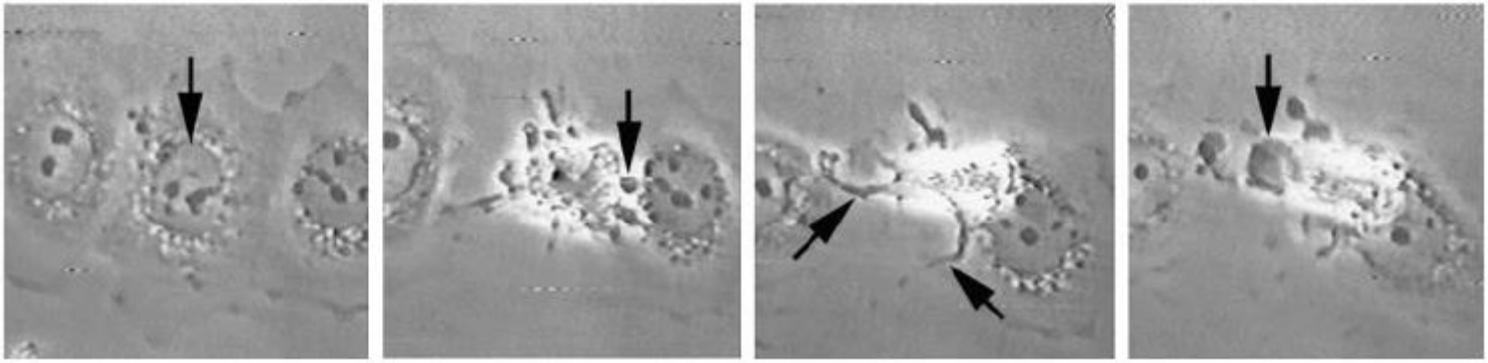


Morte Celular

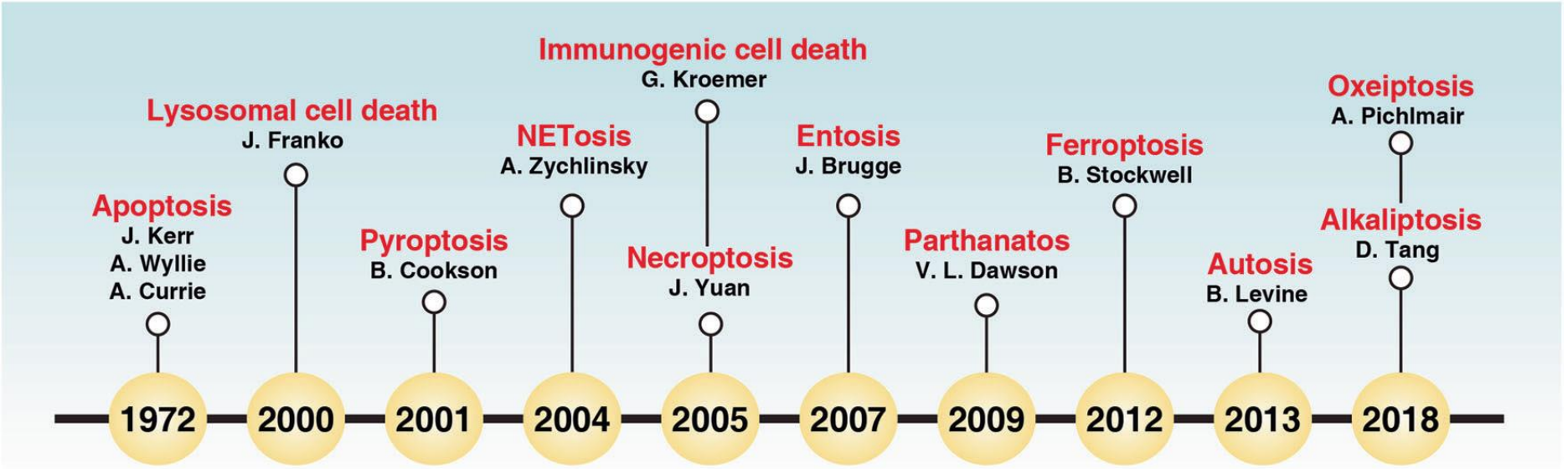
- ✓ Carl Vogt em 1842
- ✓ 1972: Kerr, Wyllie e Currie – apoptose

Kerr et al. Apoptosis: a basic phenomenon with wide-ranging implications in tissue kinetics. Br. J. Cancer 26: 239-257, 1972.

- ✓ apoptose = *falling off* (folhas caindo de uma árvore)



Diferentes nomes para morte celular



2005 - Nomenclature Committee on Cell Death - NCCD

2005

Cell Death and Differentiation (2005) 12, 1463–1467
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www.nature.com/cdd

News and Commentary

Classification of cell death: recommendations of the Nomenclature Committee on Cell Death

G Kroemer*,[1], WS El-Deiry[2], P Golstein[3], ME Peter[4], D Vaux[5], P Vandenabeele[6], B Zhivotovsky[7], MV Blagosklonny[8], W Malorni[9], RA Knight[10], M Piacentini[11], S Nagata[12] and G Melino[10,13]

with or without, caspase activation and that 'autophagic cell death' represents a type of cell death with (but not necessarily through) autophagic vacuolization. This article details the 2005 recommendations of NCCD. Over time, molecular definitions are expected to emerge for those forms of cell death that remain descriptive.

2009

Cell Death and Differentiation (2009) 16, 3–11
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www.nature.com/cdd

Review

Classification of cell death: recommendations of the Nomenclature Committee on Cell Death 2009

G Kroemer*,[1,2,3], L Galluzzi[1,2,3], P Vandenabeele[4,5], J Abrams[6], ES Alnemri[7], EH Baehrecke[8], MV Blagosklonny[9], WS El-Deiry[10], P Golstein[11,12,13], DR Green[14], M Hengartner[15], RA Knight[16], S Kumar[17], SA Lipton[18,19,20], W Malorni[21], G Nuñez[22], ME Peter[23], J Tschopp[24], J Yuan[25], M Piacentini[26,27], B Zhivotovsky[28] and G Melino[29,30]

2012

Cell Death and Differentiation (2012) 19, 107–120
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www.nature.com/cdd

Review

Molecular definitions of cell death subroutines: recommendations of the Nomenclature Committee on Cell Death 2012

L Galluzzi[1,2,3], I Vitale[1,2,3], JM Abrams[4], ES Alnemri[5], EH Baehrecke[6], MV Blagosklonny[7], TM Dawson[8], VL Dawson[8], WS El-Deiry[9], S Fulda[10], E Gottlieb[11], DR Green[12], MO Hengartner[13], O Kepp[1,2,3], RA Knight[14], S Kumar[15,16], SA Lipton[17,18,19,20], X Lu[21], F Madeo[22], W Malorni[23,24], P Mehlen[25,26,27,28], G Nuñez[29], ME Peter[30], M Piacentini[31,32], DC Rubinsztein[33], Y Shi[34], H-U Simon[35], P Vandenabeele[36,37], E White[38], J Yuan[39], B Zhivotovsky[40], G Melino[41,42] and G Kroemer*,[1,43,44,45,46]

2015

Cell Death and Differentiation (2015) 22, 58–73
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www.nature.com/cdd

OPEN

Review

Essential *versus* accessory aspects of cell death: recommendations of the NCCD 2015

L Galluzzi*[,1,2,3,126], JM Bravo-San Pedro[1,2,4], I Vitale[5], SA Aaronson[6], JM Abrams[7], D Adam[8], ES Alnemri[9], L Altucci[10], D Andrews[11], M Annicchiarico-Petruzzelli[12], EH Baehrecke[13], NG Bazan[14], MJ Bertrand[15,16], K Bianchi[17,18], MV Blagosklonny[19], K Blomgren[20], C Borner[21], DE Bredesen[22,23], C Brenner[24,25,26], M Campanella[27], E Candi[28], F Cecconi[29,30,31], FK Chan[32], NS Chandel[33], EH Cheng[34], JE Chipuk[6], JA Cidlowski[35], A Ciechanover[36], TM Dawson[37,38], VL Dawson[37,38], V De Laurenzi[39], R De Maria[5], K-M Debatin[40], N Di Daniele[41], VM Dixit[42], BD Dynlacht[43], WS El-Deiry[44], GM Fimia[45,46], RA Flavell[47], S Fulda[48], C Garrido[49,50], M-L Gougeon[51], DR Green[52], H Gronemeyer[53], G Hajnoczky[54], JM Hardwick[55], MO Hengartner[56], H Ichijo[57], B Joseph[58], PJ Jost[59], T Kaufmann[60], O Kepp[2,4,61], DJ Klionsky[62], RA Knight[63,64], S Kumar[65,66], JJ Lemasters[67], B Levine[68,69], A Linkermann[70], SA Lipton[71,72,73,74], RA Lockshin[75], C López-Otín[76], E Lugli[77], F Madeo[78], W Malorni[79,80], J-C Marine[81,82], SJ Martin[83], J-C Martinou[84], JP Medema[85], P Meier[86], S Melino[87], N Mizushima[88], U Moll[89], C Muñoz-Pinedo[90], G Nuñez[91], A Oberst[92], T Panaretakis[58], JM Penninger[93], ME Peter[94], M Piacentini[30,46], P Pinton[95], JH Prehn[96], H Puthalakath[97], GA Rabinovich[98], KS Ravichandran[99], R Rizzuto[100], CM Rodrigues[101], DC Rubinsztein[102], T Rudel[103], Y Shi[104], H-U Simon[105], BR Stockwell[69,106], G Szabadkai[100,107], SW Tait[108,109], HL Tang[55], N Tavernarakis[110,111], Y Tsujimoto[112], T Vanden Berghe[15,16], P Vandenabeele[15,16,113], A Villunger[114], EF Wagner[115], H Walczak[116], E White[117], WG Wood[118,119], J Yuan[120], Z Zakeri[121,122], B Zhivotovsky[123,124], G Melino[28,64] and G Kroemer*[,2,3,4,61,125,126]

2018

Cell Death & Differentiation
https://doi.org/10.1038/s41418-017-0012-4

Cell Death & Differentiation

REVIEW

Check for updates

Molecular mechanisms of cell death: recommendations of the Nomenclature Committee on Cell Death 2018

Lorenzo Galluzzi[1,2,3] · Ilio Vitale[4,5] et al.

Received: 11 October 2017 / Accepted: 13 October 2017
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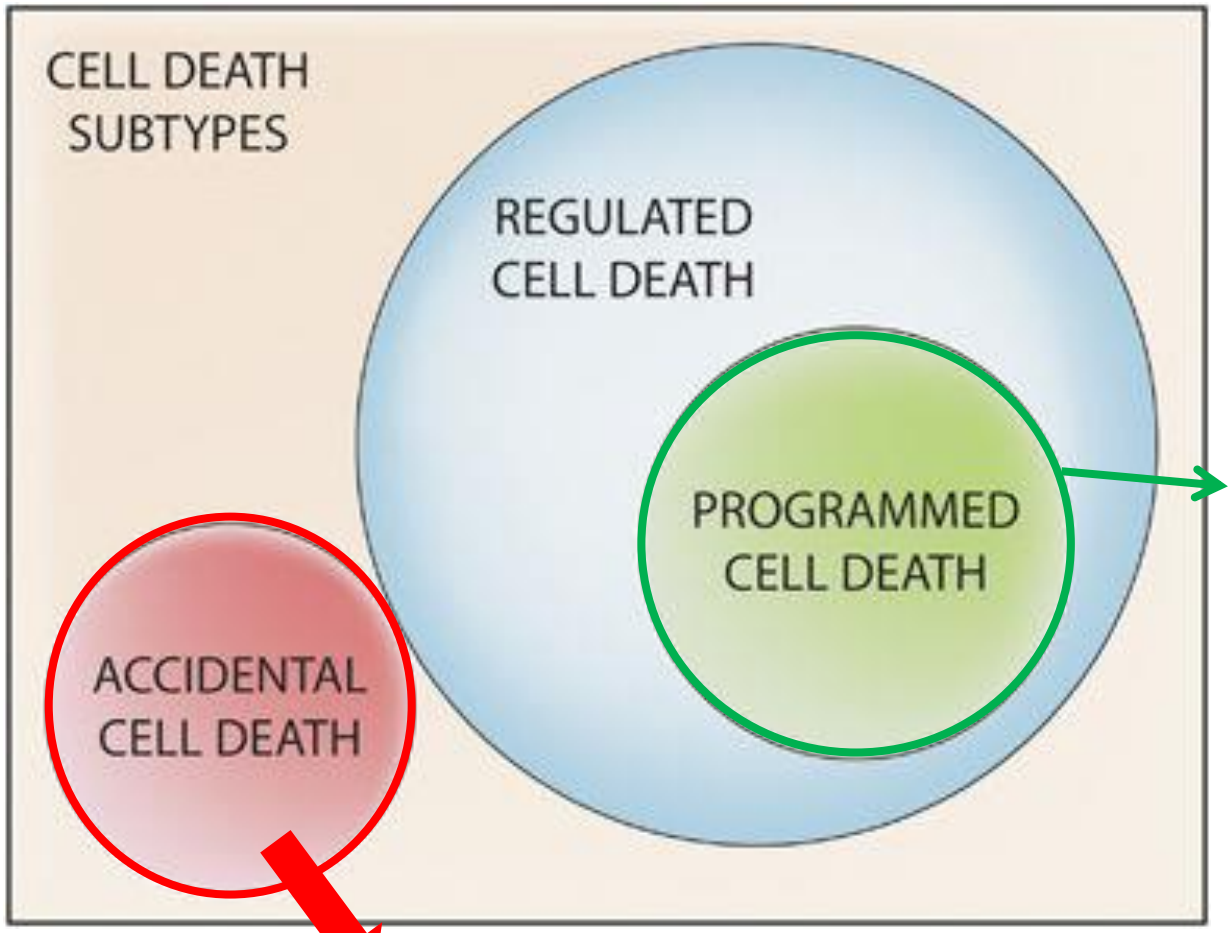


FISIOLÓGICA

INSULTO EXTREMO

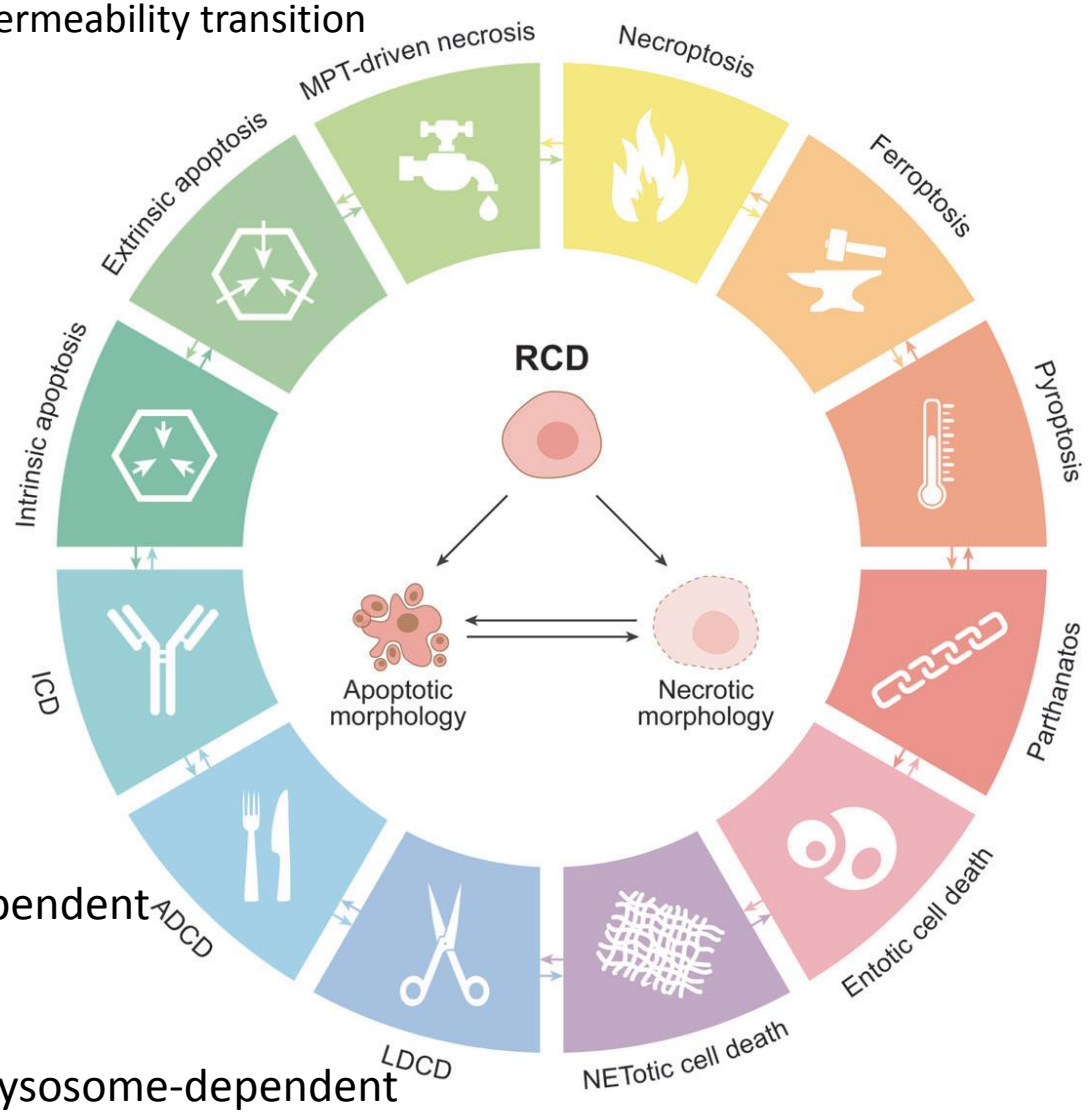
- **mecânico, térmico, químico**
- **Inevitável e irreversível**
- **Não depende de uma 'maquinaria' molecular**

Essential *versus* accessory aspects of cell death: recommendations of the NCCD 2015

http://www.nature.com/cdd/journal/v22/n1/full/cdd2014137a.html?foxtrotcallback=true

Principais tipos de morte celular, de acordo com o NCCD 2018 :

mitochondrial permeability transition



Immunogenic cell death

autophagy-dependent cell death

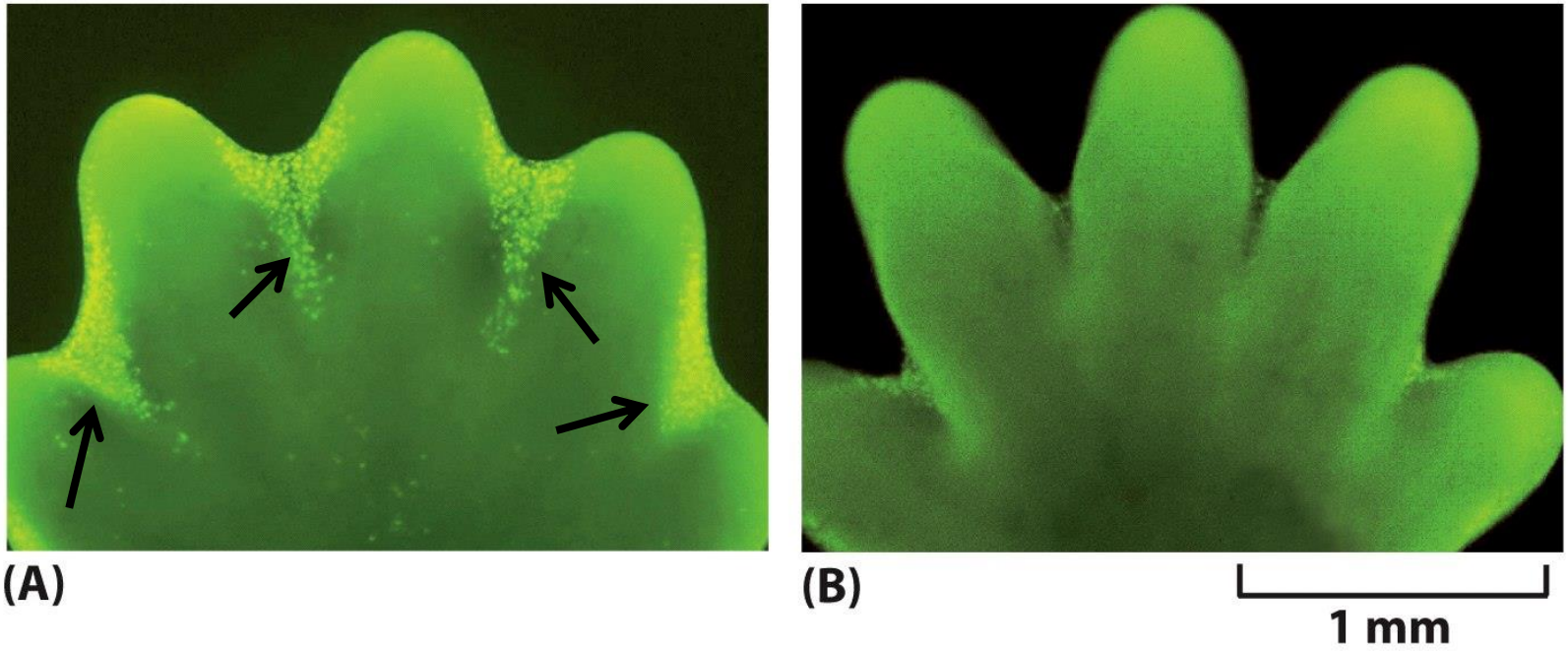
lysosome-dependent cell death

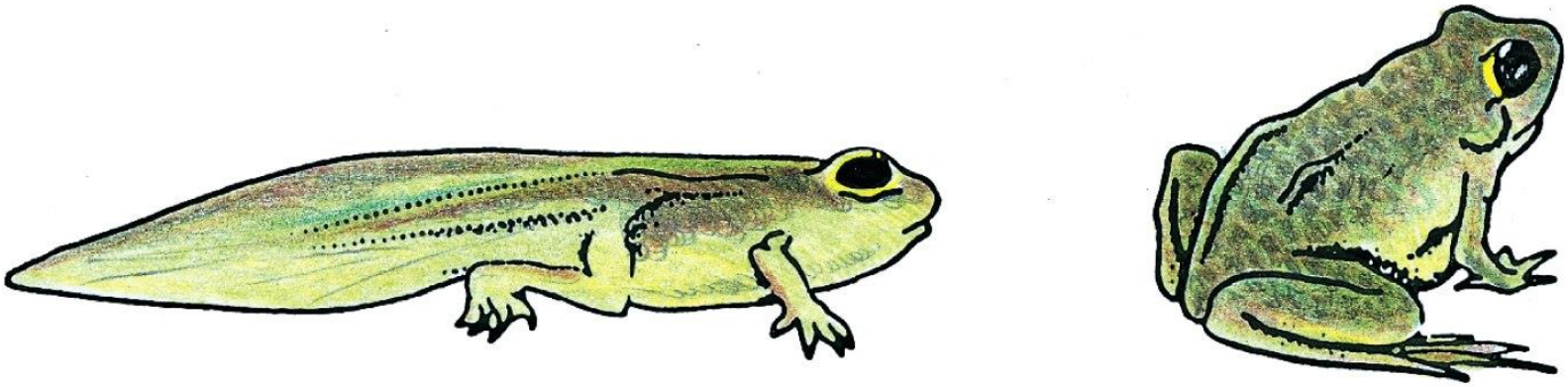
https://www.nature.com/articles/s41418-017-0012-4

Morte Celular Programada (*PCD*)

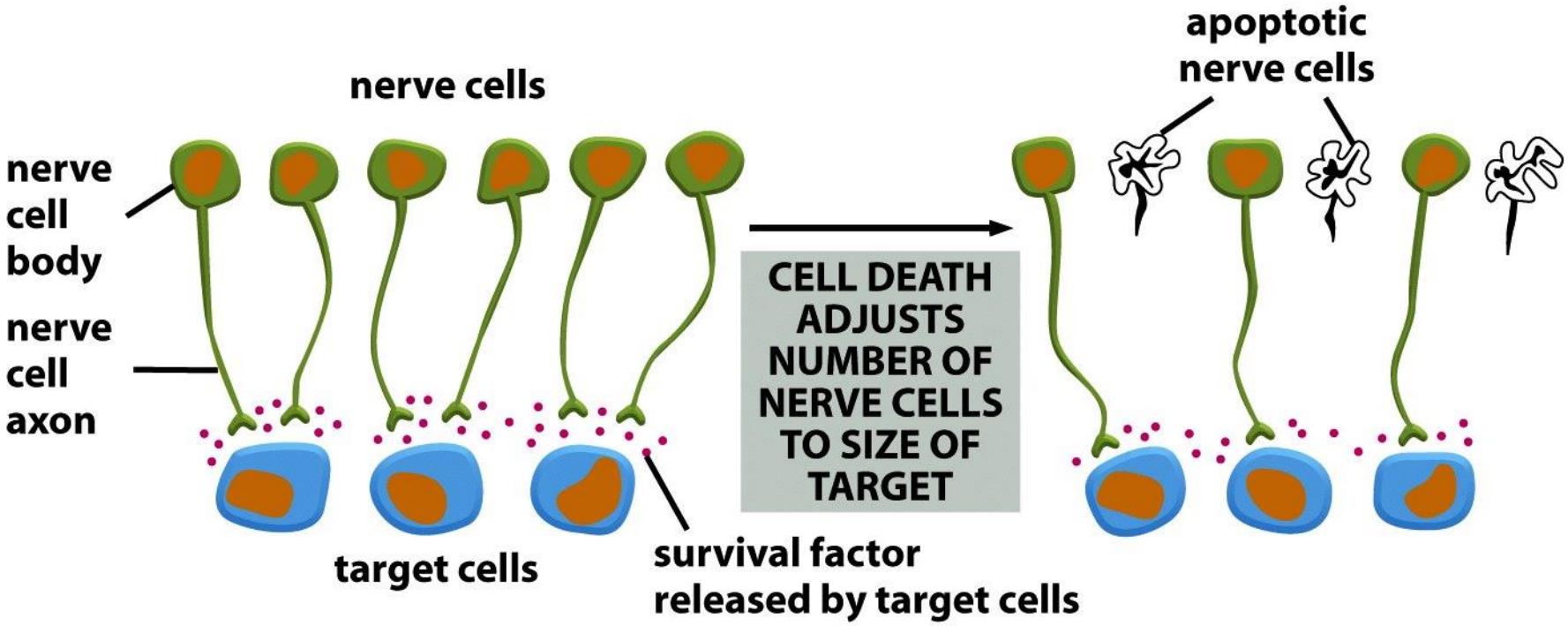
- Forma particular de morte celular regulada que ocorre em situações fisiológicas.
- NÃO ocorre em decorrência de perturbações da homeostase.

Morte celular no desenvolvimento





Morte celular no desenvolvimento



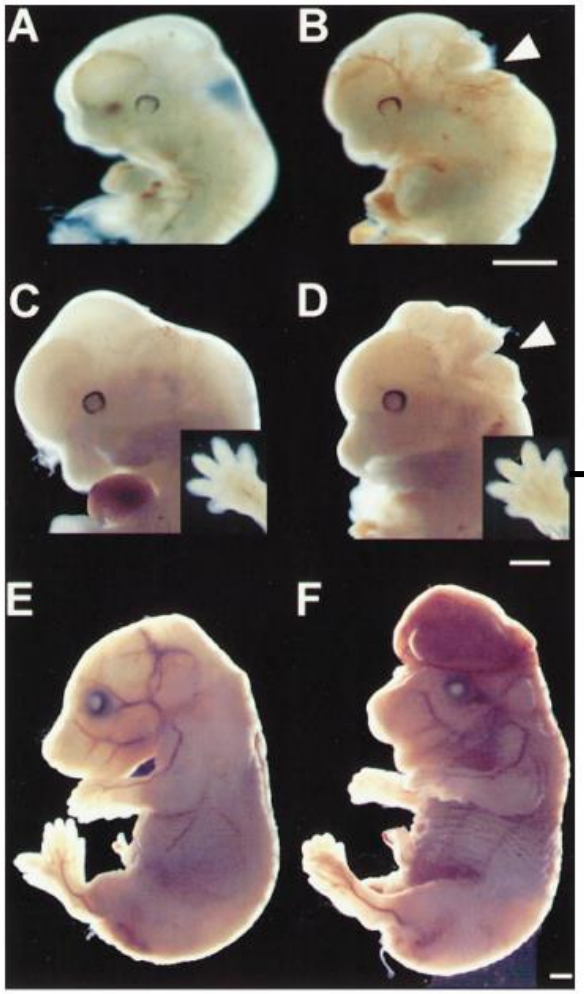
camundongos selvagens

camundongos deficientes em caspase-9

E10,5

E13,5

E16,5

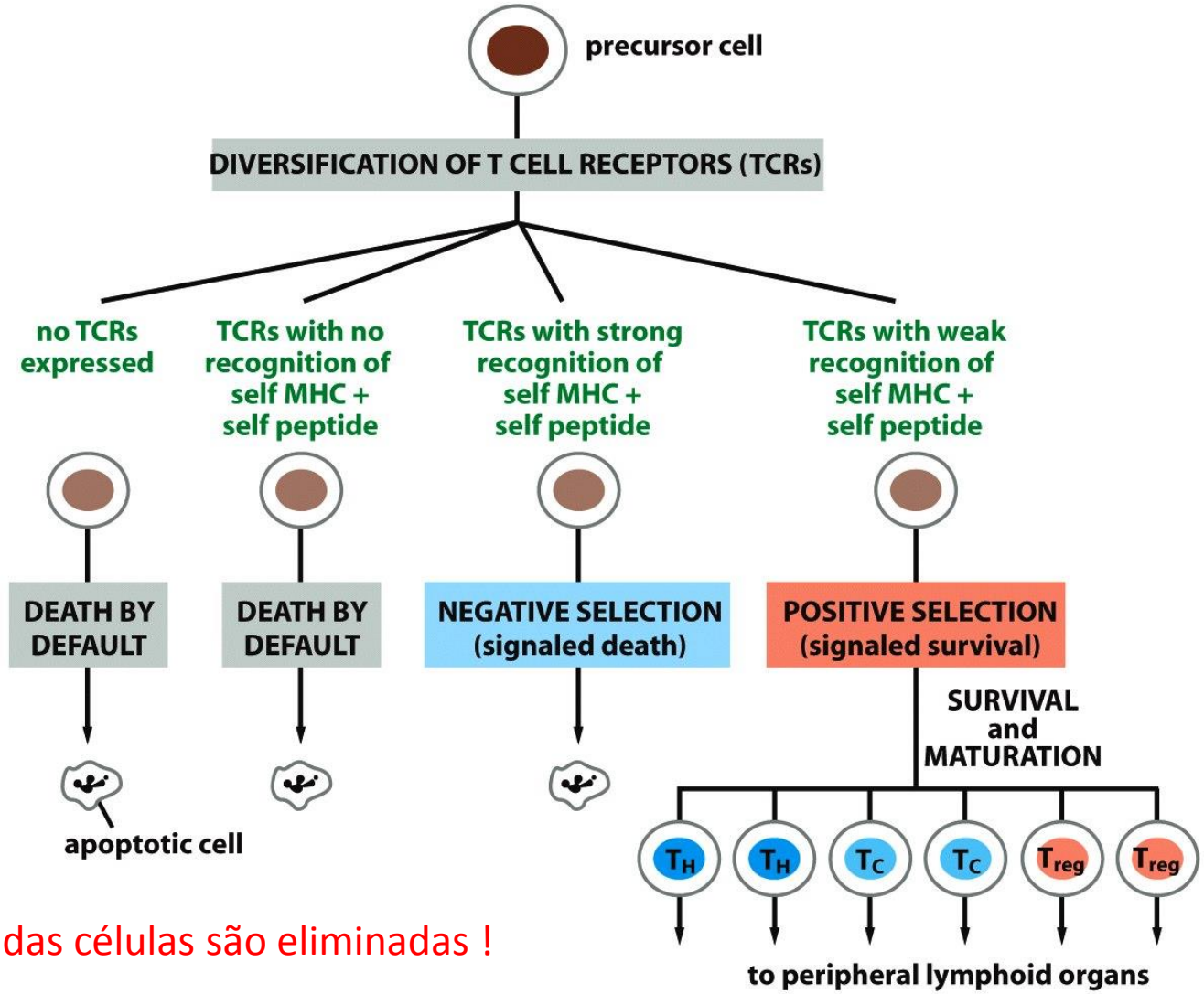


membranas interdigitais não diferem

Kuida K et al, 1998. Reduced Apoptosis and Cytochrome c–Mediated Caspase Activation in Mice Lacking Caspase 9.Cell, 94: 325–337

Morte celular no “controle de qualidade” de células do sistema imune

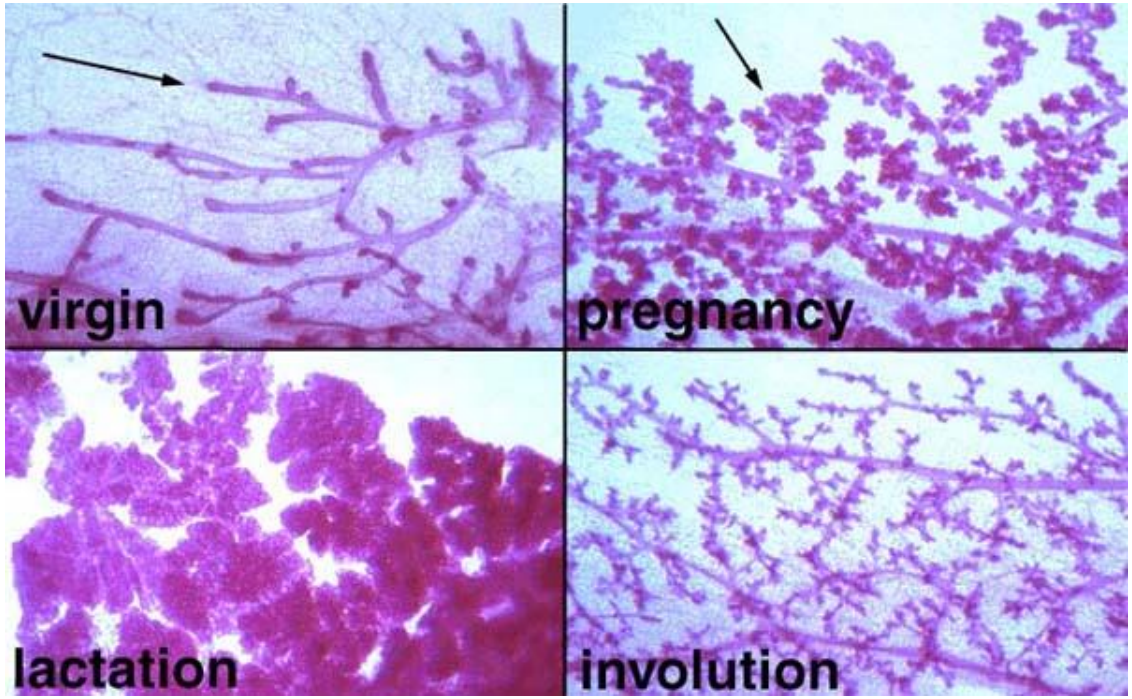
(eliminação de células T autoreativas)

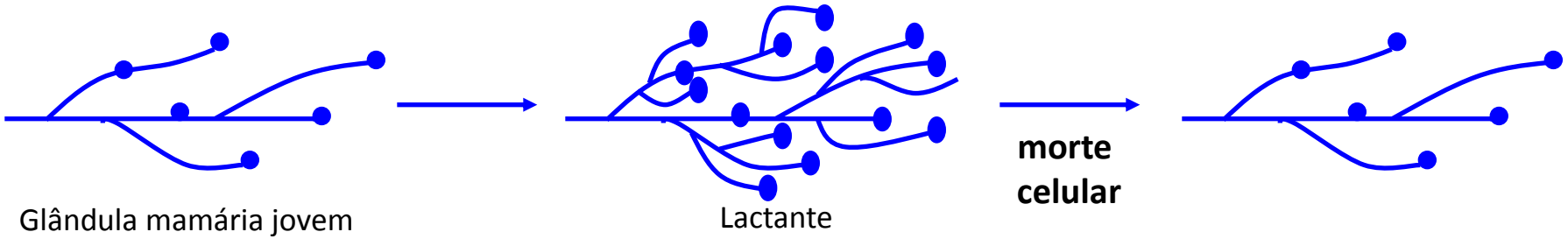


95% das células são eliminadas !

Figure 25-64 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Controle do tamanho dos orgãos e eliminação de células que não são mais necessárias:



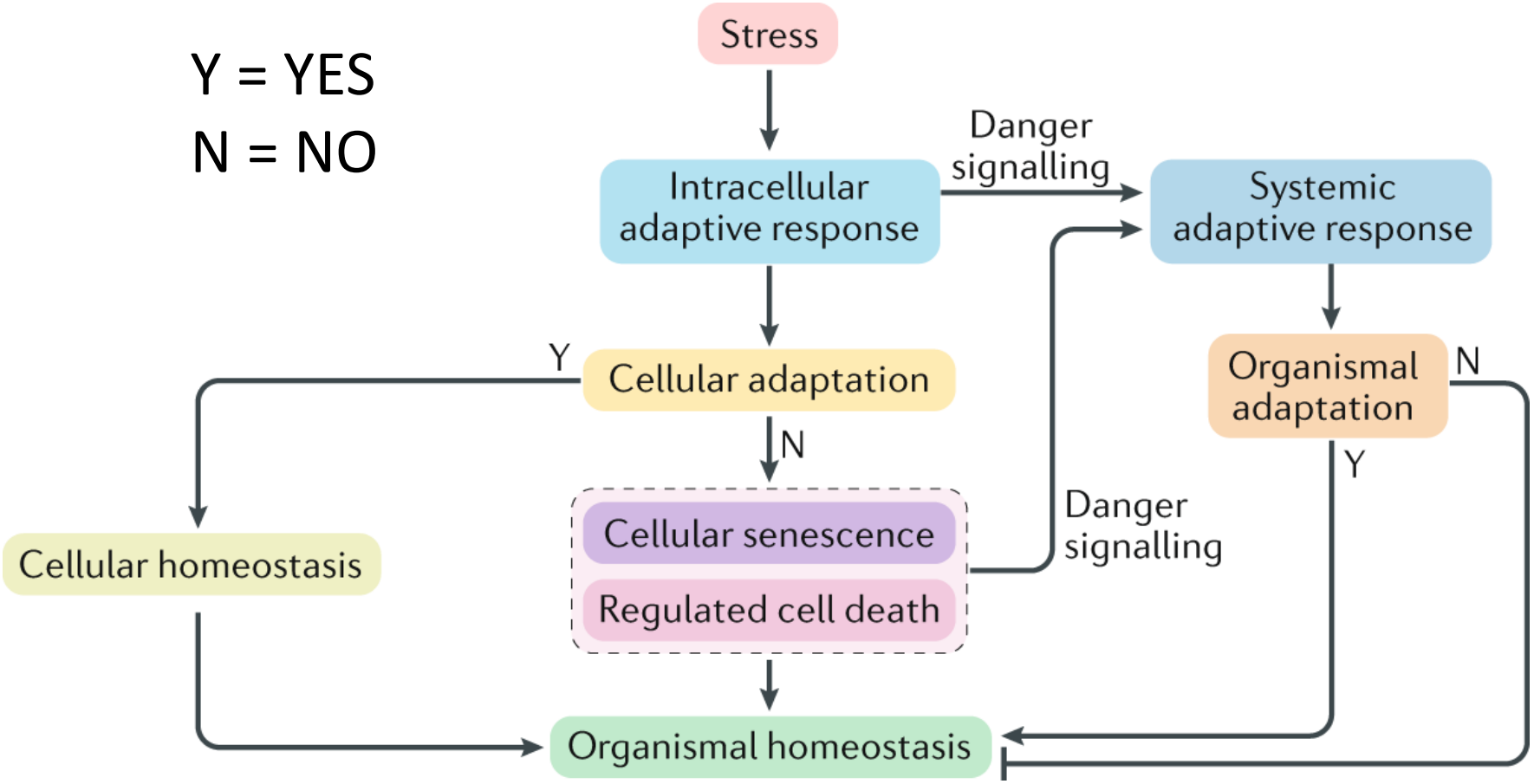


Nessa aula

- Apoptose
- Autofagia
- Necroptose

Y = YES

N = NO



Lorenzo Galluzzi L, Yamazaki T & Kroemer G, 2016. Linking cellular stress responses to systemic homeostasis. Nat Rev Mol Cel Biol, 19: 731-745

apoptose

Células encolhem
Colapso do citoesqueleto
Rompimento do envelope nuclear
Fragmentação da cromatina
Formação dos corpos apoptóticos
Células apoptóticas são fagocitadas (B)

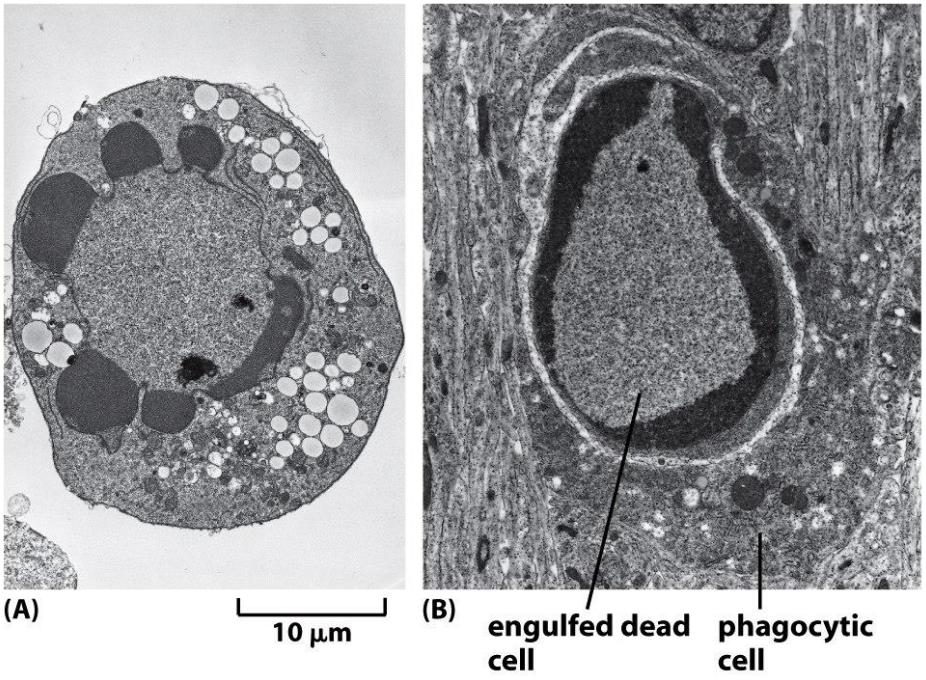


Figure 18-1 Molecular Biology of the Cell 5/e (© Garland Science 2008)

linfócito

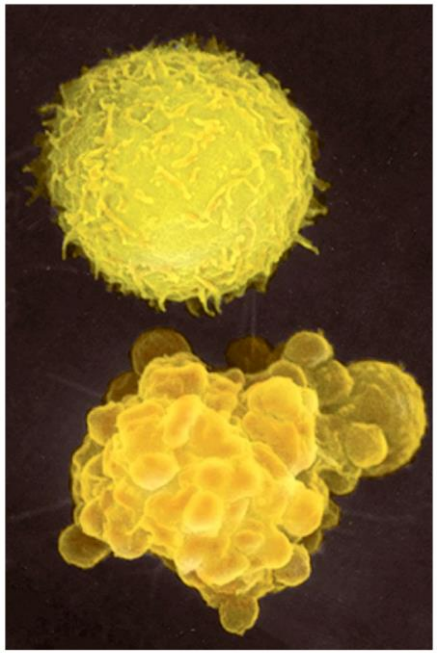


Figure 9-18a The Biology of Cancer (© Garland Science 2007)

Células HeLa

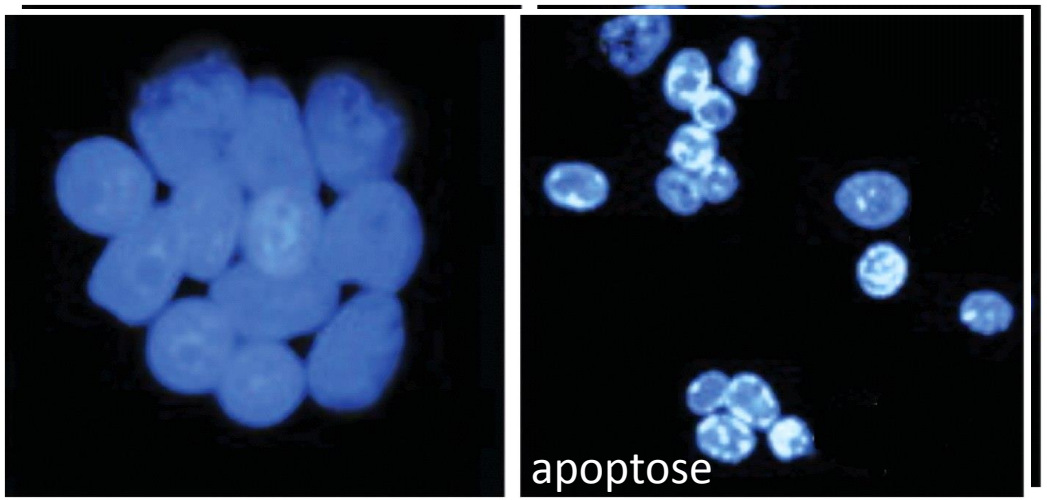


Figure 9-18b The Biology of Cancer (© Garland Science 2007)

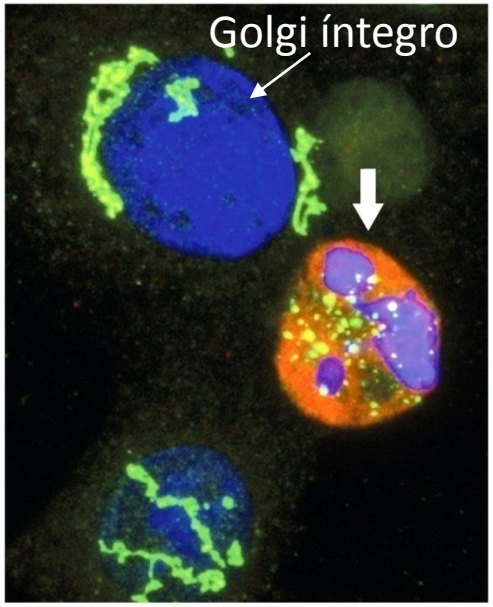


Figure 9-18d The Biology of Cancer (© Garland Science 2007)

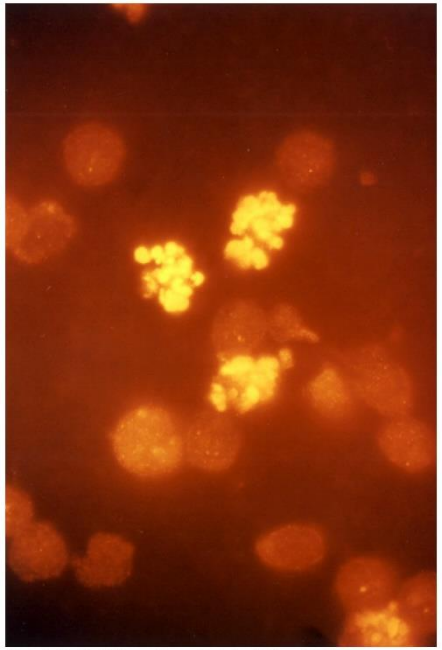


Figure 9-18e The Biology of Cancer (© Garland Science 2007)

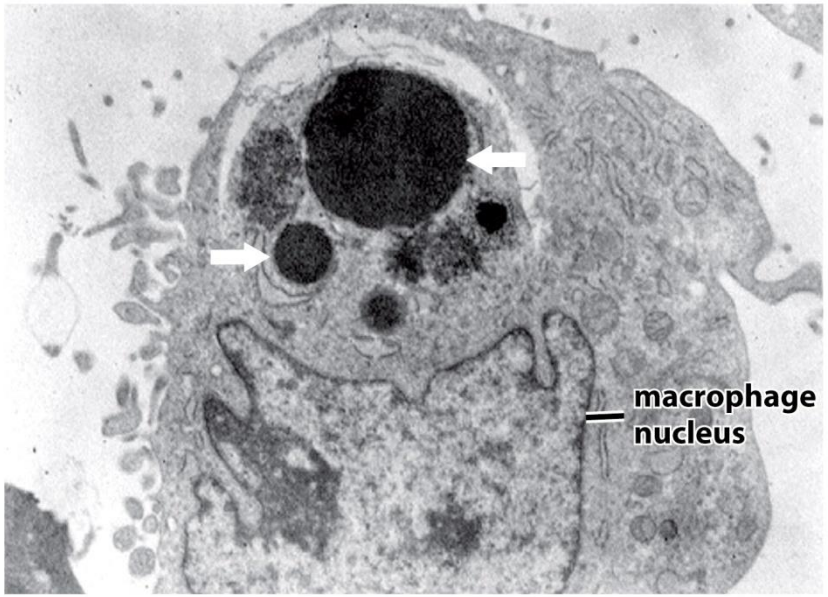
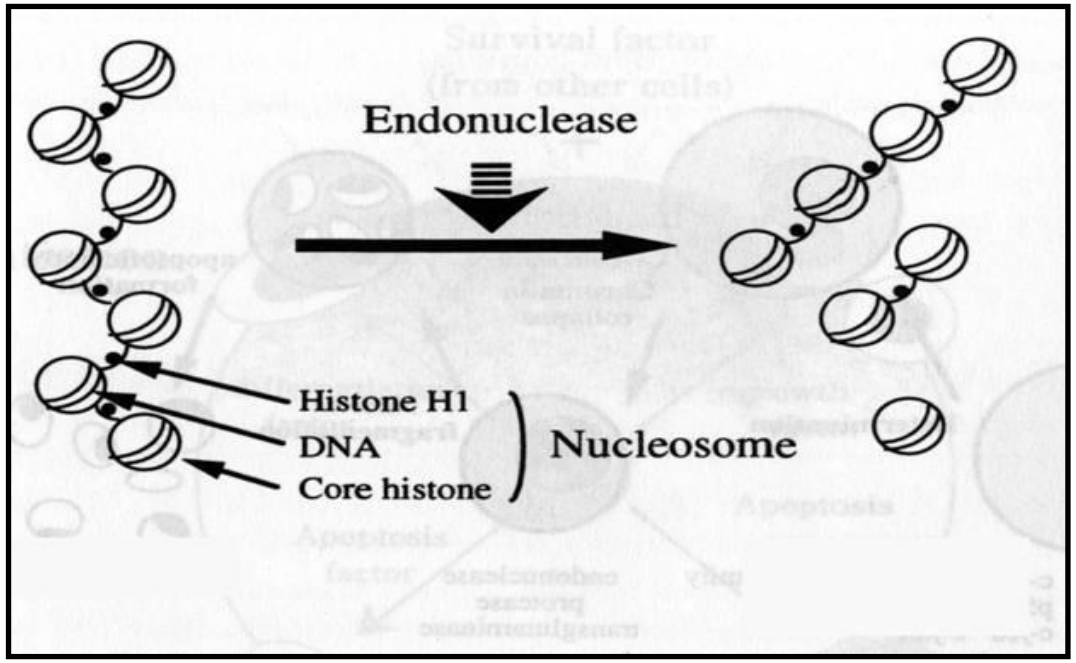
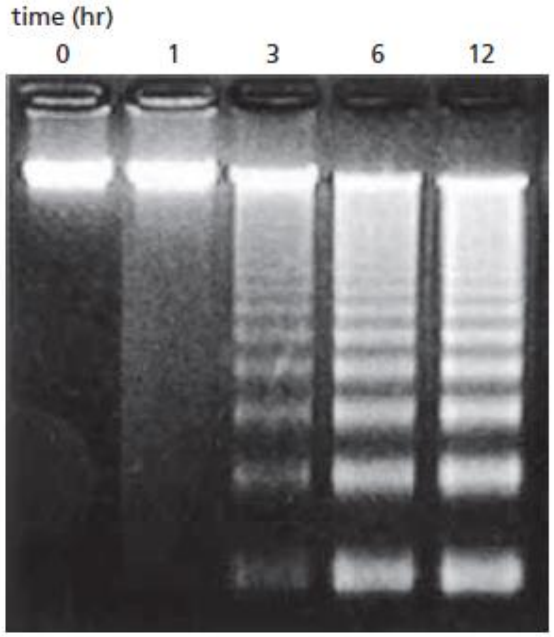


Figure 9-18f The Biology of Cancer (© Garland Science 2007)

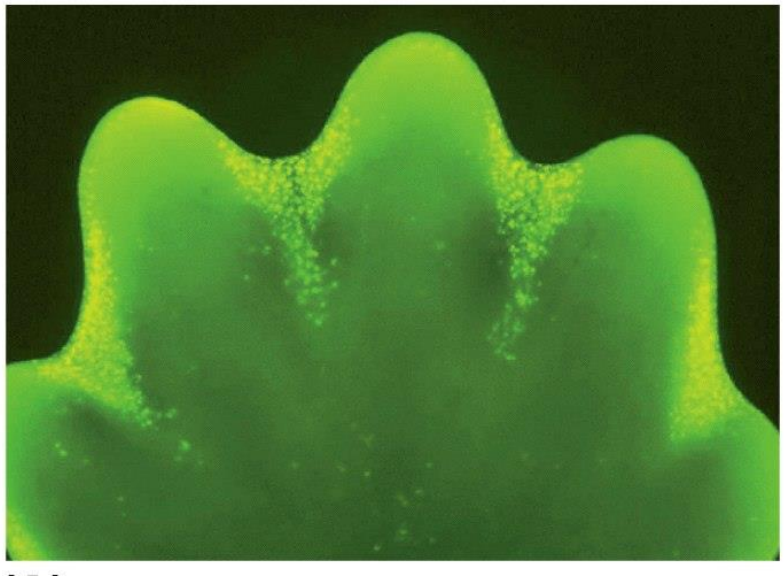
Como as células apoptóticas são experimentalmente detectas?

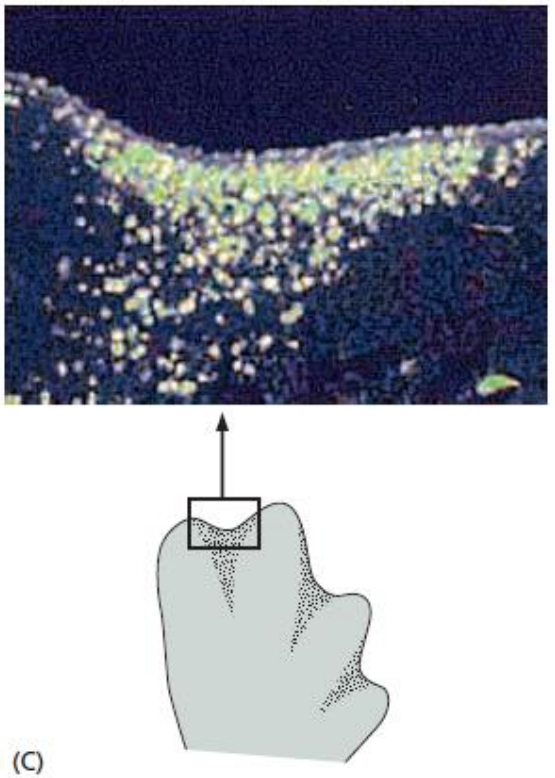
“escada” de DNA em gel de eletroforese





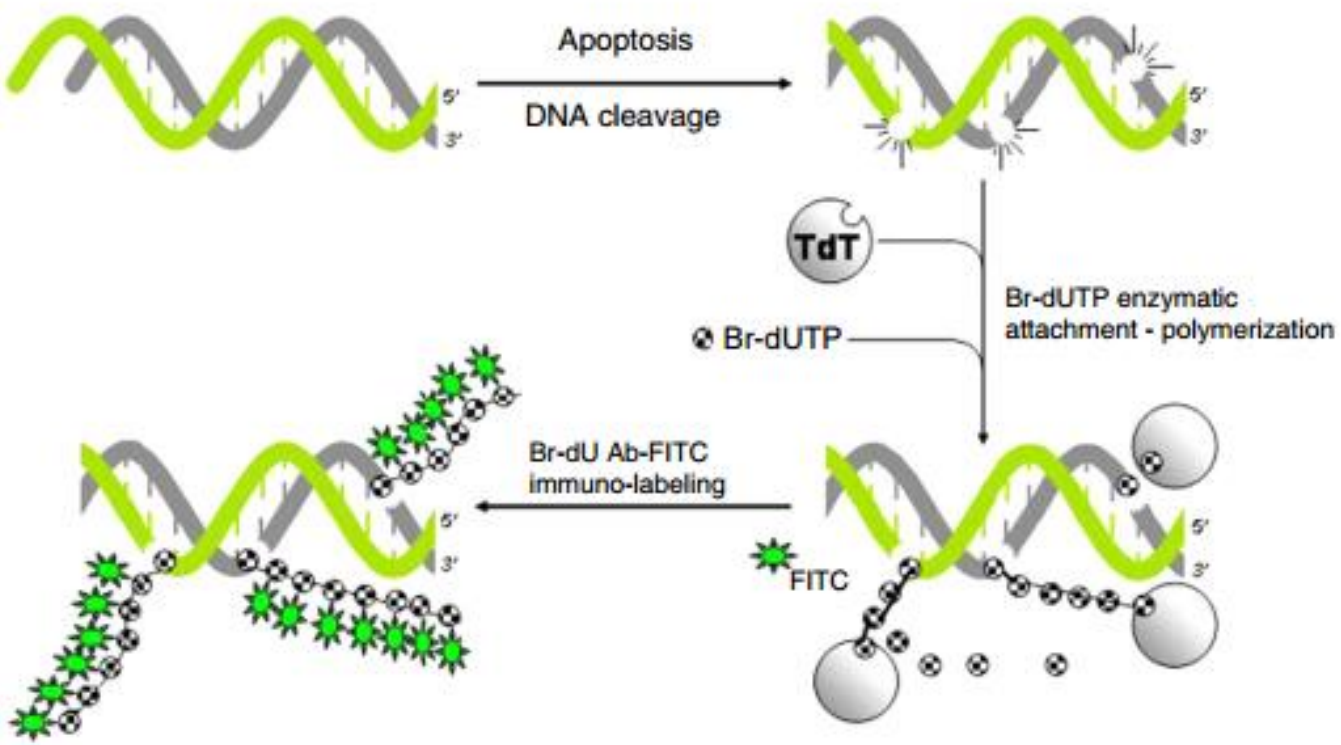
TdT-mediated dUTP nick end labeling (TUNEL)



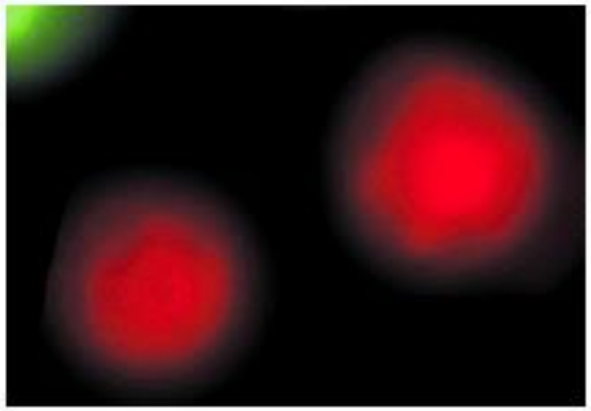


TdT-mediated dUTP nick end labeling (TUNEL)

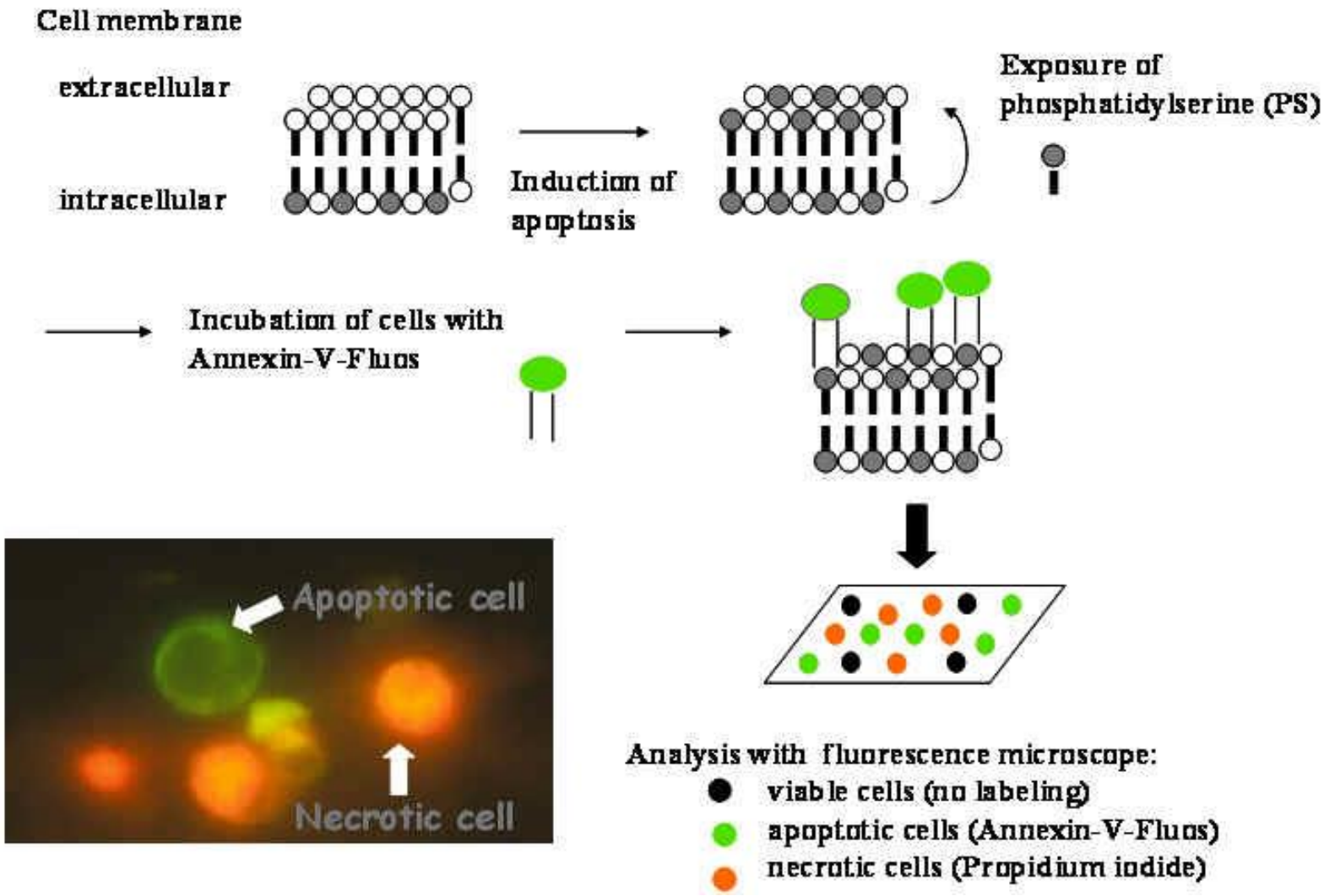
TdT = terminal desoxinucleotidil transferase



Permeabilidade da membrana



Exposição de fosfatidilserina na superfície da célula (detecção precoce da apoptose)



Caspases

(**C**ysteine-**A**spartate-**S**pecific **P**rote**ASES)**

- Enzimas responsáveis pela proteólise intracelular da apoptose

- Milhares de substratos, a maioria é desconhecido

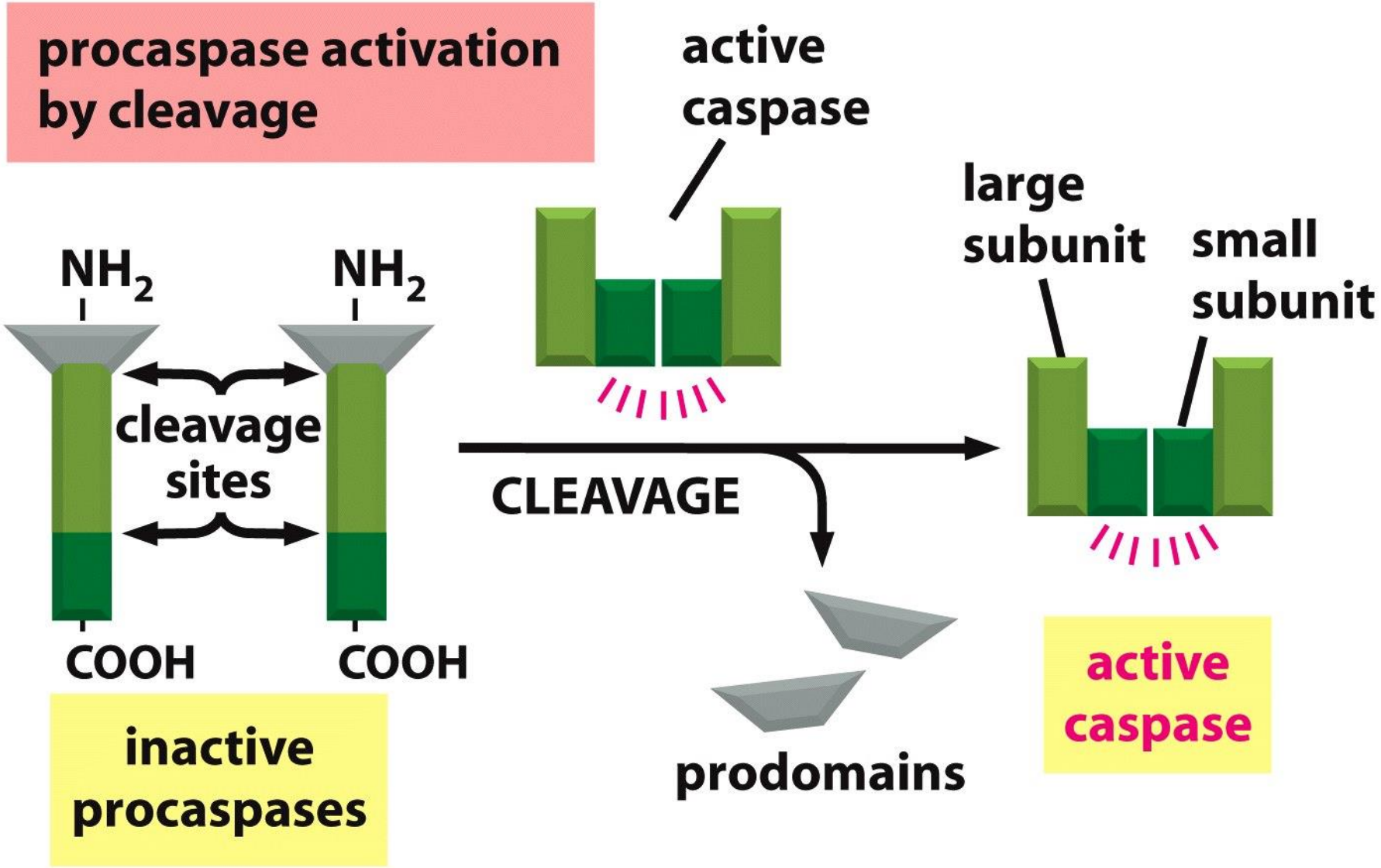


Figure 18-5a Molecular Biology of the Cell 5/e (© Garland Science 2008)

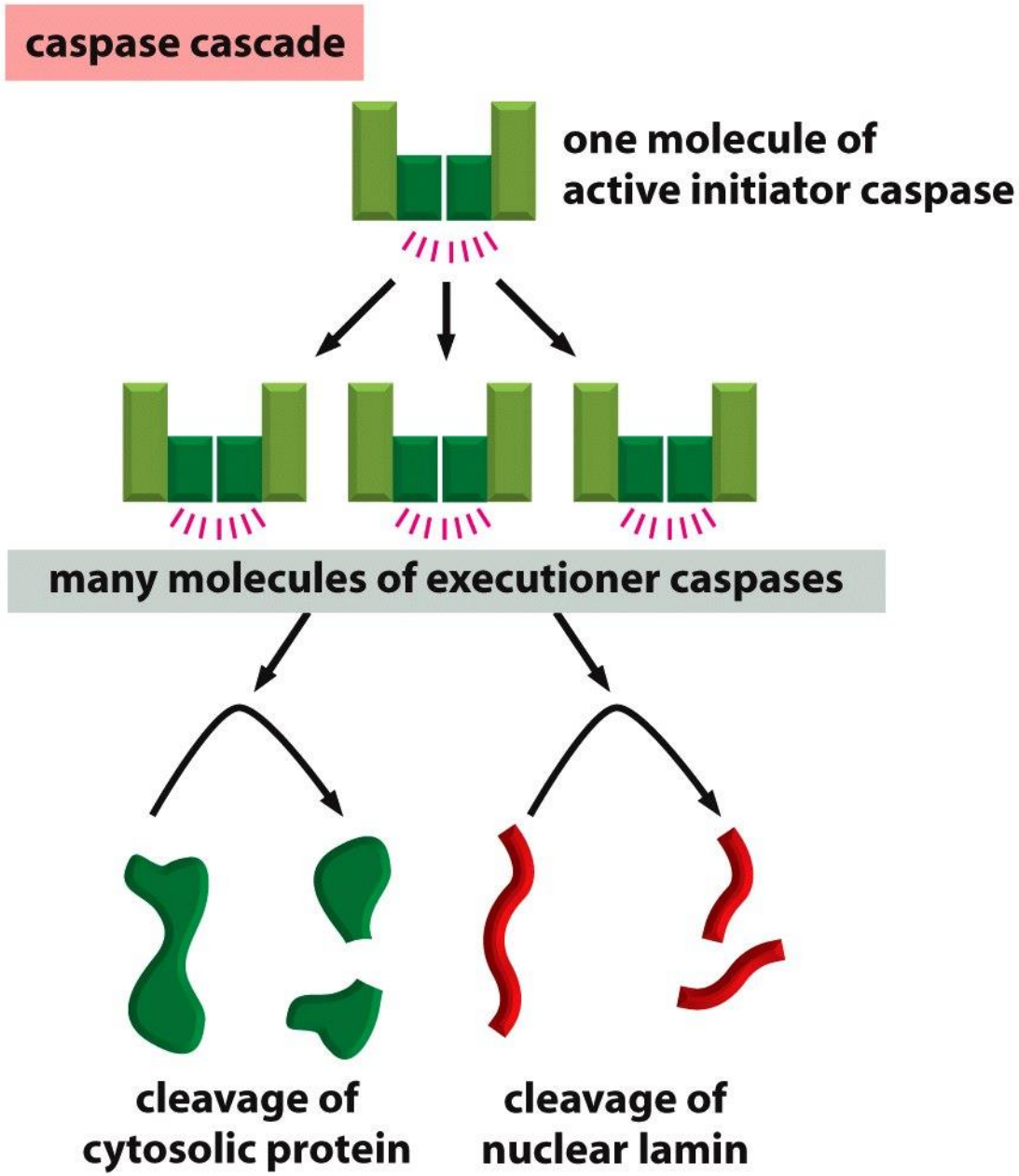


Figure 18-5b *Molecular Biology of the Cell* (© Garland Science 2008)

DOIS TIPOS DE CASPASES:

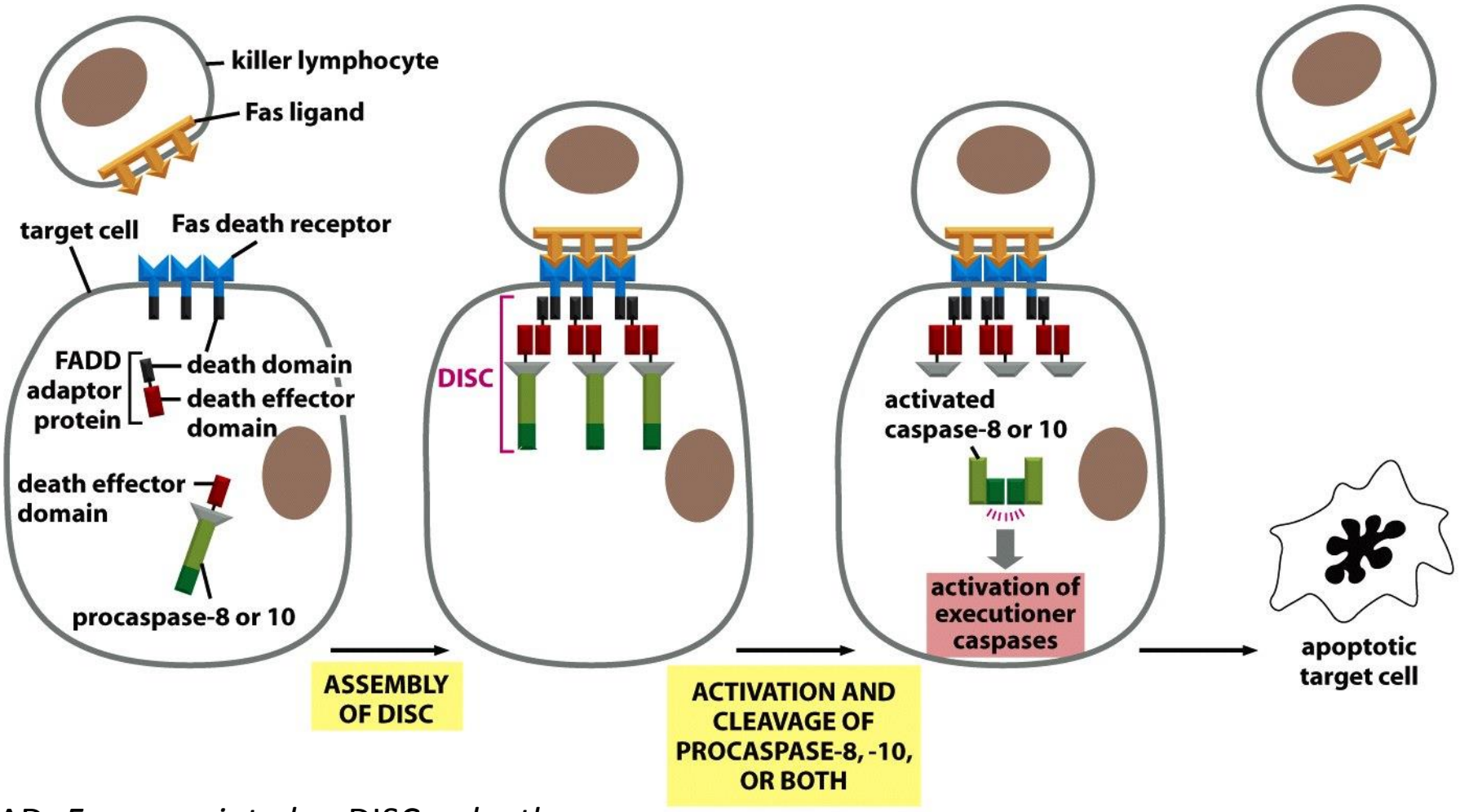
Iniciadoras: caspases 1, 2, 8, 9, 10

Executores: caspases 3, 4, 5, 6, 7, 11 a 17

Há 2 vias de sinalização que ativam as caspases

- Via extrínsica
- Via intrínsica

Via extrínsica



FAAD=*Fas-associated death domain*

DISC = *death-induced signaling complex*

Exemplo típico de indução de apoptose pela via extrínsica

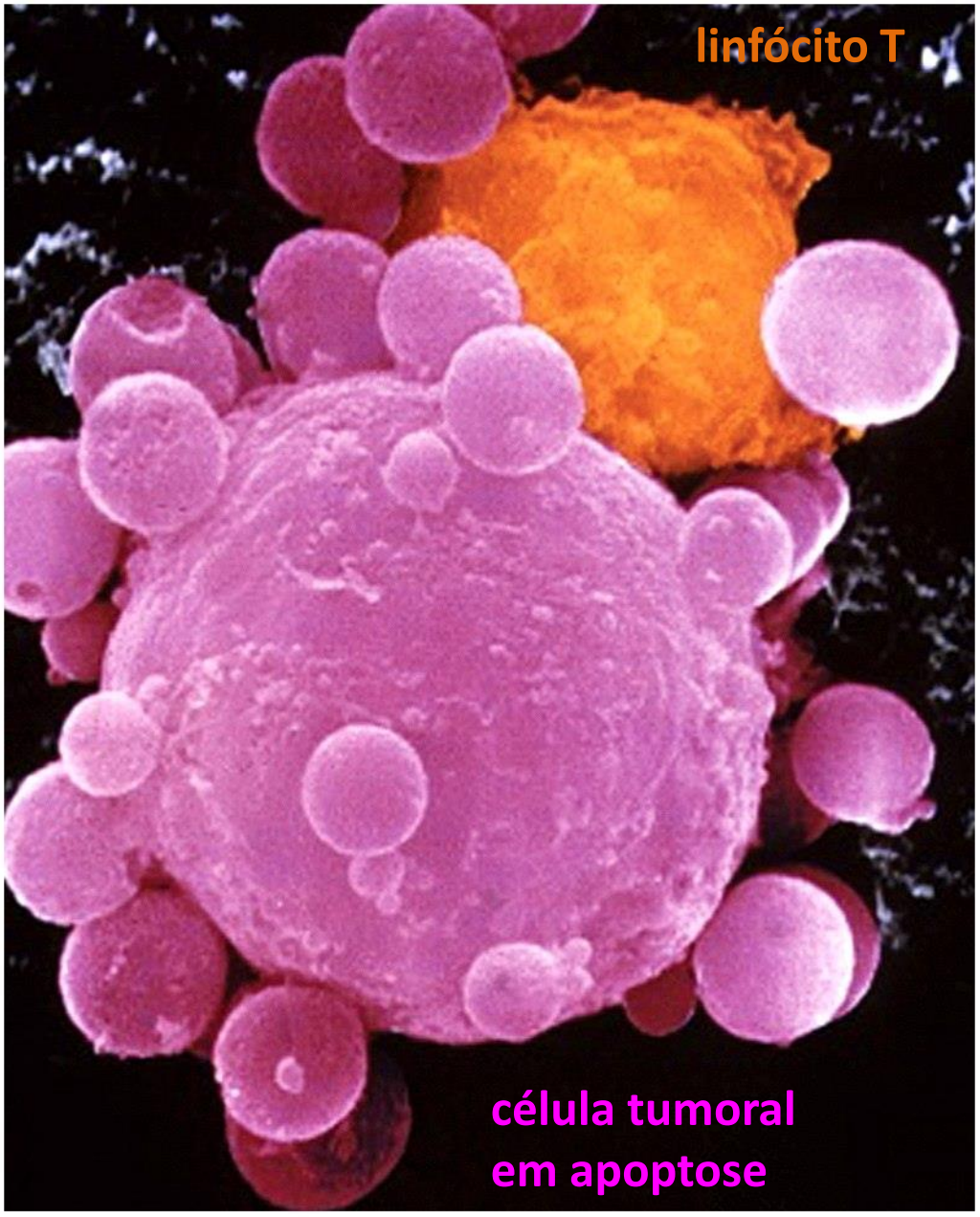
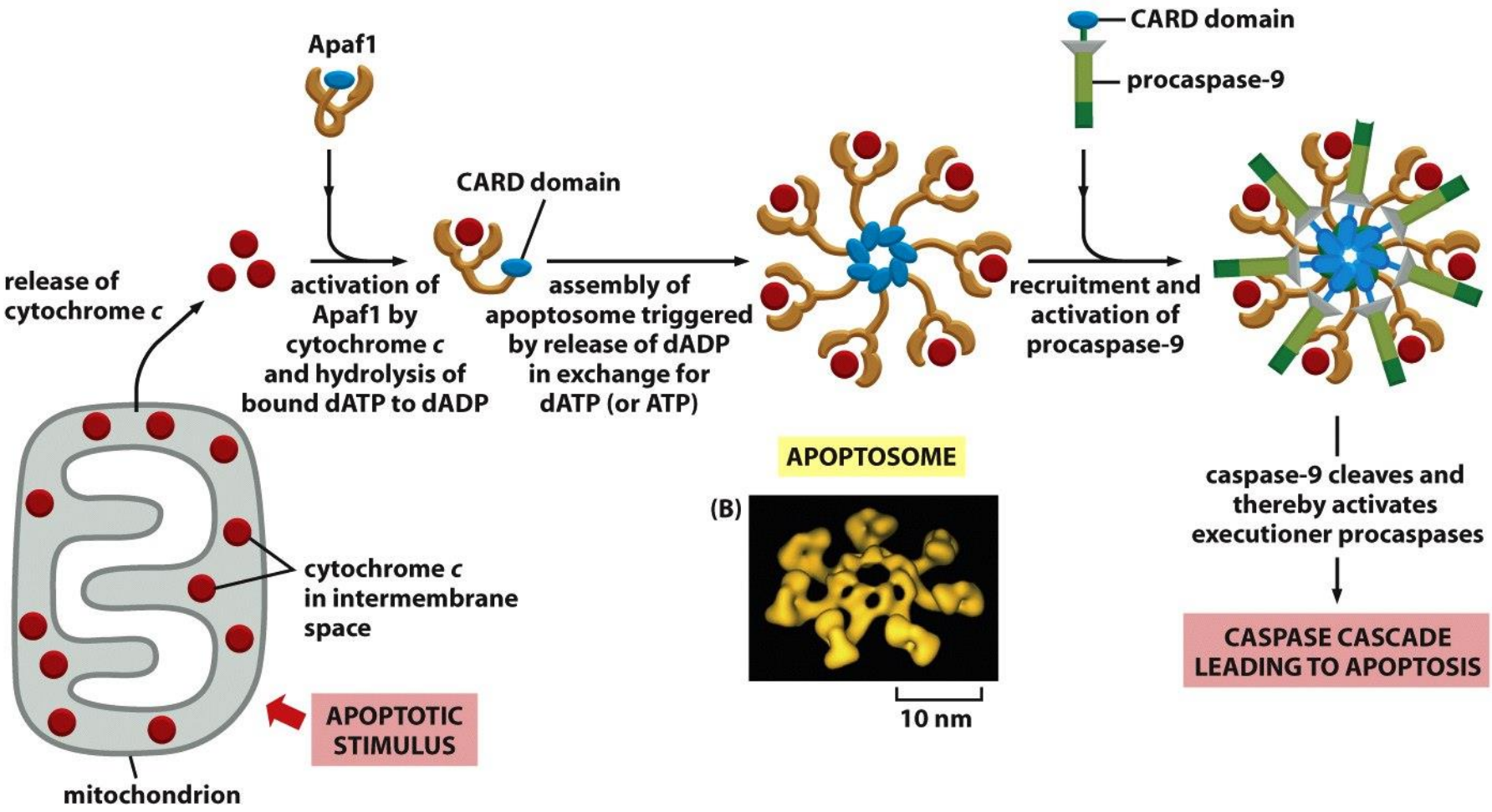


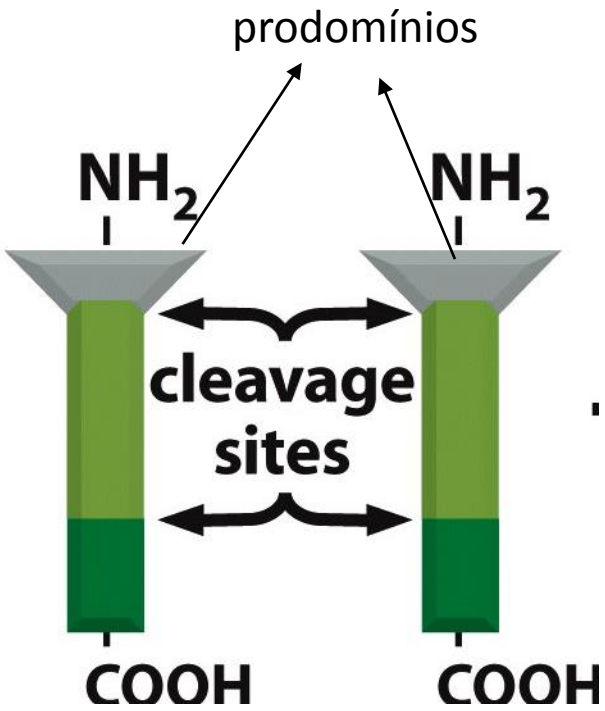
Figure 9-31c The Biology of Cancer (© Garland Science 2007)

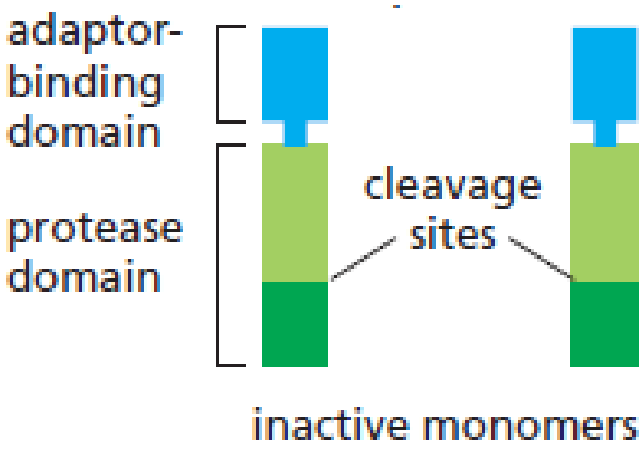
Via intrínsica



Apaf1 = *apoptotic protease activating factor-1*
CARD=*caspase recruitment domain*

Caspases iniciadoras (recapitulando..)





CARD=*caspase recruitment domain*

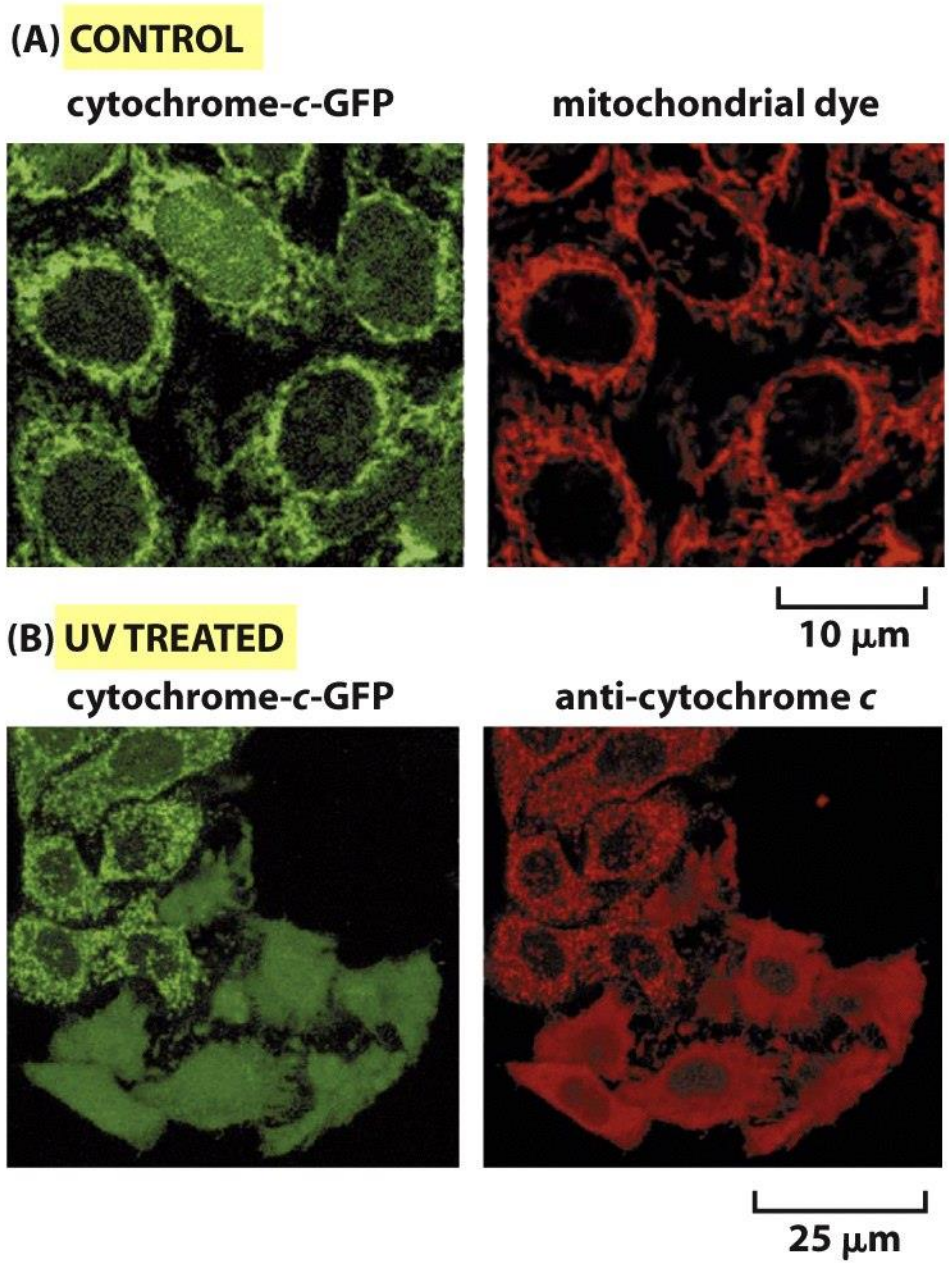
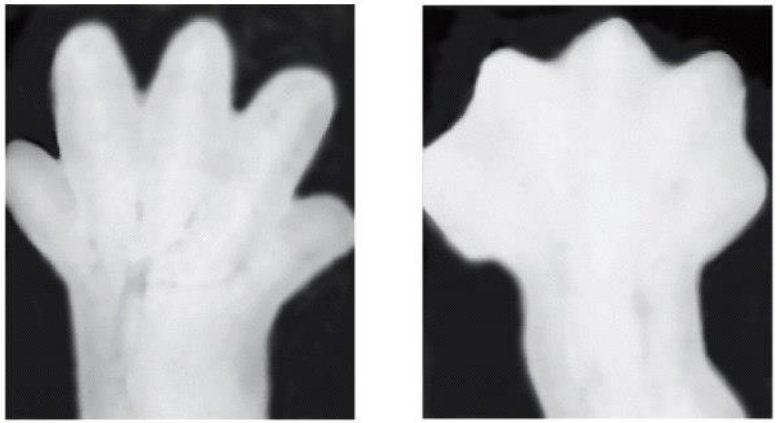
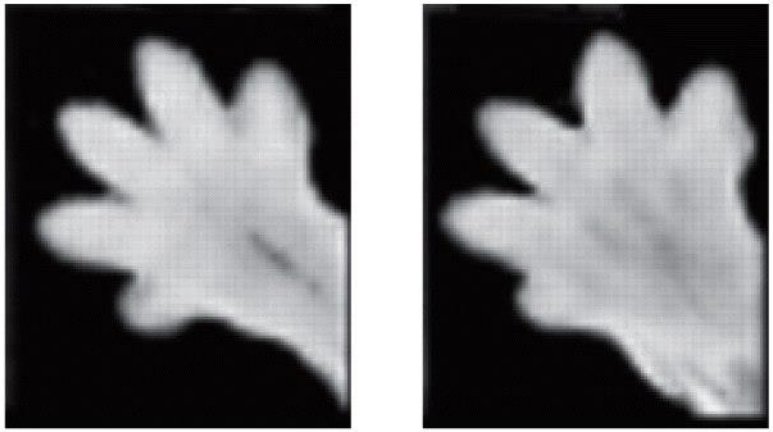


Figure 18-7 *Molecular Biology of the Cell* (© Garland Science 2008)



+/– –/–

Apaf1



+/+ –/–

Casp9

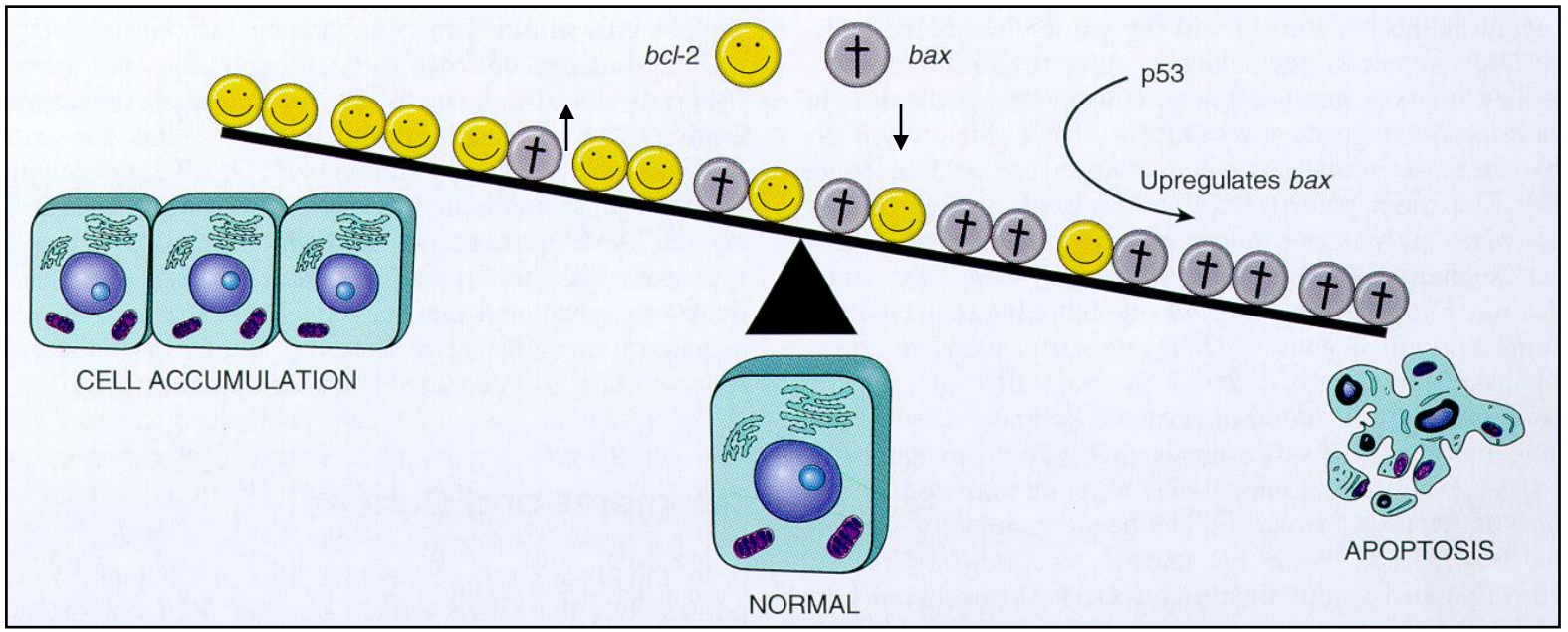
A família Bcl-2

• Originalmente detectadas em linfoma folicular de células B (***B*-*c*ell *l*ymphoma**)

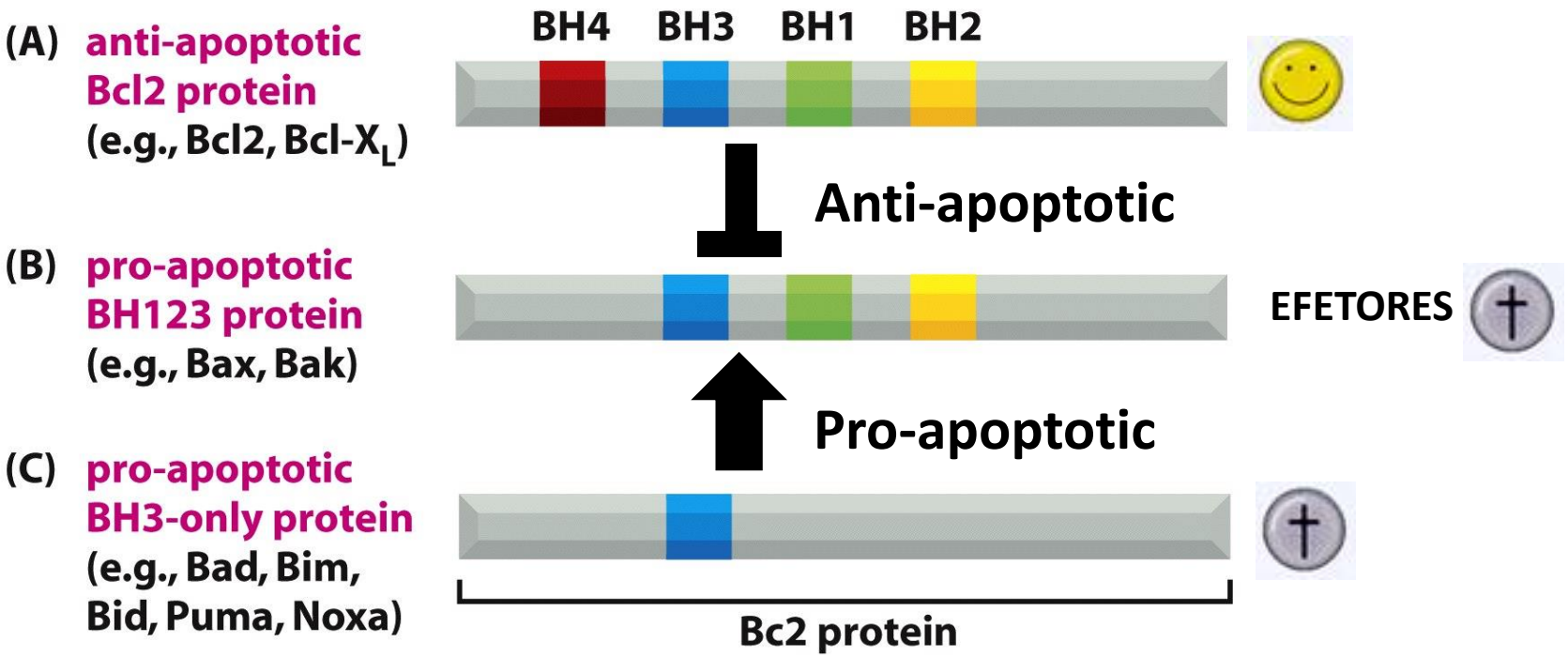
• controlam a liberação de citocromo C

•anti-apoptóticos – bloqueiam a liberação de cyt C

•pró-apoptóticos – estimulam a liberação de cyt C



Membros da família Bcl2



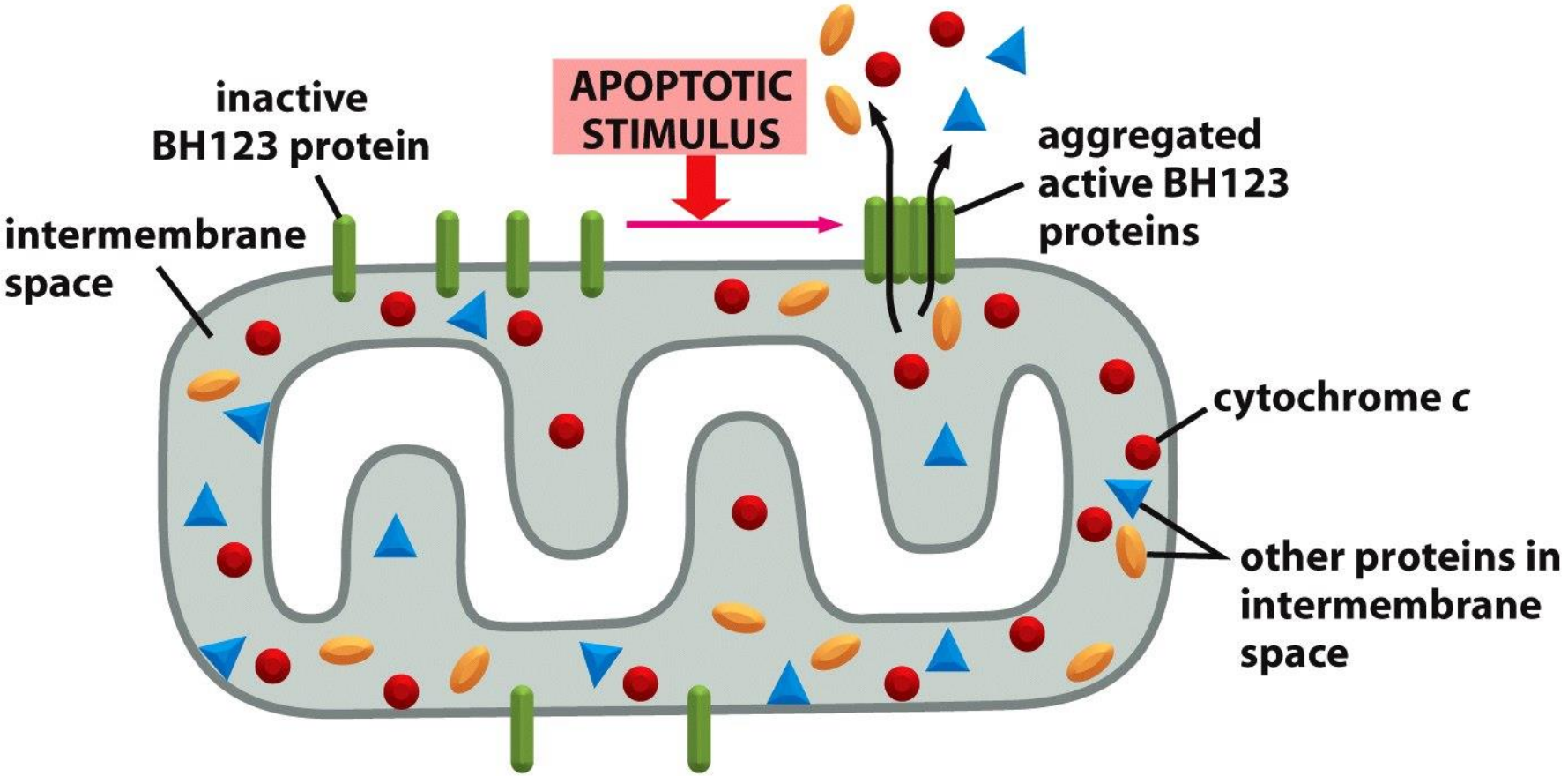
atenção!

anti-apoptotic = pro-survival

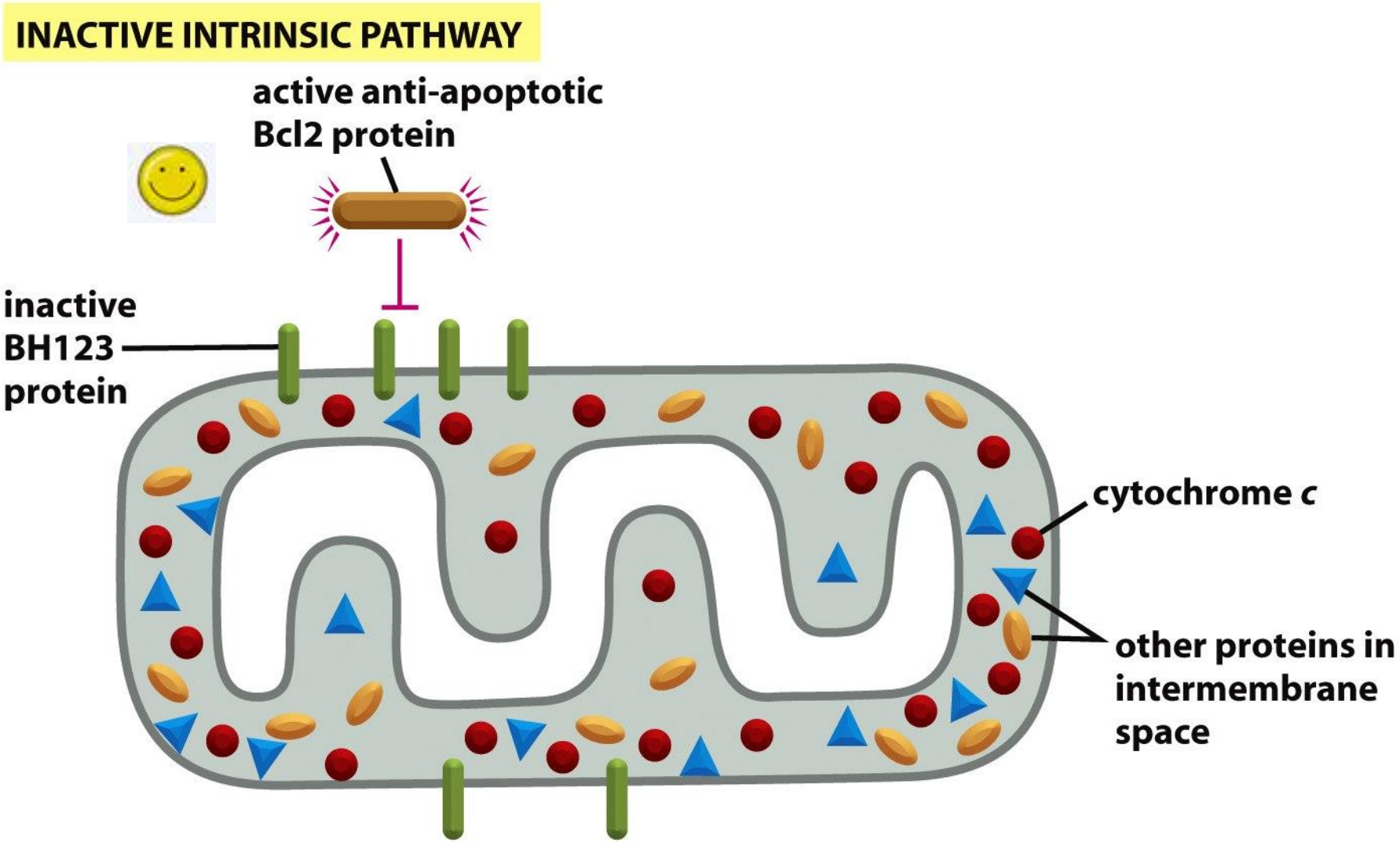
pro-apoptotic = pro-death = anti-survival

BH = *Bcl-2 homology*

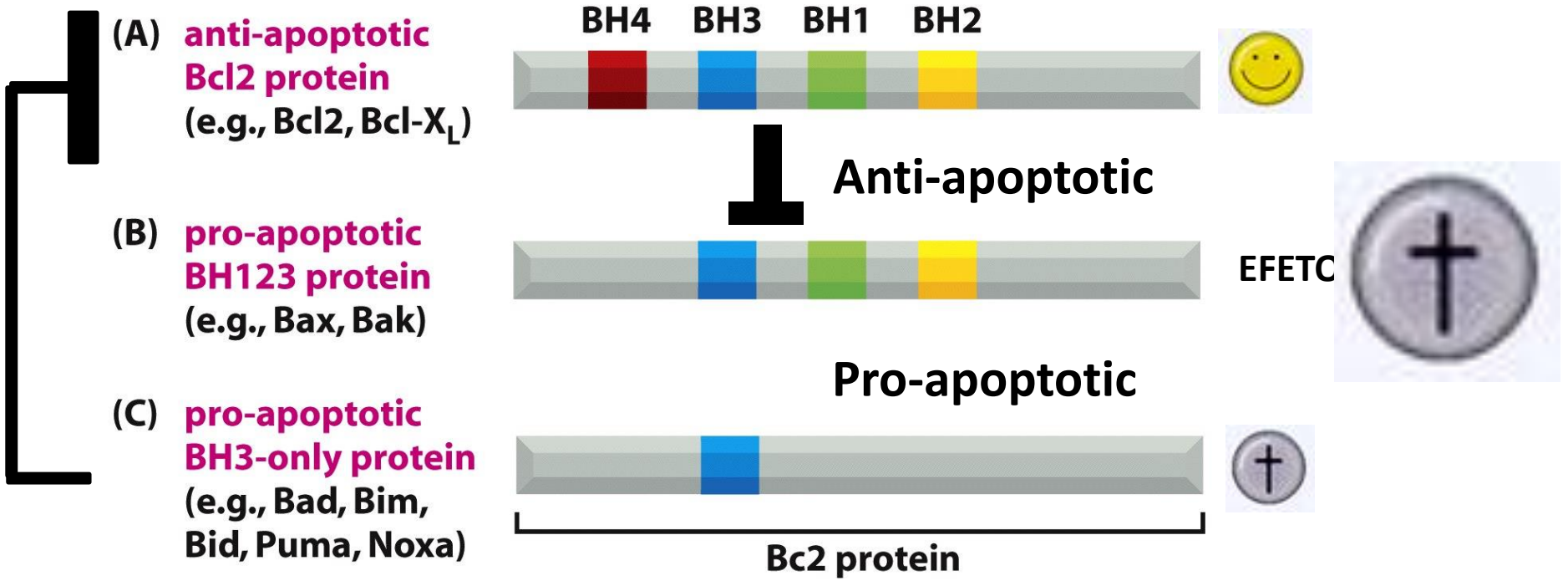
Como os pró-apoptóticos BH123 atuam?



Como os anti-apoptóticos Bcl2 atuam?



Membros da família Bcl2



Os BH3 RECEBEM OS ESTÍMULOS APOPTÓTICOS

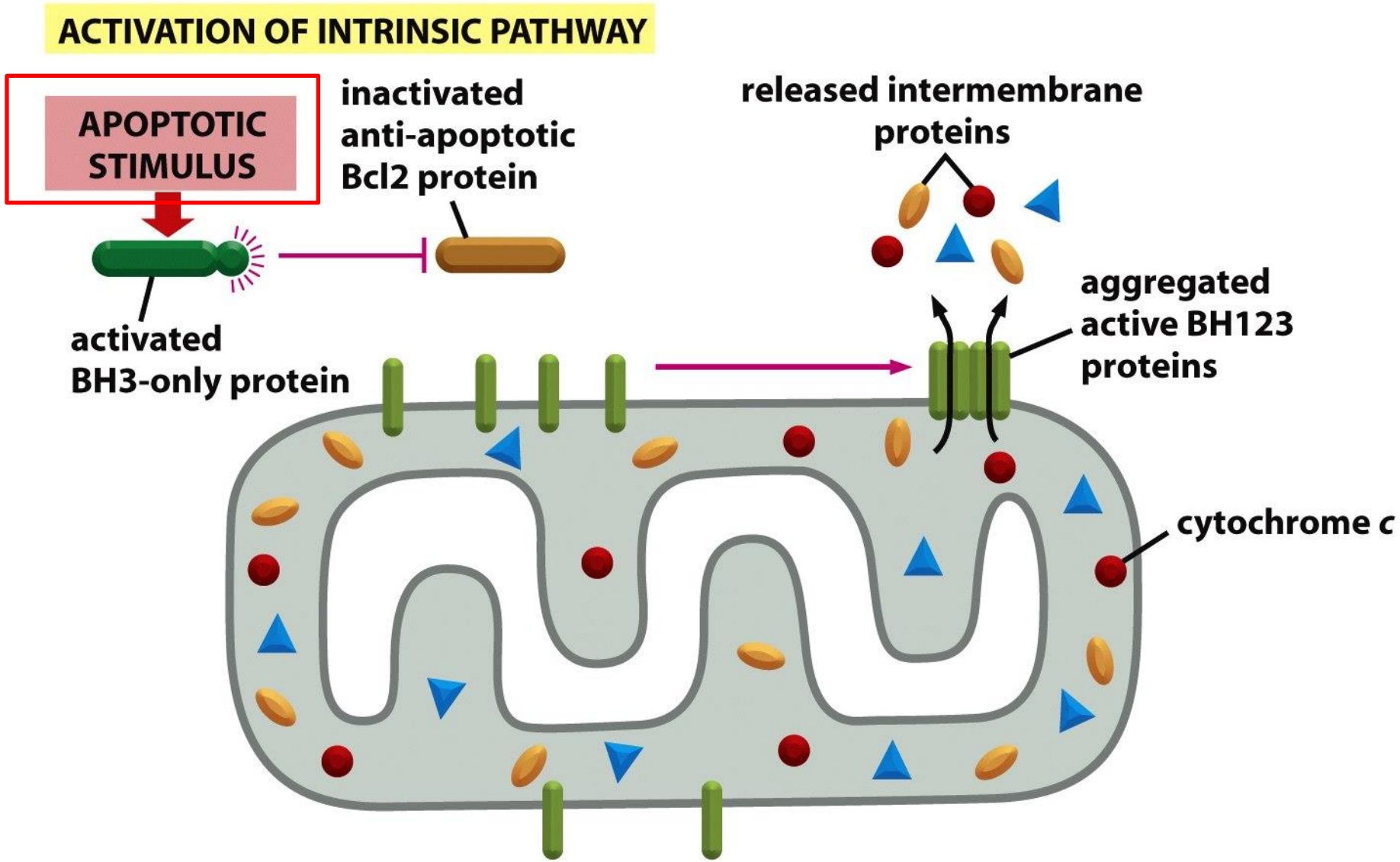


Figure 18-11b *Molecular Biology of the Cell* (© Garland Science 2008)

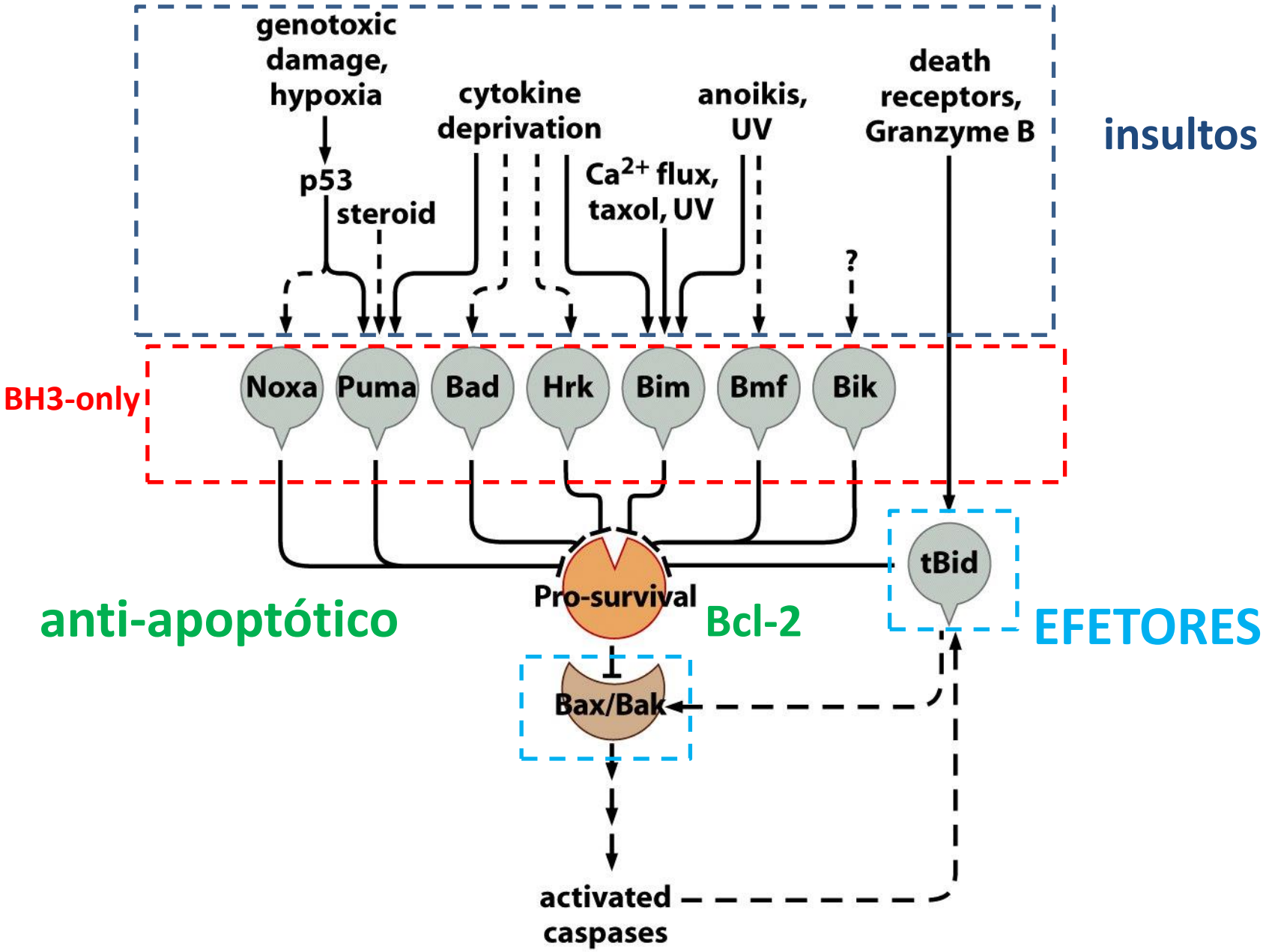
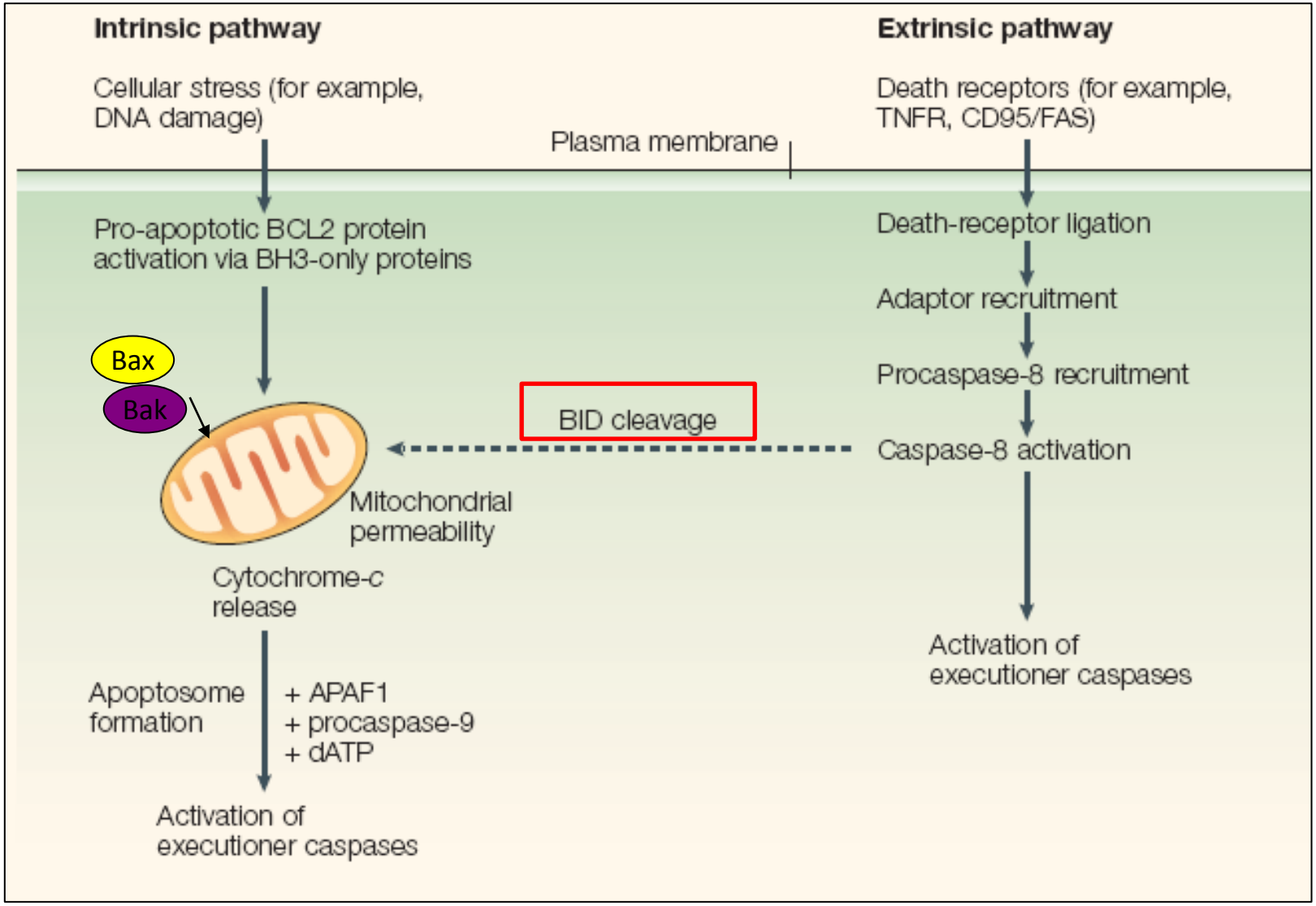
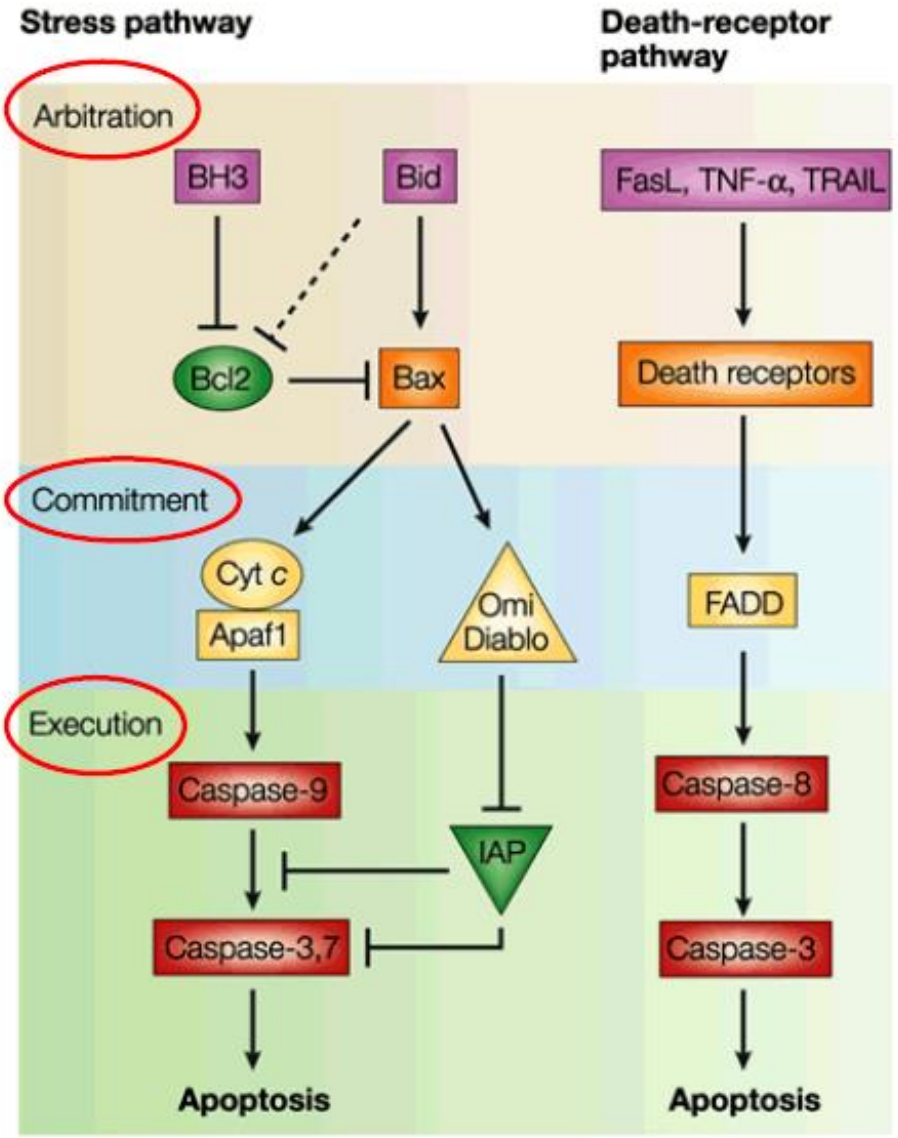


Figure 9-27a The Biology of Cancer (© Garland Science 2007)

A via intrínsica ‘ajuda’ a extrínsica

Chipuk & Green, Nat Rev Mol Cel Biol, 2005, 6:268-275





Nature Reviews Cancer **2**; 647-656 (2002)

Estudos *in vivo* indicam que esse Equilíbrio é complexo...

Deleção de UM alelo de bim-2 (pró-apoptose) basta para reverter o fenótipo

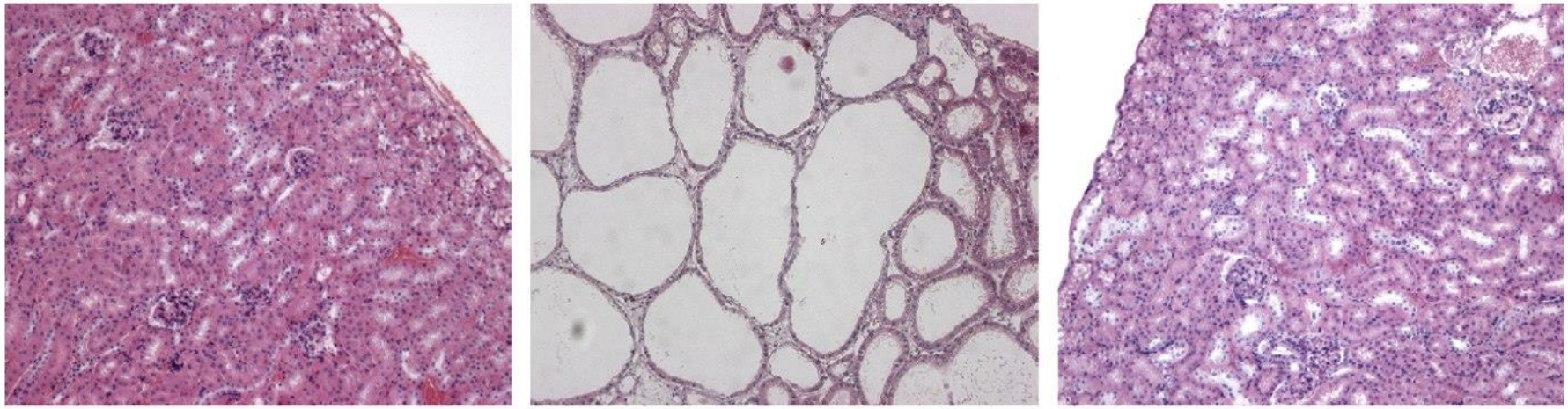
Rim normal

Anti-apoptose

***wt*, 5 wk**

***bcl–2*$^{-/-}$, 5 wk**

***bcl–2*$^{-/-}$ *bim–2*$^{+/-}$, 5 wk**

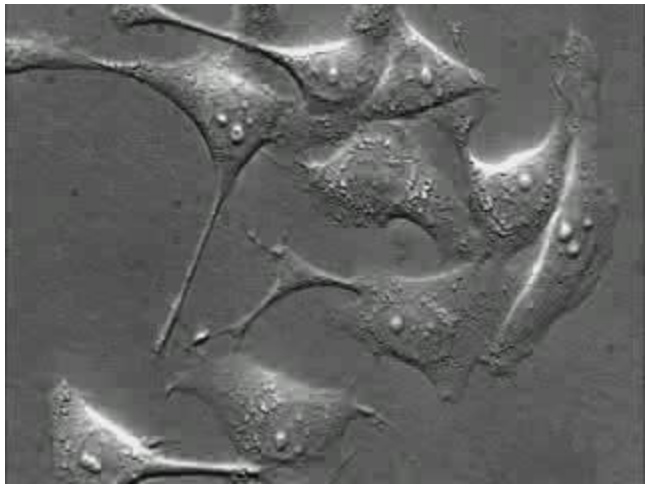


(A) **(B)** **(C)**

Figure 9-26 The Biology of Cancer (© Garland Science 2007)

Apoptose

Visualização simultânea de **citocromo**, **fosfatidilserina** e **DNA**



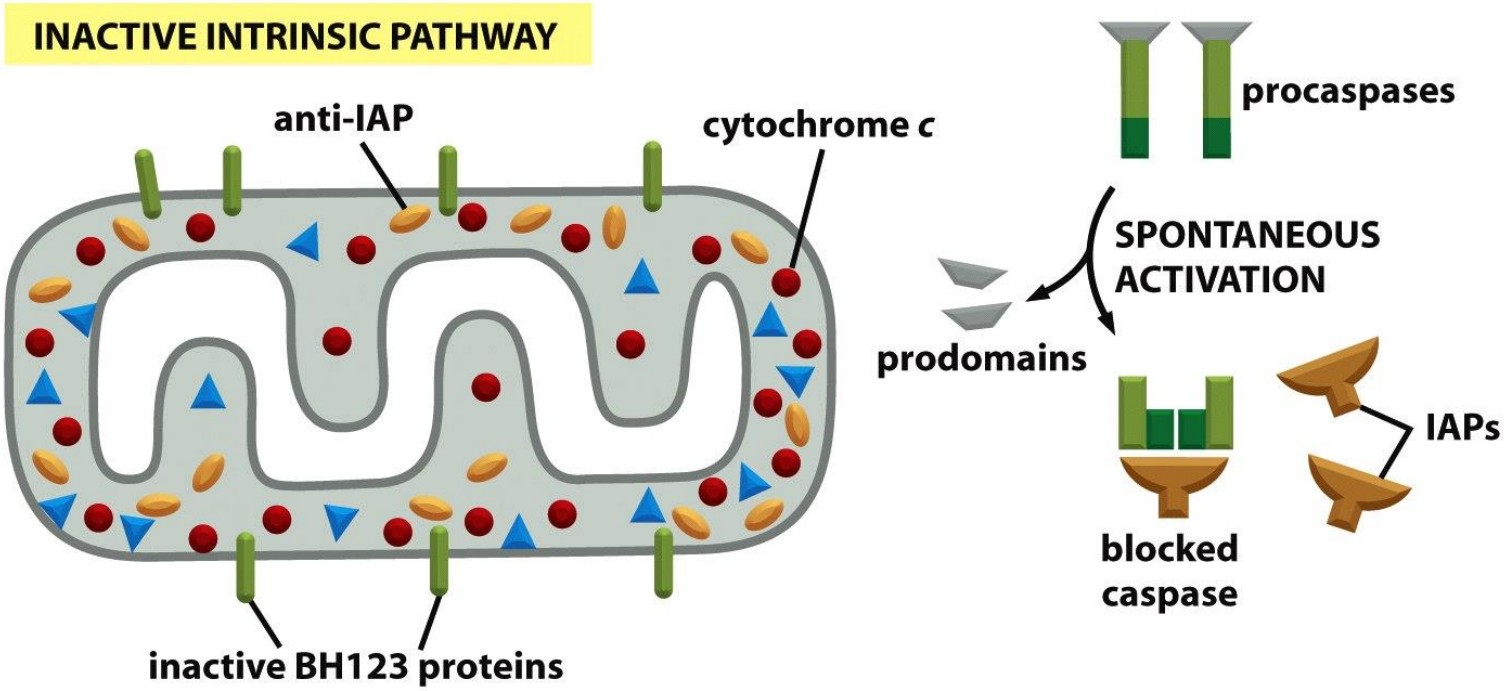
https://www.youtube.com/watch?v=rs1Je-8Y3Po

Resumo..

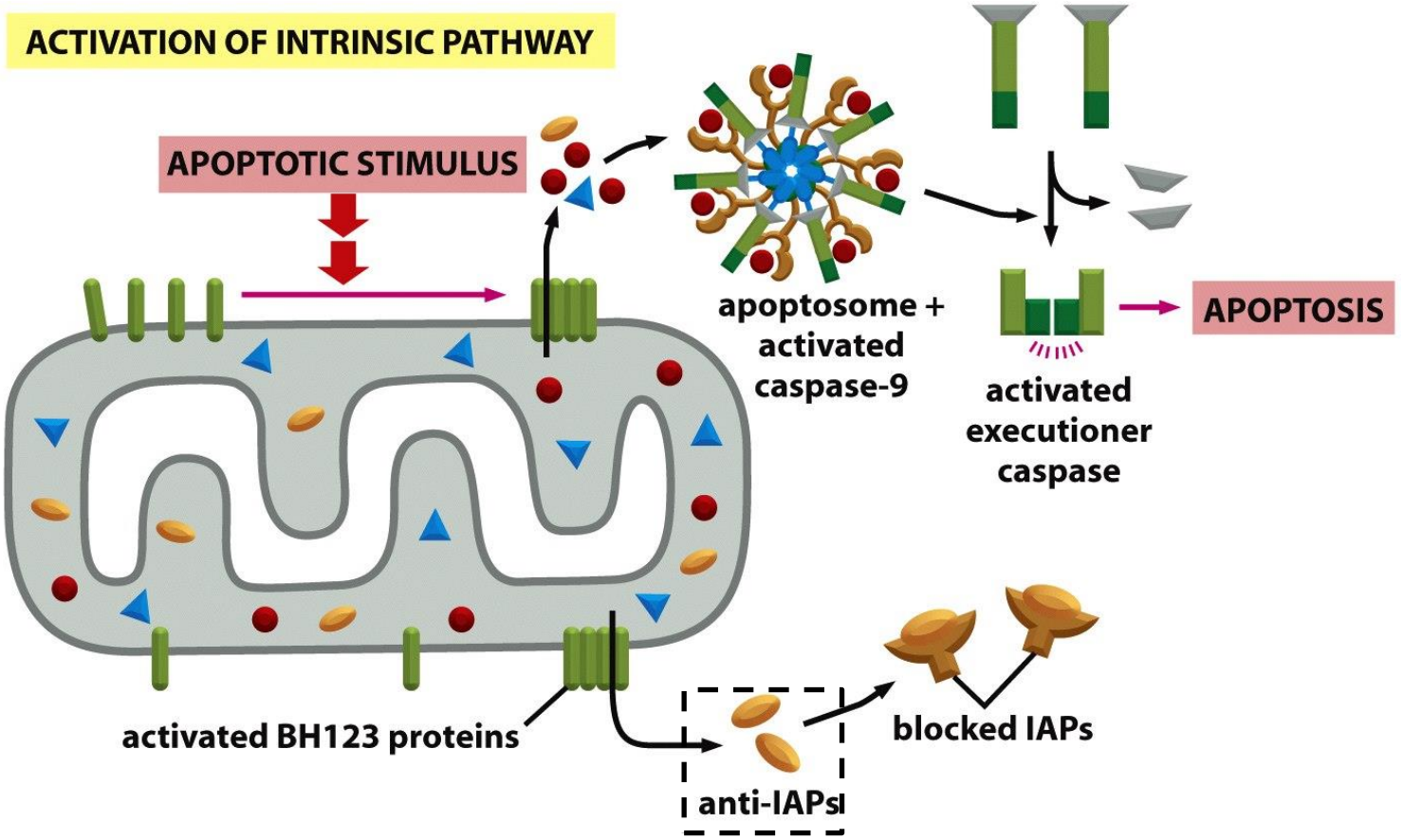
- A via extrínsica pode ativar a intrínsica para amplificar a cascata de caspases. Isso é feito através da BH3 Bid
- Caspase 8 →clivagem de Bid →tBid transloca para a mitocôndria e induz agregação dos BH123
- Bim, Bid e Puma (entre outros) são capazes de inibir TODOS os membros ANTI-apoptóticos

IAPs e anti-IAPs

- *IAP = inhibitors of apoptosis*
- "Equivalentes" às proteínas Bcl2 em mamíferos



Na presença de um estímulo apoptótico a mitocôndria libera ANTI-IAPs




p53
GENOME GUARDIAN

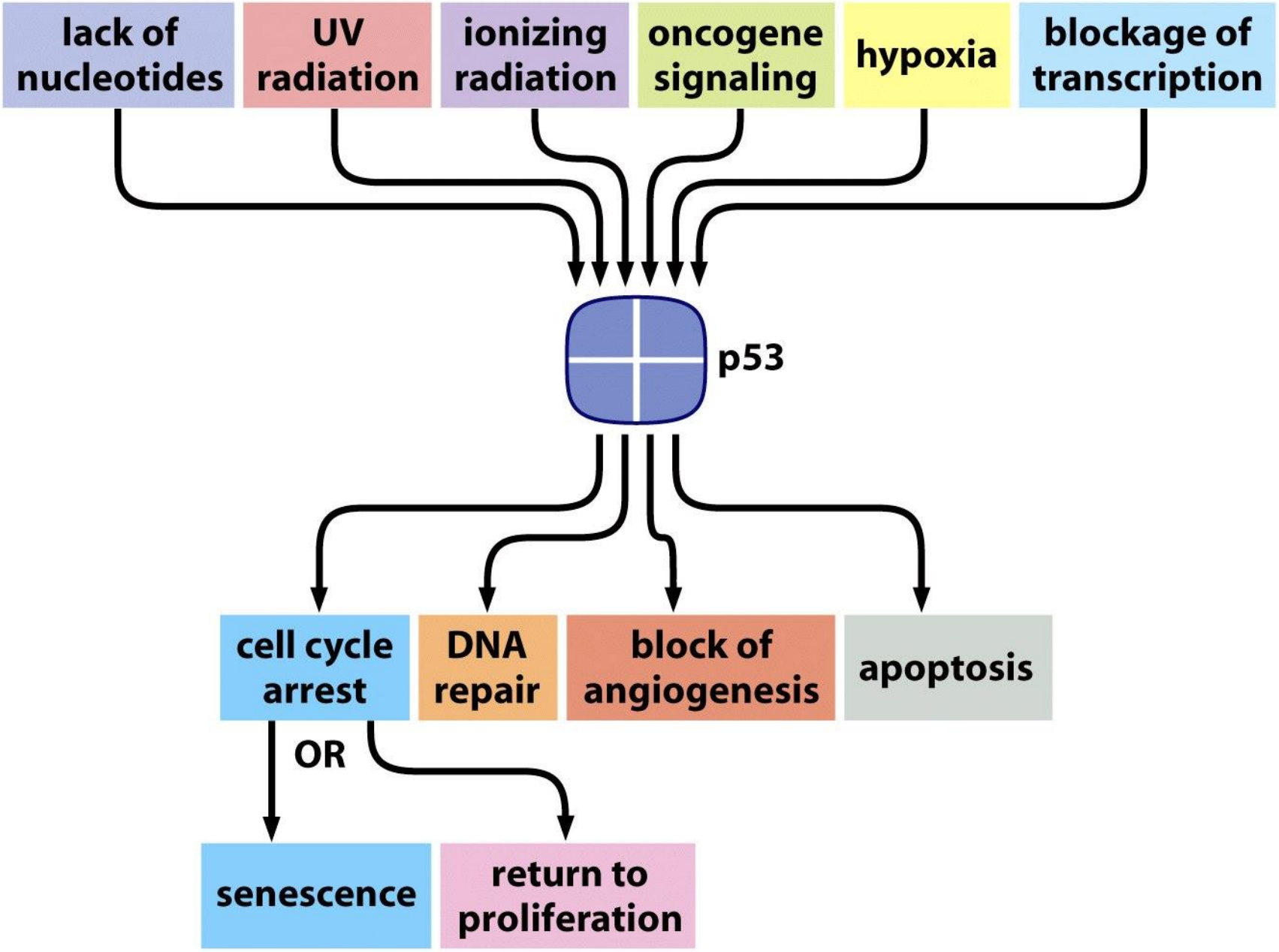


Figure 9-8 The Biology of Cancer (© Garland Science 2007)

Como p53 promove a apoptose?

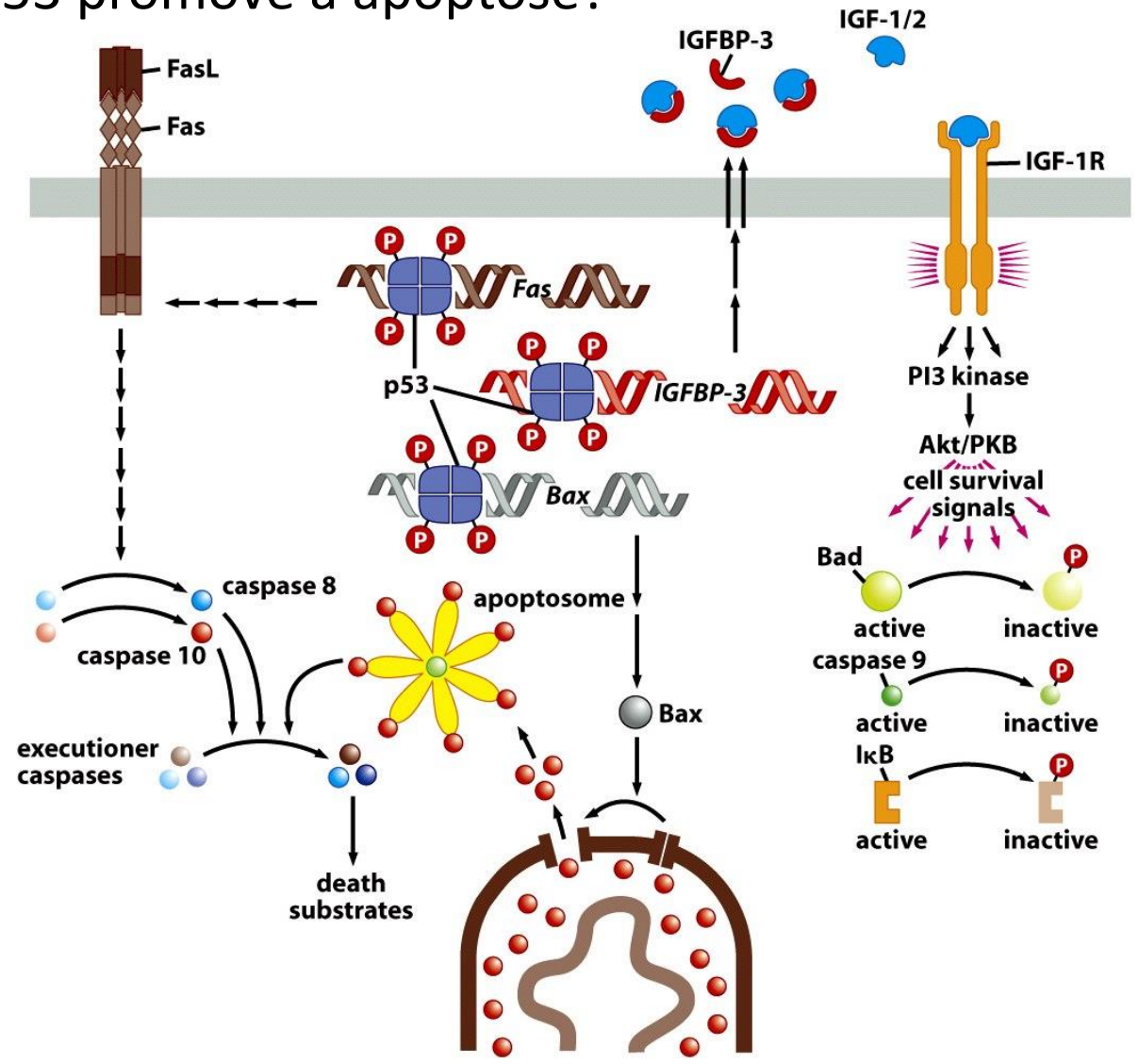
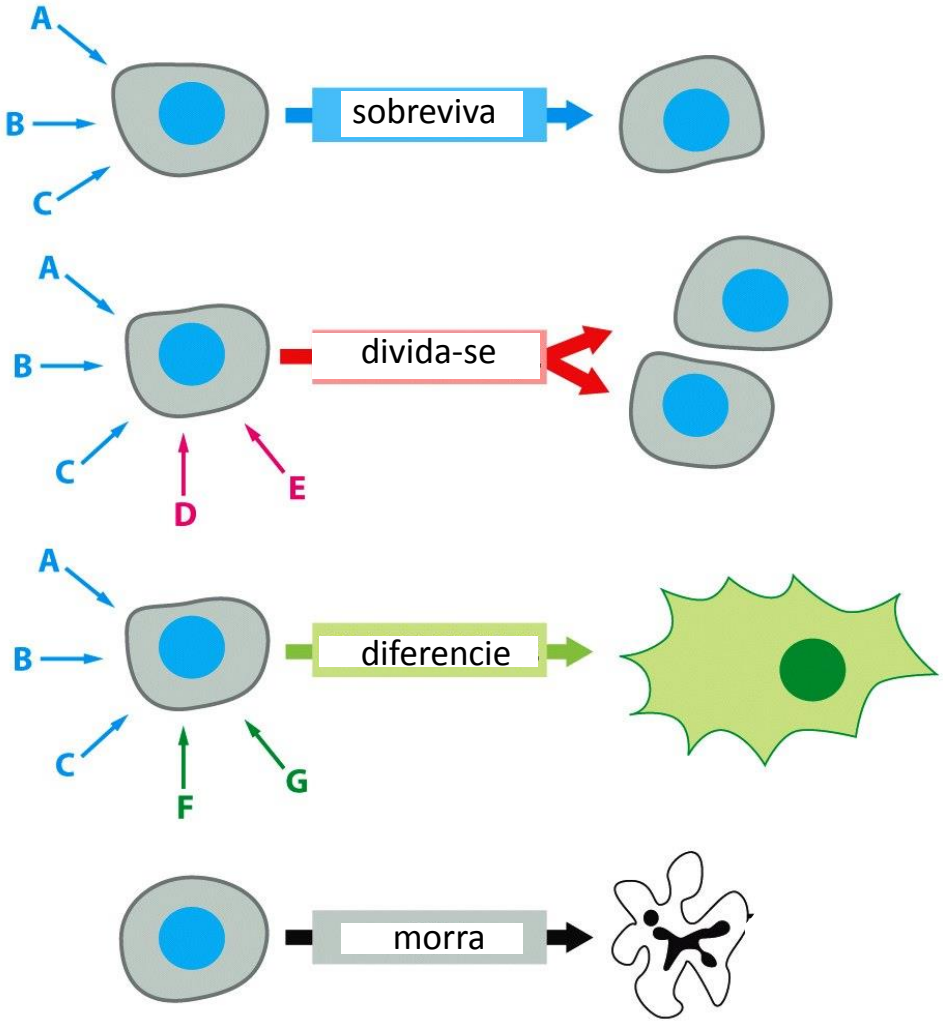


Figure 9-33 The Biology of Cancer (© Garland Science 2007)

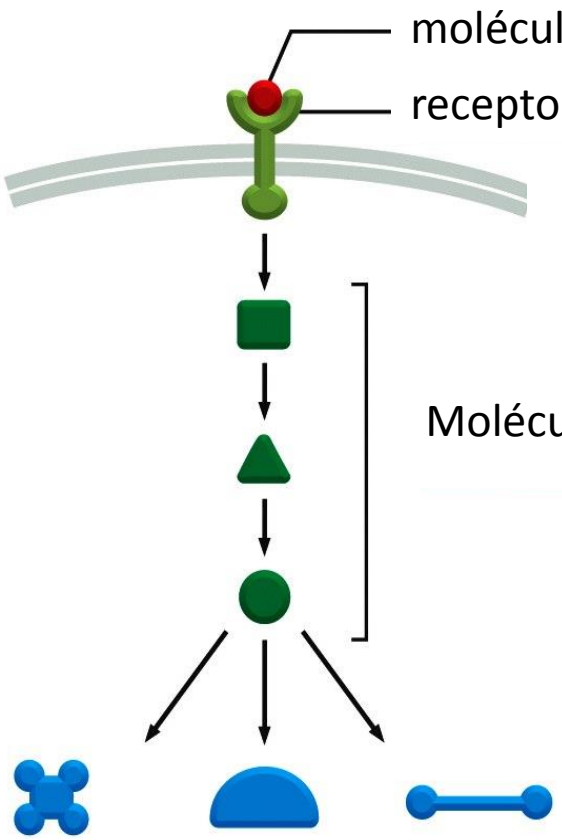
IGFBP-3- insulin-like growth fator binding protein

Fatores de Sobrevivência

Lembrando da aula de sinalização..

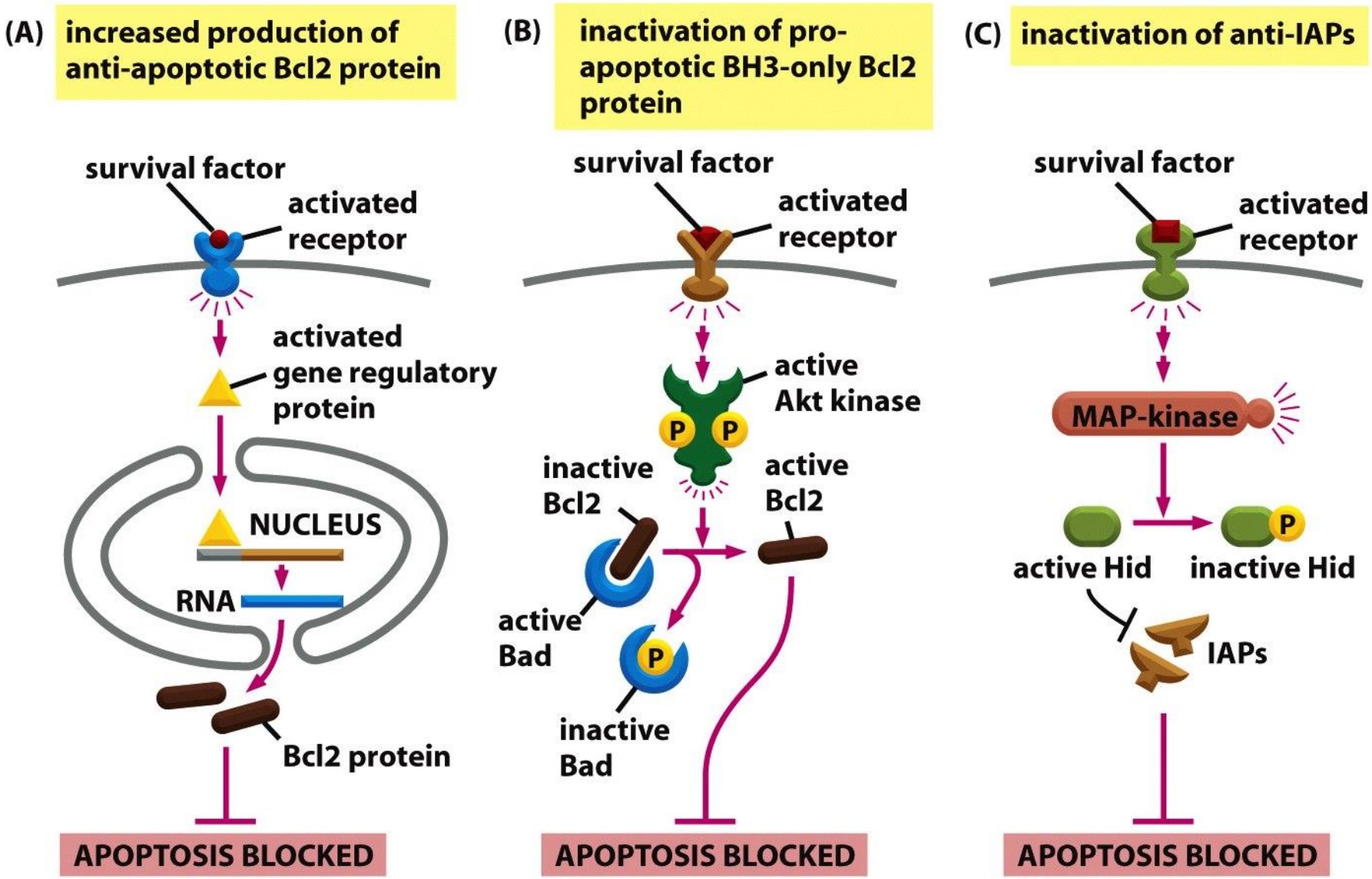


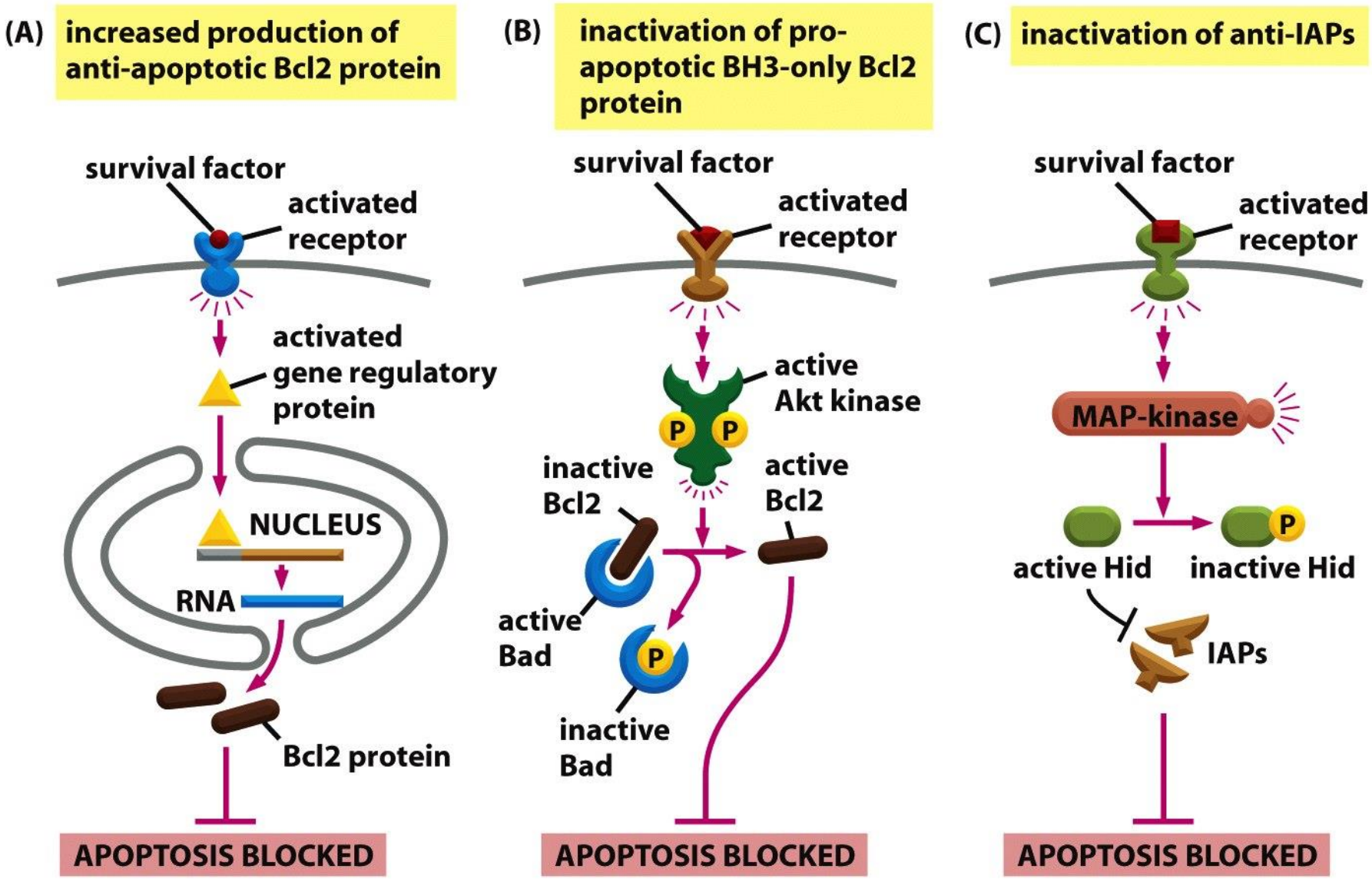
Sinalização dos fatores de sobrevivência segue a mesma regra ....



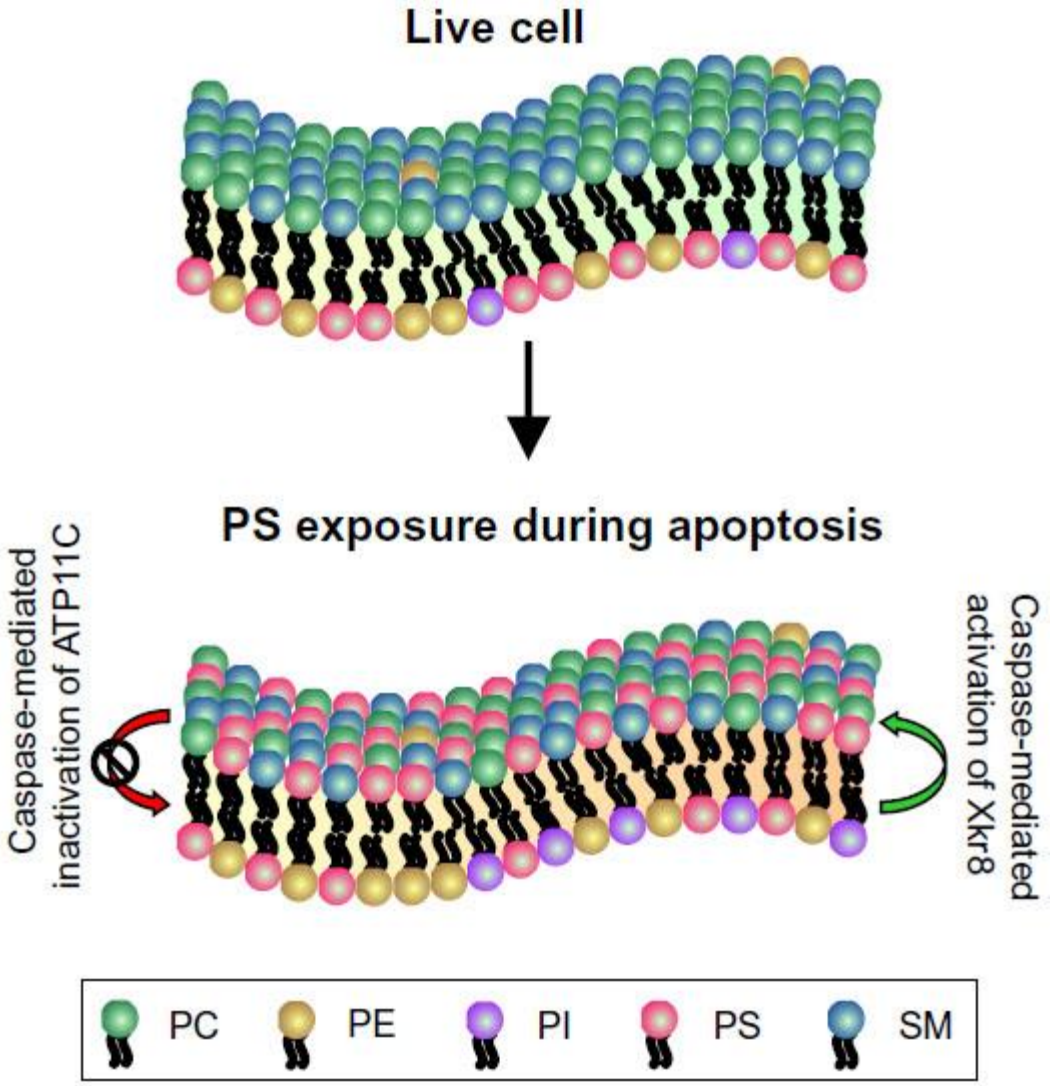
fator de sobrevivência

Proteínas Bcl2a


(A)
increased production of anti-apoptotic Bcl2 protein
survival factor
activated receptor
activated gene regulatory protein
NUCLEUS
RNA
Bcl2 protein
APOPTOSIS BLOCKED
(B)
inactivation of pro-apoptotic BH3-only Bcl2 protein
survival factor
activated receptor
active Akt kinase
P
P
inactive Bcl2
active Bcl2
active Bad
P
inactive Bad
APOPTOSIS BLOCKED
(C)
inactivation of anti-IAPs
survival factor
activated receptor
MAP-kinase
P
active Hid
inactive Hid
IAPs
APOPTOSIS BLOCKED

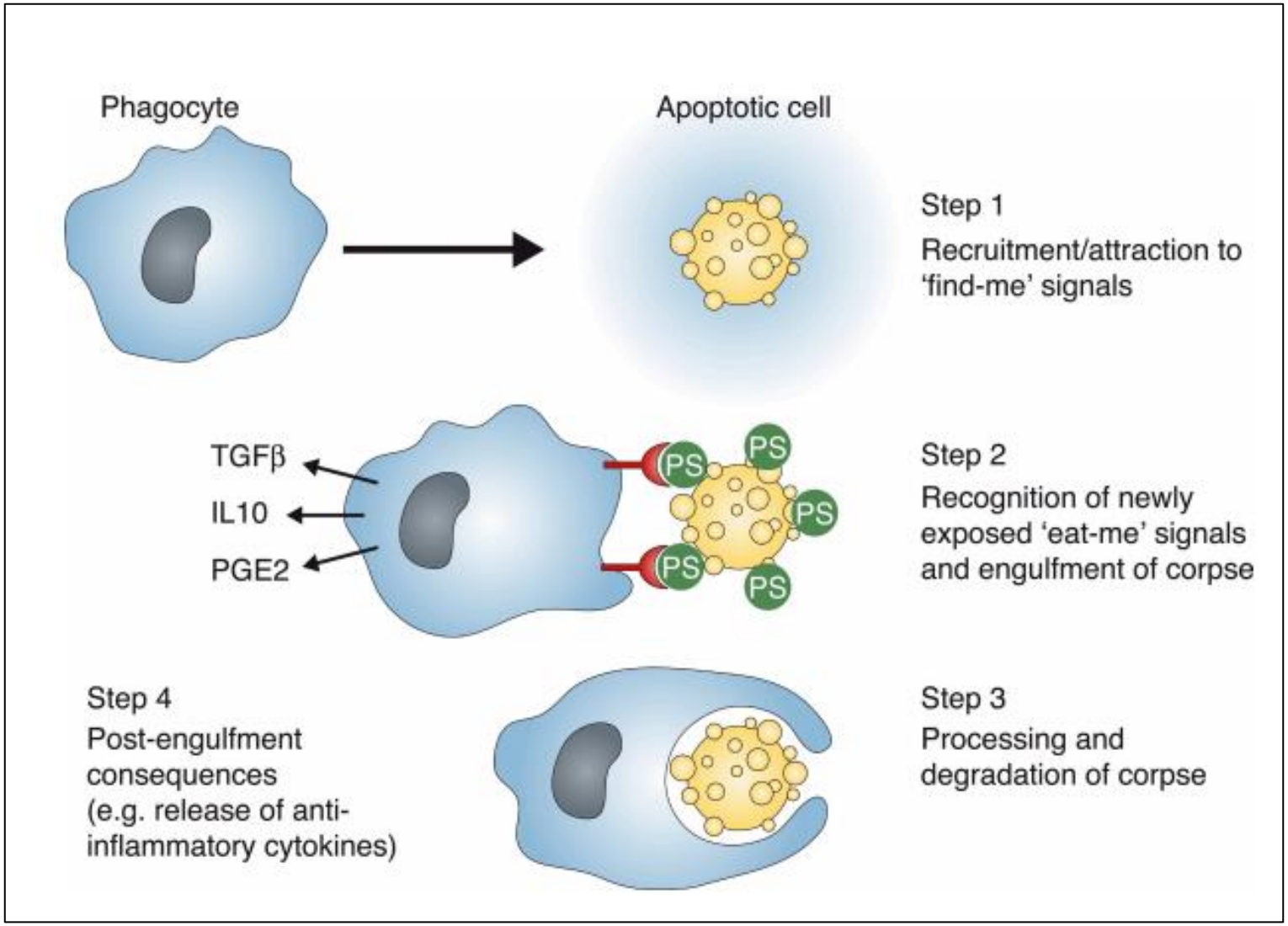

(A)
increased production of anti-apoptotic Bcl2 protein
survival factor
activated receptor
activated gene regulatory protein
NUCLEUS
RNA
Bcl2 protein
APOPTOSIS BLOCKED
(B)
inactivation of pro-apoptotic BH3-only Bcl2 protein
survival factor
activated receptor
active Akt kinase
P
P
inactive Bcl2
active Bcl2
active Bad
P
inactive Bad
APOPTOSIS BLOCKED
(C)
inactivation of anti-IAPs
survival factor
activated receptor
MAP-kinase
P
active Hid
inactive Hid
IAPs
APOPTOSIS BLOCKED

Como as células mortas são eliminadas?



Linda & Olson, 2015. Apoptotic membrane dynamics in health and disease. Cell Health and Cytoskeleton,7: 133–142

PC – fosfatidilcolina; PE – fosfatidiletanolamina; PI – fosfatidilinositol
PS – fosfatidilserina; SM - esfingomielina



Ravichandran KS, 2010. Find-me and eat-me signals in apoptotic cell clearance: progress and conundrums. J. Exp. Med. Vol. 207 No. 9 1807-1817

Doenças associadas à morte celular

- Huntington
- Alzheimer
- Parkinson
- Câncer
- Doenças auto-imunes
- Infartos e derrames

Table 9.5 Examples of anti-apoptotic alterations found in human tumor cells

Alteration	Mechanism of anti-apoptotic action	Types of tumors
CASP8 promoter methylation	inactivation of extrinsic cascade	SCLC, pediatric tumors
CASP3 repression	inactivation of executioner caspase	breast carcinomas
Survivin overexpression[a]	caspase inhibitor	mesotheliomas, melanomas, many carcinomas
ERK activation	repression of caspase-8 expression	many types
ERK activation	protection of Bcl-2 from degradation	many types
Raf activation	sequestration of Bad by 14-3-3 proteins	many types
PI3K mutation/activation	activation of Akt/PKB	gastrointestinal
NF-κB constitutive activation[b]	induction of anti-apoptotic genes	many types
p53 mutation	loss of ability to induce pro-apoptotic genes	many types
$p14^{ARF}$ gene inactivation	suppression of p53 levels	many types
Mdm2 overexpression	suppression of p53 levels	sarcomas
IAP-1 gene amplification	antagonist of caspases-3 and 7	esophageal, cervical
APAF1 methylation	loss of caspase-9 activation by cytochrome *c*	melanomas
BAX mutation	loss of pro-apoptotic protein	colon carcinomas
Bcl-2 overexpression	closes mitochondrial channel	~ of human tumors
PTEN inactivation	hyperactivity of Akt/PKB kinase	glioblastoma, prostate carcinoma, endometrial carcinoma
IGF-1/2 overexpression	activates PI3K	many types
IGFBP repression	loss of anti-apoptotic IGF-1/2 antagonist	many types
Casein kinase II	activation of NF-κB	many types
TNFR1 methylation	repressed expression of death receptor	Wilms tumor
FLIP overexpression	inhibition of caspase-8 activation by death receptors	melanomas, many others
Akt/PKB activation	phosphorylation and inactivation of pro-apoptotic Bcl-2-like proteins	many types
Stat3 activation	induces expression of Bcl-X_L	several types
TRAIL-R1 repression	loss of responsiveness to death ligand	small-cell lung carcinoma
FAP-1 overexpression	inhibition of Fas receptor signaling	pancreatic carcinoma
XAF1 methylation[c]	loss of inhibition of anti-apoptotic XIAP	gastric carcinoma
Wip1 overexpression[d]	suppression of p53 activation	breast and ovarian carcinomas, neuroblastoma

[a]Survivin is an inhibitor of apoptosis (IAP) in gastric, lung, and bladder cancer and melanoma in addition to the mesotheliomas indicated here. The expression of a number of IAP genes is directly induced by the NF-κB TFs.
[b]Induces synthesis of c-IAPs, XIAP, Bcl-X_L, and other anti-apoptotic proteins.
[c]XAF1 (XIAP-associated factor 1) normally binds and blocks the anti-apoptotic actions of XIAP, the most potent of the IAPs.
[d]Wip1 is a phosphatase that inactivates p38 MAPK, which otherwise would phosphorylate and stimulate the pro-apoptotic actions of p53.

Table 9-5 The Biology of Cancer (© Garland Science 2007)

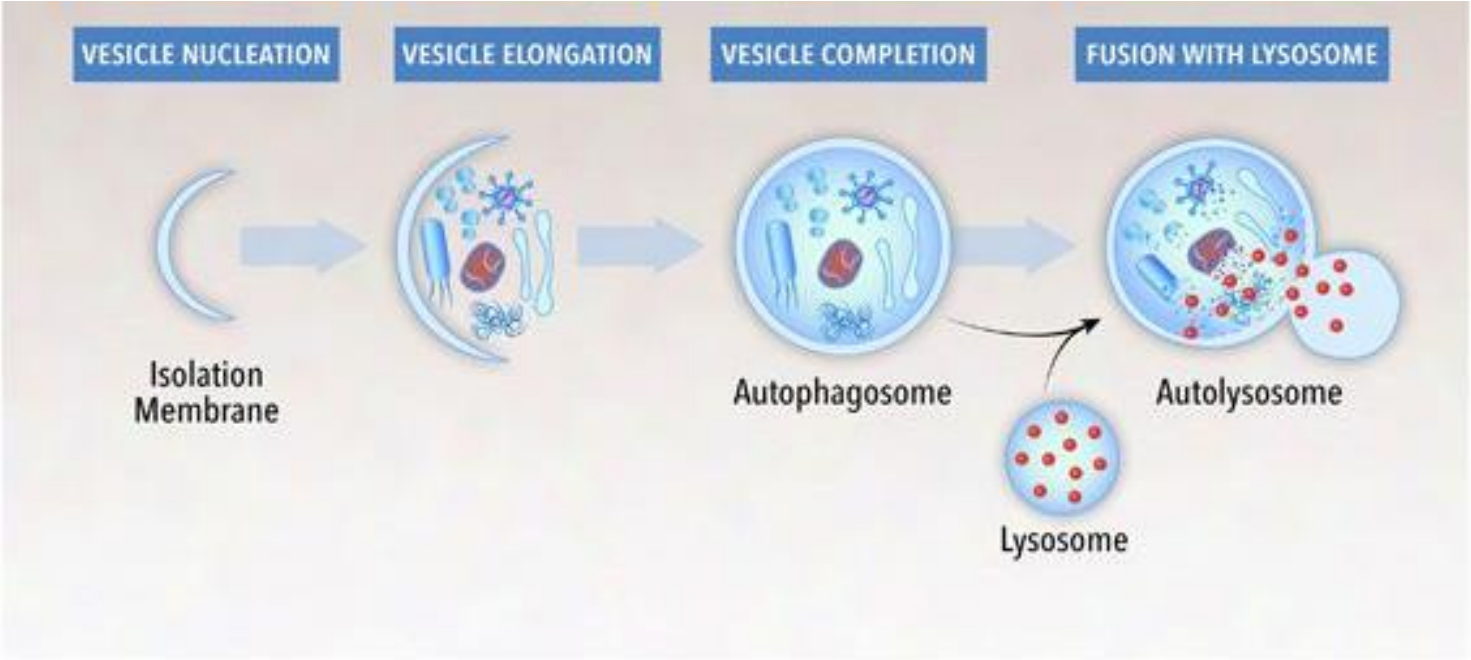
Nessa aula

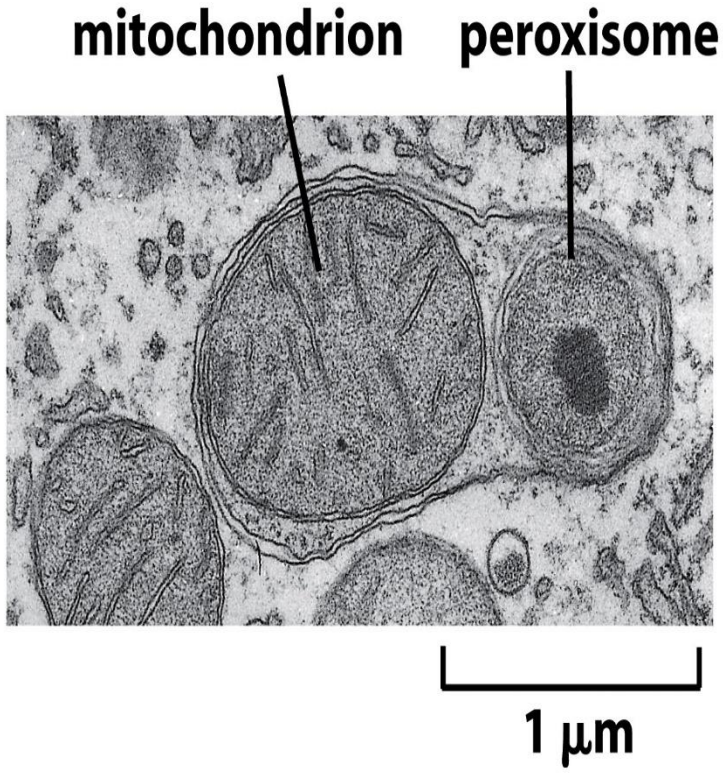
- Apoptose
- Autofagia
- Necroptose

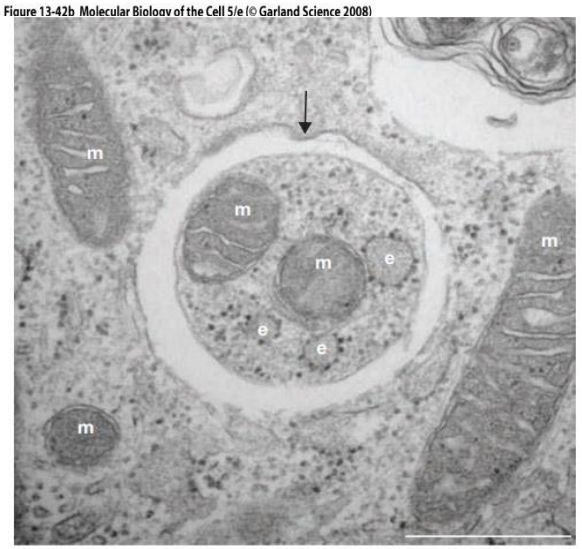
Autofagia

- Processo através do qual macromoléculas e organelas são degradadas e recicladas
- A autofagia é ativada para proteger a células de alguns tipos de estresse: falta de nutrientes, de hormônios, de fatores de crescimento, estresse de , infecções, alta demanda energética
- **PORTANTO, a autofagia é primariamente um mecanismo de <u>sobrevivência</u>**

Autofagia


VESICLE NUCLEATION
VESICLE ELONGATION
VESICLE COMPLETION
FUSION WITH LYSOSOME
Isolation Membrane
Autophagosome
Autolysosome
Lysosome





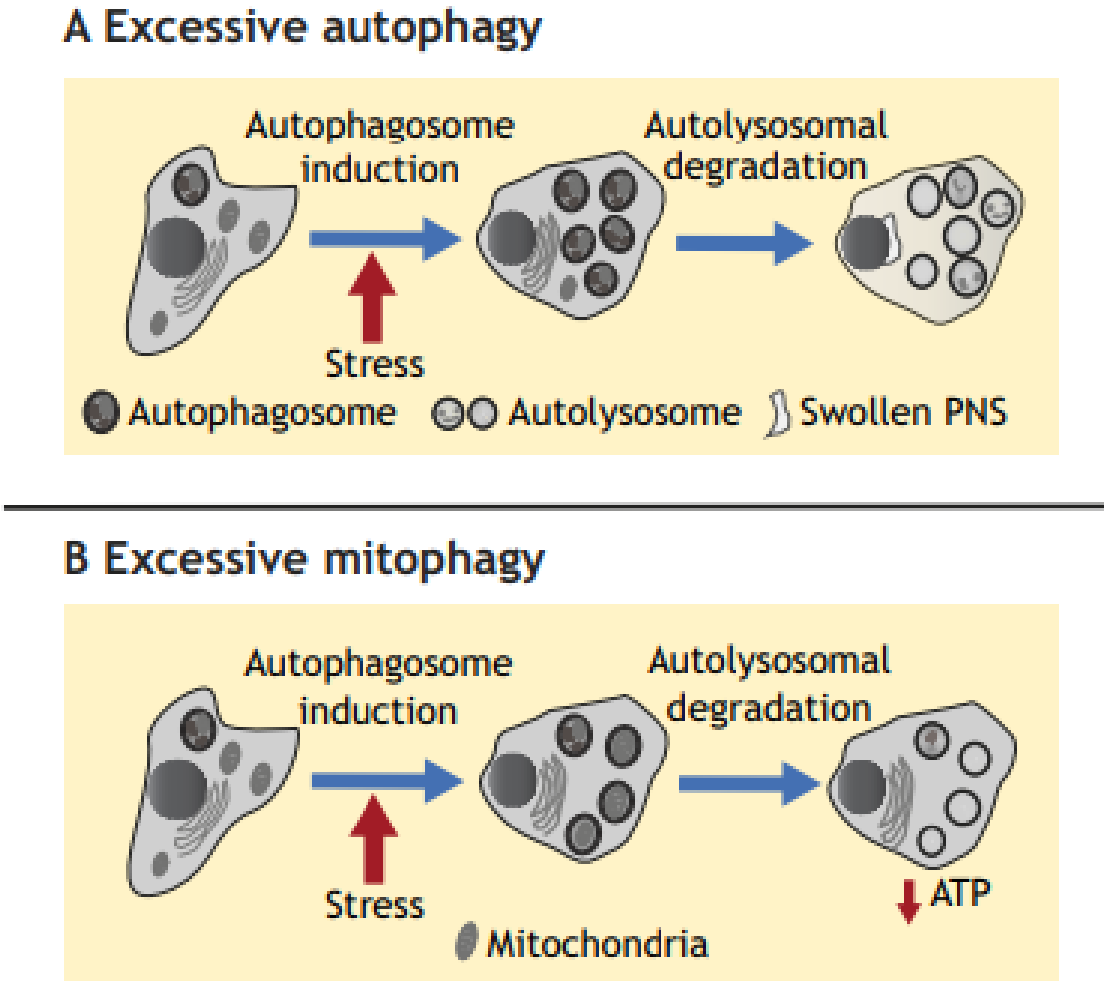
Fibroblasto de embrião carenciado de nutrientes

e – retículo endoplasmático
m – mitocôndria

Morte dependente de autofagia
(ADCD - *autophagy-dependent cell death*)

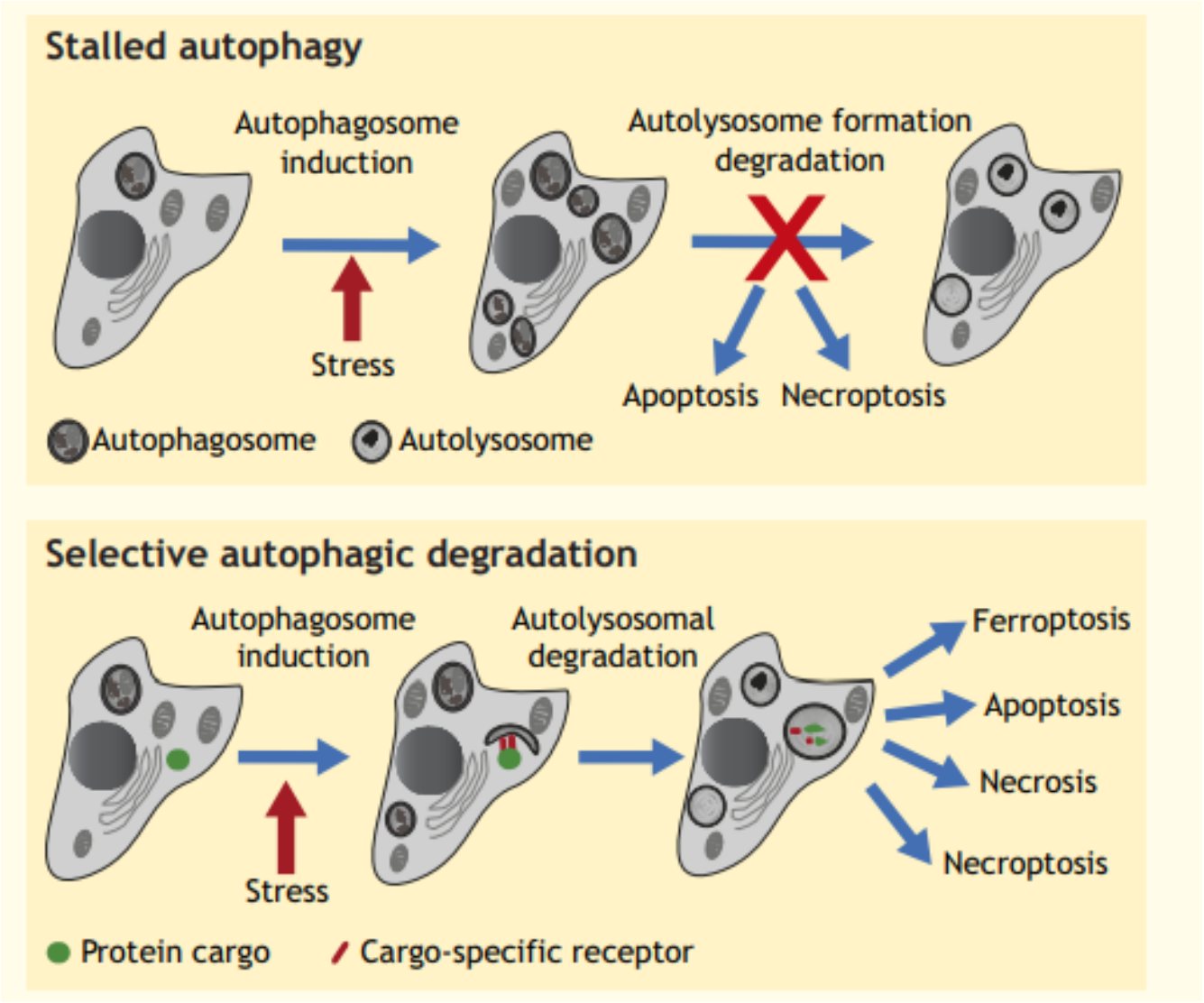
- De acordo com as diretrizes do Comitê de Nomenclatura de Morte celular (NCCD), a morte celular dependente de autofagia depende da maquinaria de autofagia e não envolve vias alternativas de morte celular

Morte celular dependente de autofagia (de acordo com a ACCD):



Bialik et al, 2018. Autophagy-dependent cell death –
where, how and why a cell eats itself to death J Cell Sci, 131, jcs215152. doi:10.1242/jcs.215152

Autofagia como mecanismo de ATIVAR OUTRAS VIAS DE MORTE CELULAR:



Bialik et al, 2018. Autophagy-dependent cell death –
where, how and why a cell eats itself to death J Cell Sci, 131, jcs215152. doi:10.1242/jcs.215152

Necroptose

- Termo genérico para definir morte celular independente de caspases
- Ganho de volume da célula e ‘inchaço’ das organelas
- Não há clivagem do DNA e sim descondensação da cromatina
- Lise celular e extravasamento do seu conteúdo
- Reação inflamatória
- Quando ocorre: infarto, AVC, aterosclerose, infecção viral

apoptose

~~necrose~~ **necroptose**

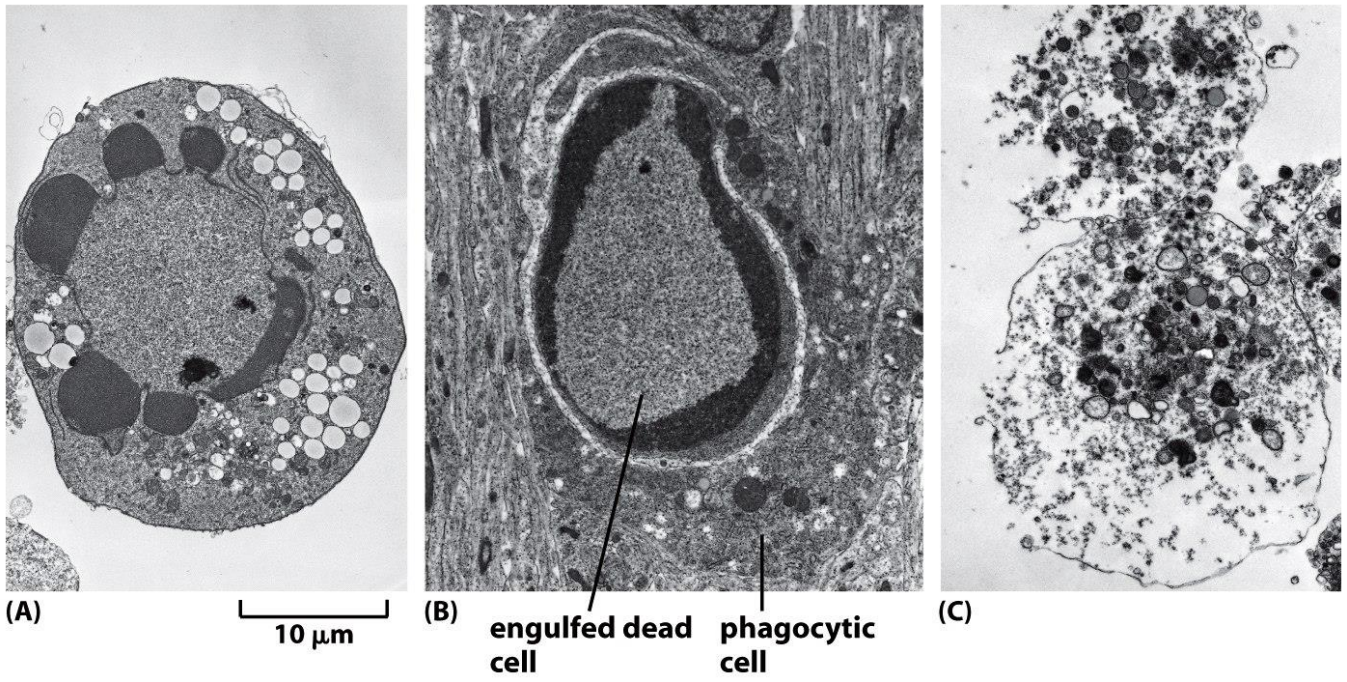


Figure 18-1 Molecular Biology of the Cell 5/e (© Garland Science 2008)

APOPTOSE

Células encolhem
Colapso do citoesquelelo
Rompimento do envelope nuclear
Fragmentação da cromatina
Formação dos corpos apoptóticos
Células apoptóticas são fagocitadas (B)

~~**NECROSE**~~ **necroptose**

rompimento da membranas plasmática
Extravasamento do conteúdo celular
Resposta inflamatória

OPINION

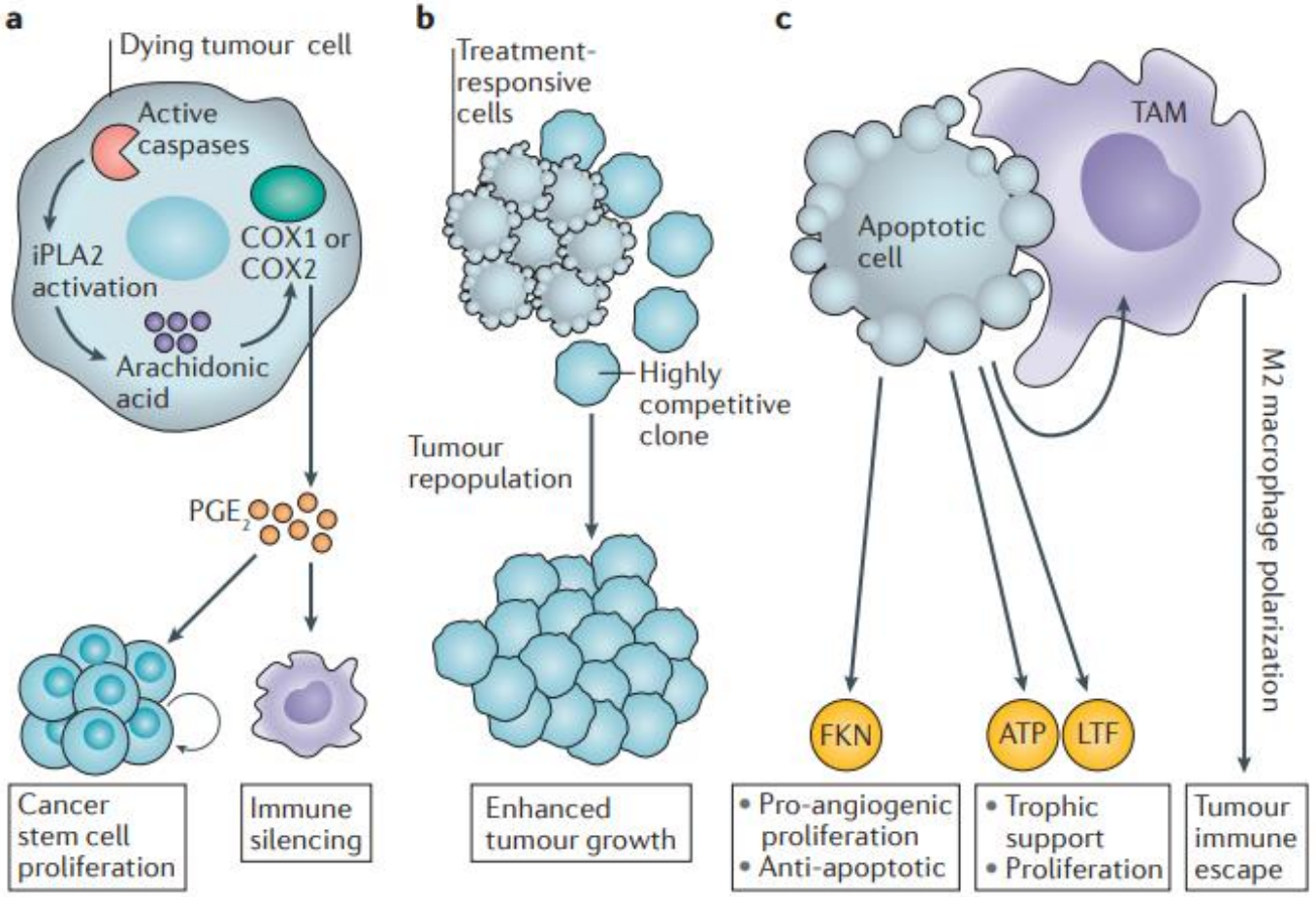
A fate worse than death: apoptosis as an oncogenic process

Gabriel Ichim and Stephen W. G. Tait

Abstract | Apoptotic cell death is widely considered a positive process that both prevents and treats cancer. Although undoubtedly having a beneficial role, paradoxically, apoptosis can also cause unwanted effects that may even promote cancer. In this Opinion article we highlight some of the ways by which apoptosis can exert oncogenic functions. We argue that fully understanding this dark side will be required to optimally engage apoptosis, thereby maximizing tumour cell kill while minimizing unwanted pro-tumorigenic effects.

Gabriel Ichim G & Tait SWG, 2016. A fate worse than death: apoptosis as an oncogenic process. Nature Rev Cancer, 16: 539-548

A fate worse than death: apoptosis as an oncogenic process



Gabriel Ichim G & Tait SWG, 2016. A fate worse than death: apoptosis as an oncogenic process. Nature Rev Cancer, 16: 539-548

WHAT WE DON'T KNOW

- How many forms of programmed cell death exist? What are the underlying mechanisms and benefits of each?

- Thousands of caspase substrates have been identified. Which ones are the critical proteins that must be cleaved to trigger the major cell remodeling events underlying apoptosis?

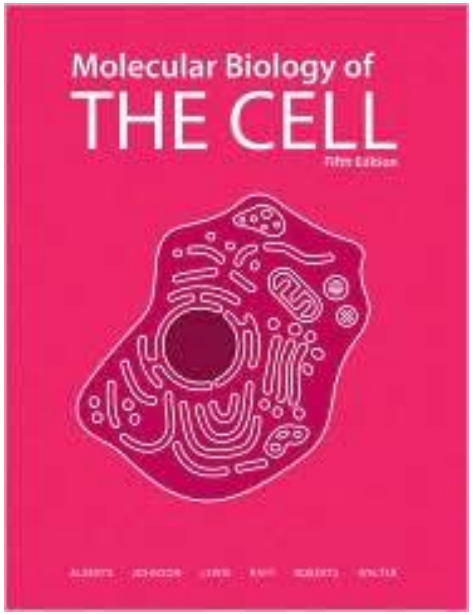
- How did the intrinsic pathway of apoptosis evolve, and what is the advantage of having mitochondria play such a central role in regulating apoptosis?

- How are "don't eat me" signals eliminated or inactivated during apoptosis to allow the cells to be phagocytosed?

Molecular Biology of the Cell, Bruce Alberts 6ª edição

Bibliografia

Capítulos 18



Cell Death & Differentiation
https://doi.org/10.1038/s41418-017-0012-4

Cell Death & Differentiation

REVIEW

Molecular mechanisms of cell death: recommendations of the Nomenclature Committee on Cell Death 2018

Lorenzo Galluzzi[1,2,3] · Ilio Vitale[4,5] et al.

Received: 11 October 2017 / Accepted: 13 October 2017
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Abstract

Over the past decade, the Nomenclature Committee on Cell Death (NCCD) has formulated guidelines for the definition and interpretation of cell death from morphological, biochemical, and functional perspectives. Since the field continues to expand and novel mechanisms that orchestrate multiple cell death pathways are unveiled, we propose an updated classification of cell death subroutines focusing on mechanistic and essential (as opposed to correlative and dispensable) aspects of the process. As we provide molecularly oriented definitions of terms including intrinsic apoptosis, extrinsic apoptosis, mitochondrial permeability transition (MPT)-driven necrosis, necroptosis, ferroptosis, pyroptosis, parthanatos, entotic cell death, NETotic cell death, lysosome-dependent cell death, autophagy-dependent cell death, immunogenic cell death, cellular senescence, and mitotic catastrophe, we discuss the utility of neologisms that refer to highly specialized instances of these processes. The mission of the NCCD is to provide a widely accepted nomenclature on cell death in support of the continued development of the field.

https://www.nature.com/articles/s41418-017-0012-4

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