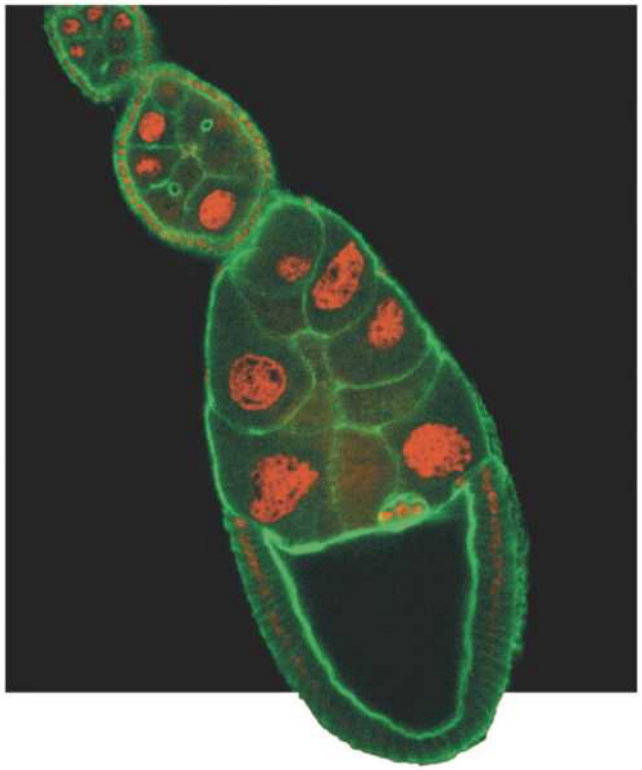
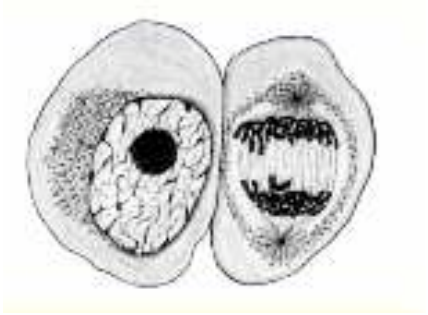
Linhagem germinativa



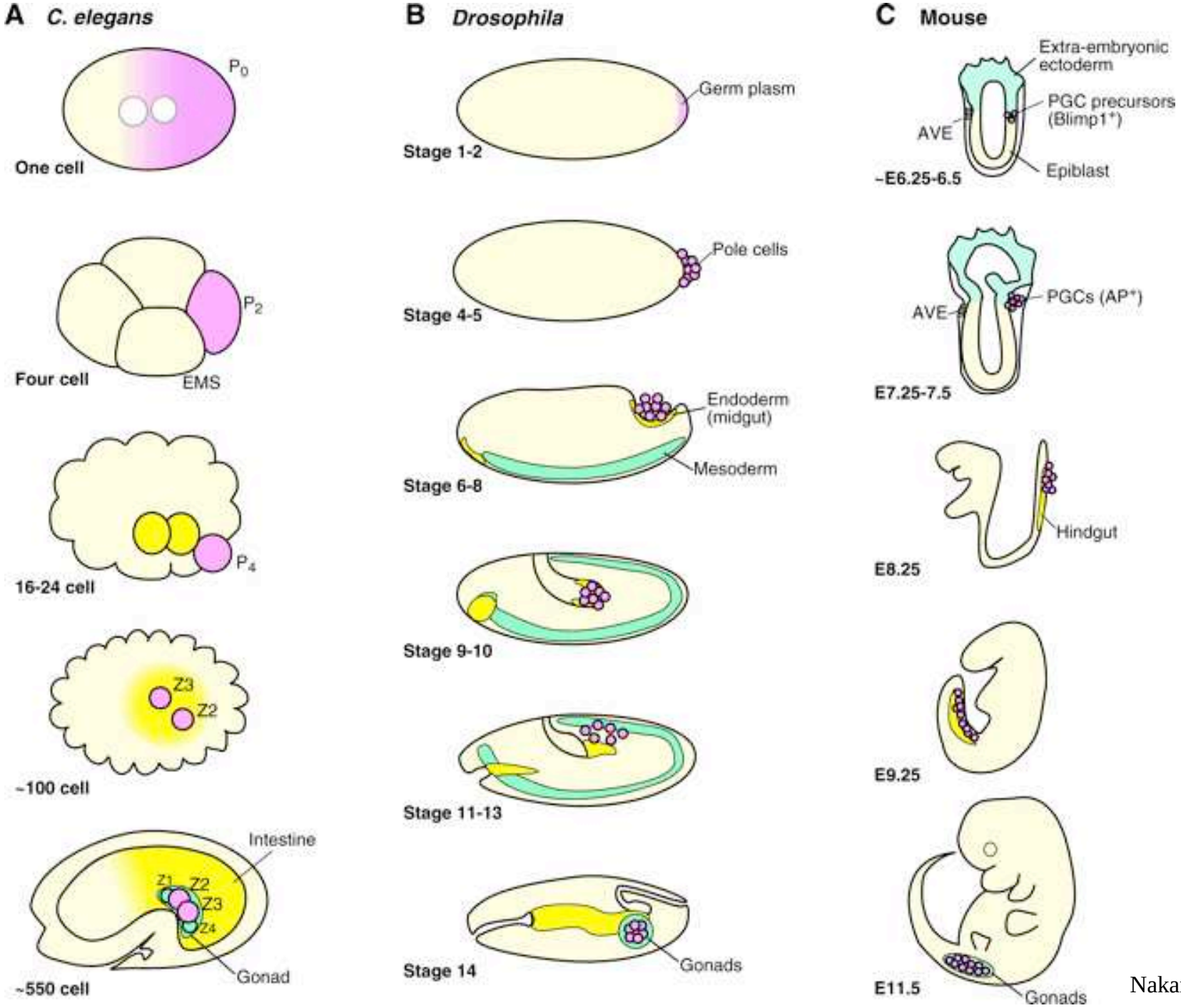
DEVELOPMENTAL BIOLOGY, Eighth Edition, Chapter 19, Opener © 2006 Sinauer Associates, Inc.



PGCs da crista gonadal da tartaruga *Sternoterus odoratus*

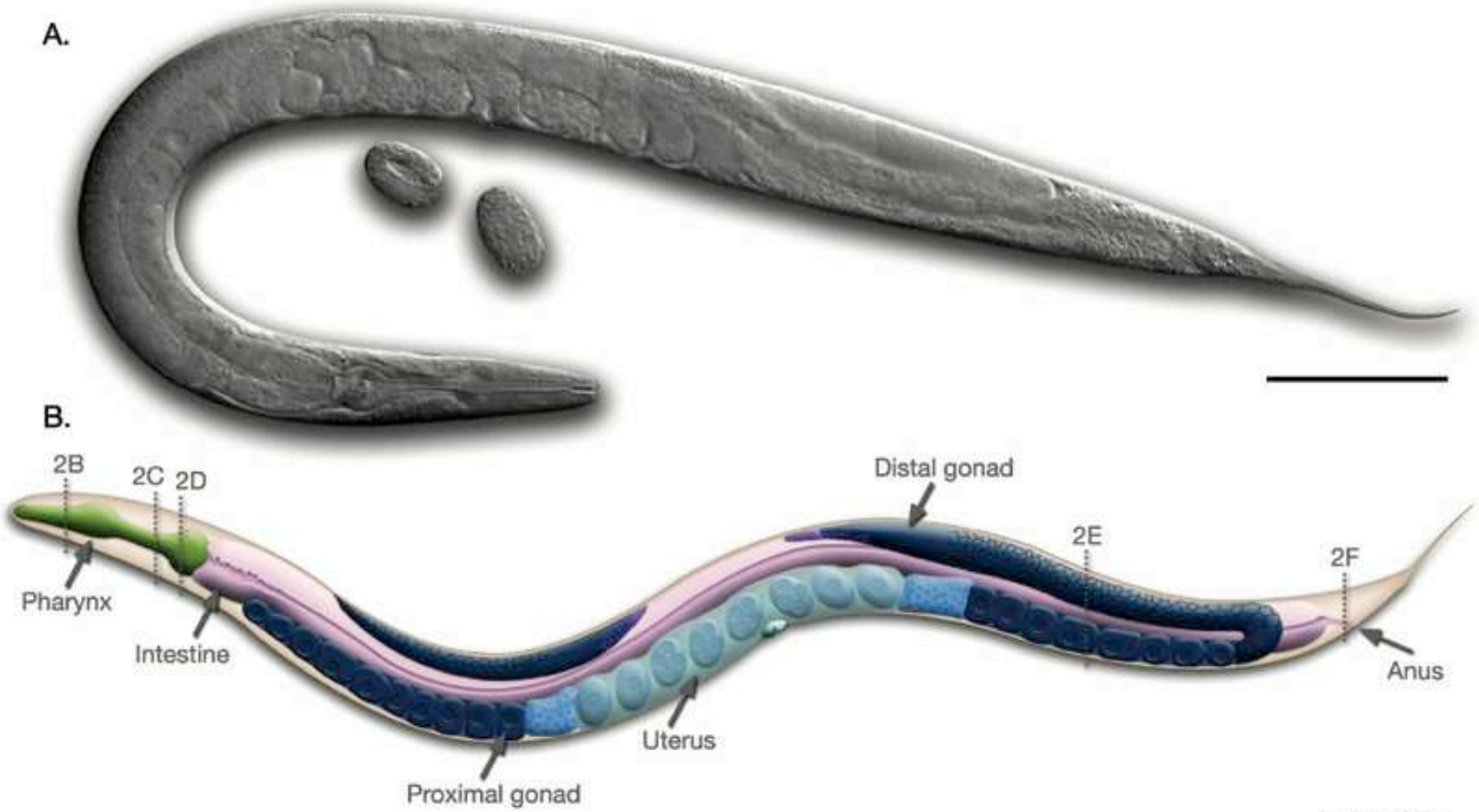
(Extavour, 2003)

Formas de determinação das células germinativas em modelos animais

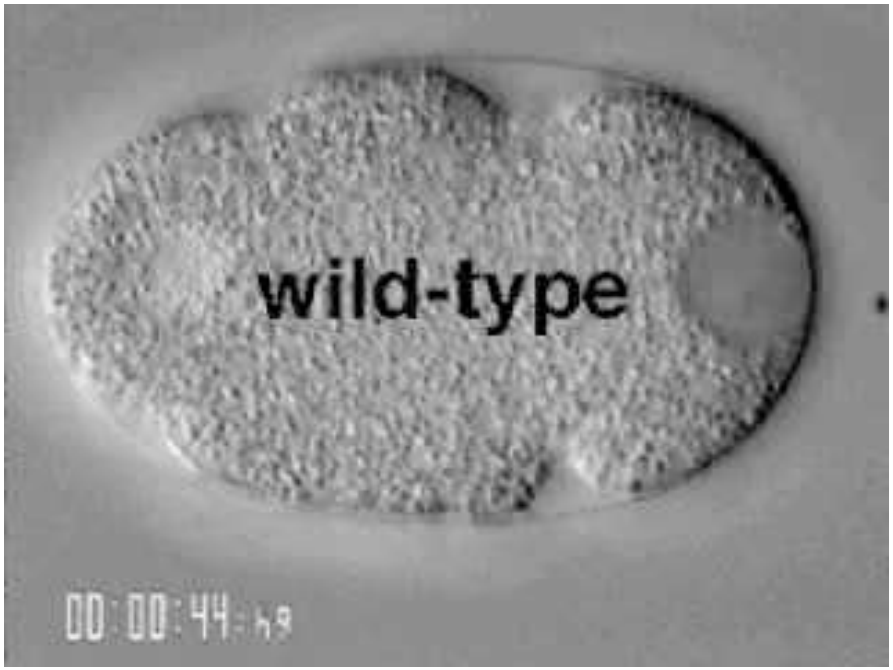


Nakamura & Seydoux, 2008

Linhagem germinativa e gametogênese em nemátoides

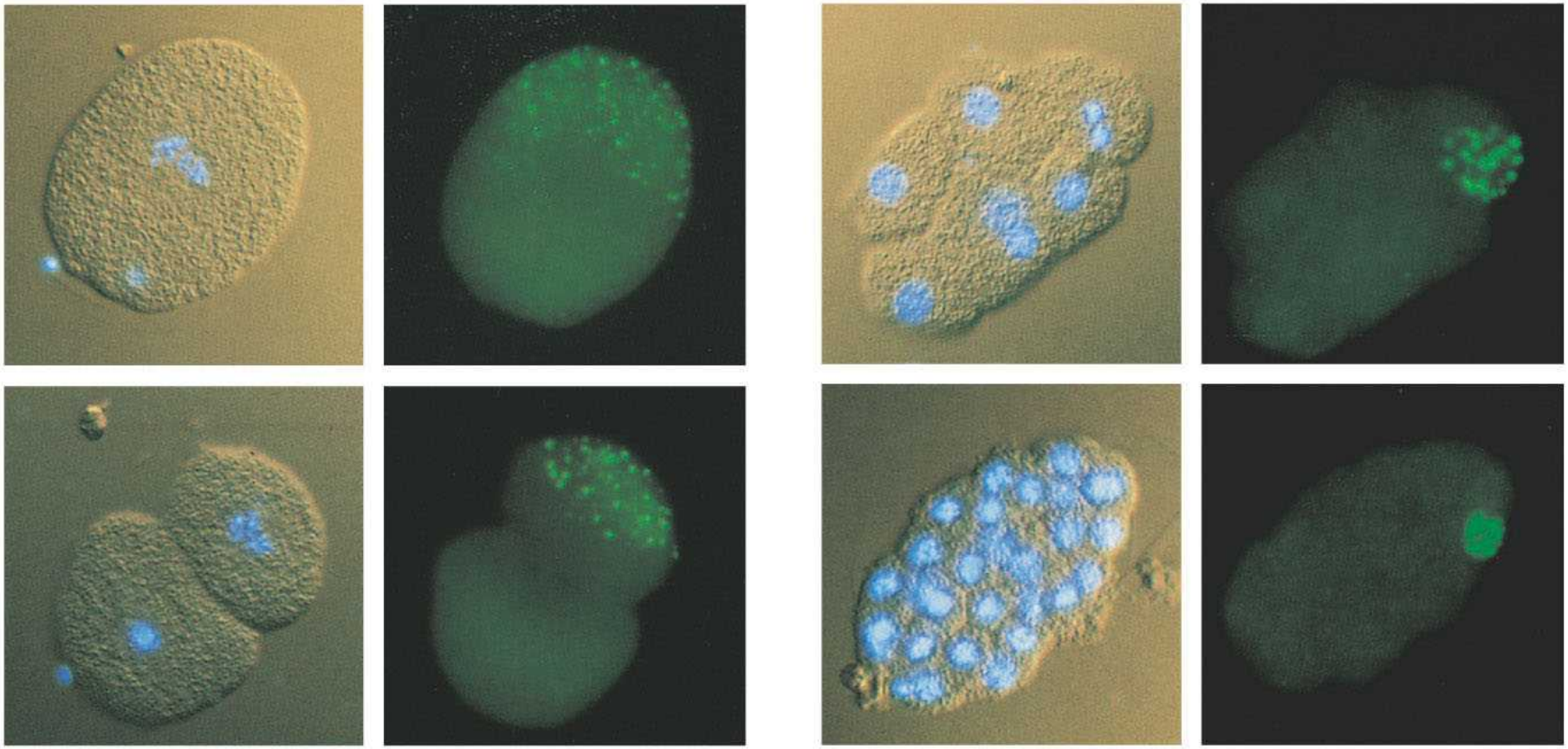


Primeiras divisões em C. elegans

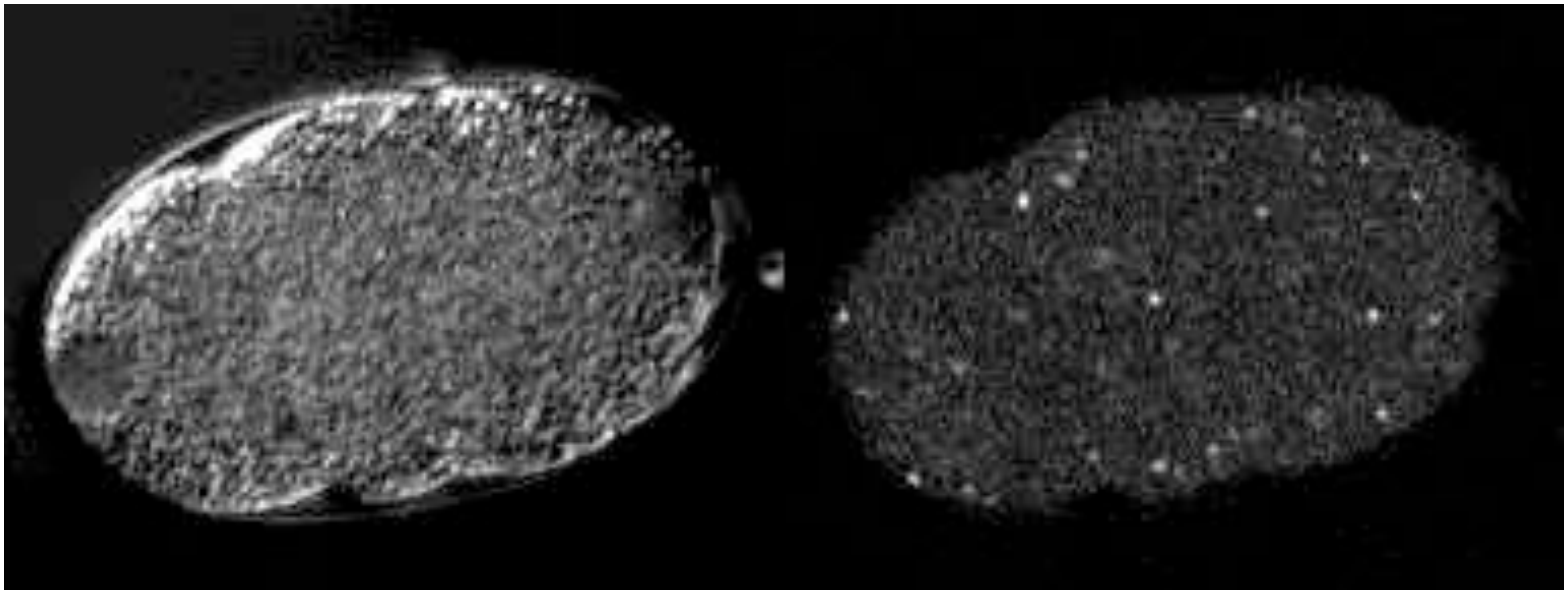


Molecular Cell Biology. 2004. Lodish et al. 5th Ed. WH Freeman and Co.

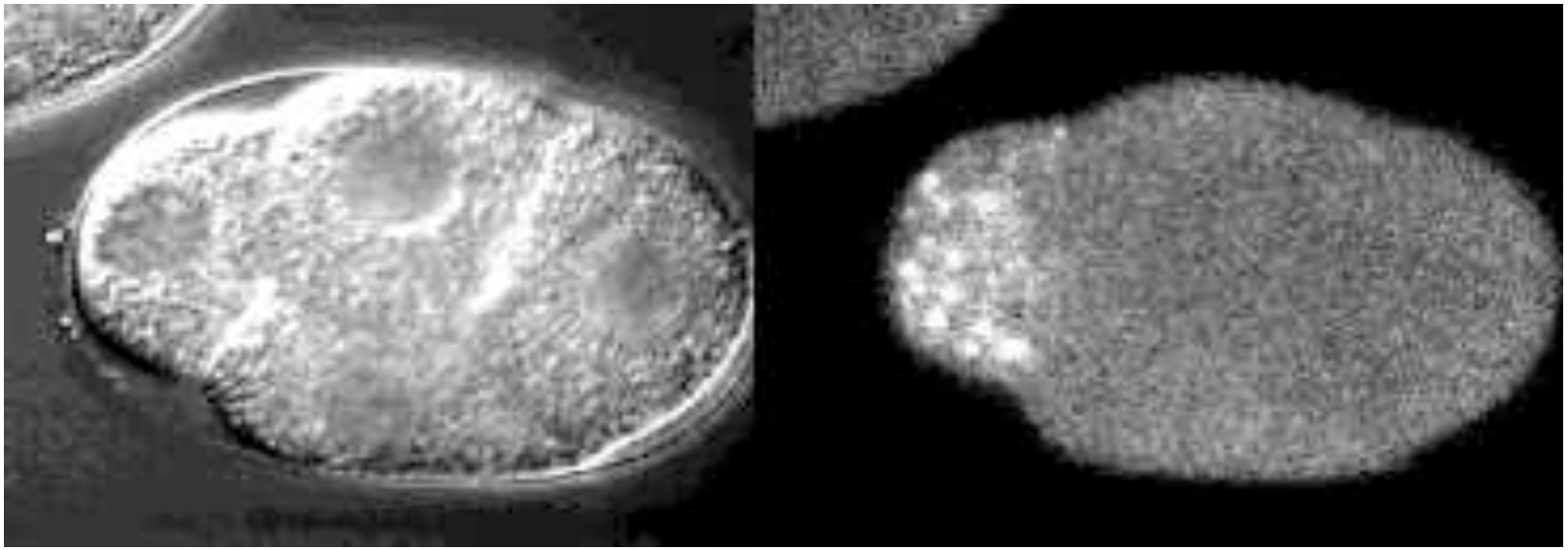
Segregation of the P-granules into the germ line lineage of the *C. elegans* embryo



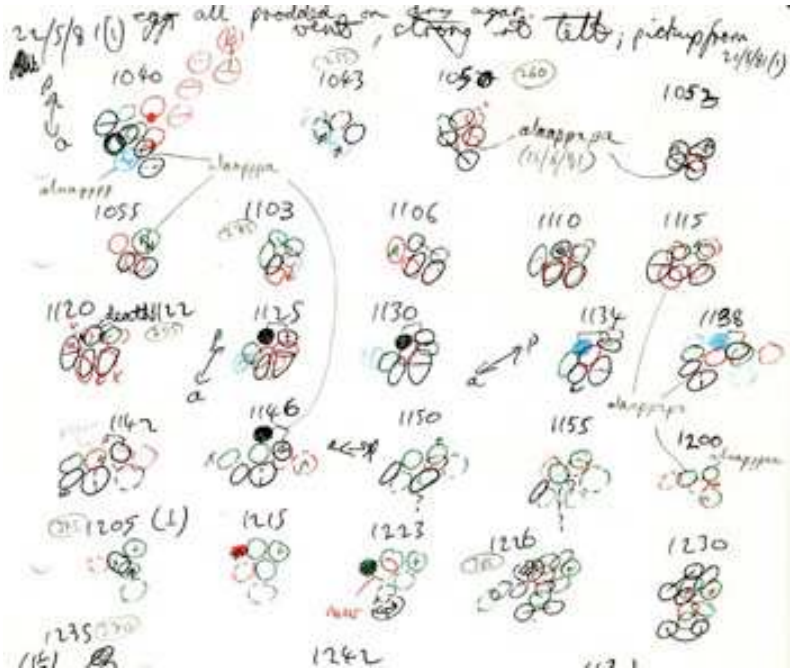
P-Granule Migration *in C. elegans*: First Division

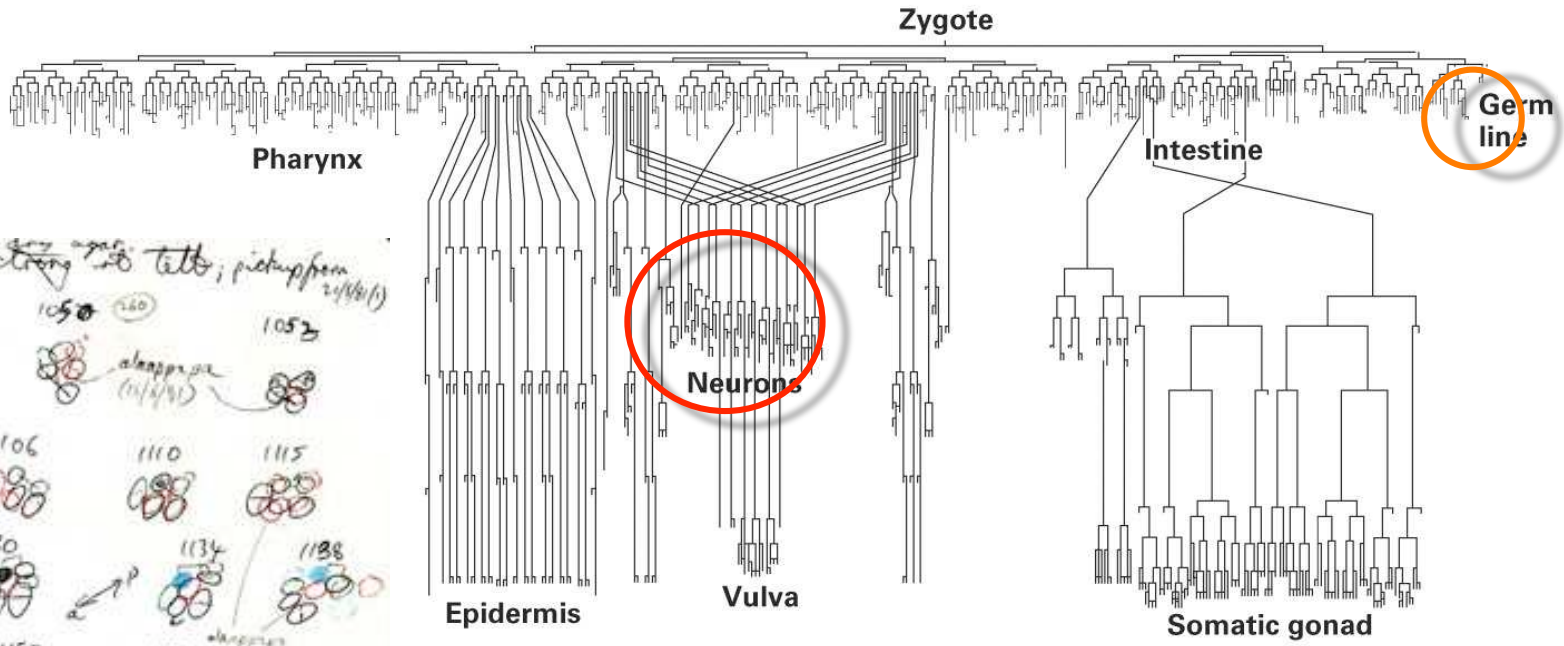


P-Granule Migration *in C. elegans*: Third Division

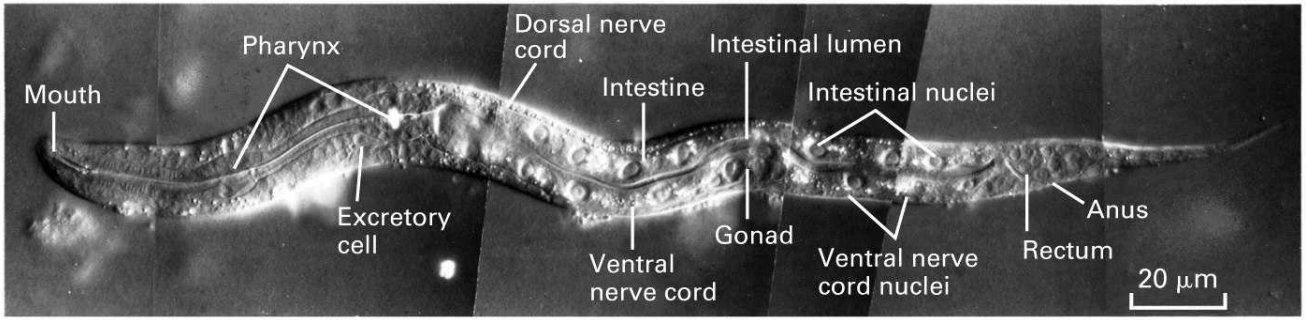


A linhagem germinativa é determinada muito cedo no desenvolvimento de *C. elegans*



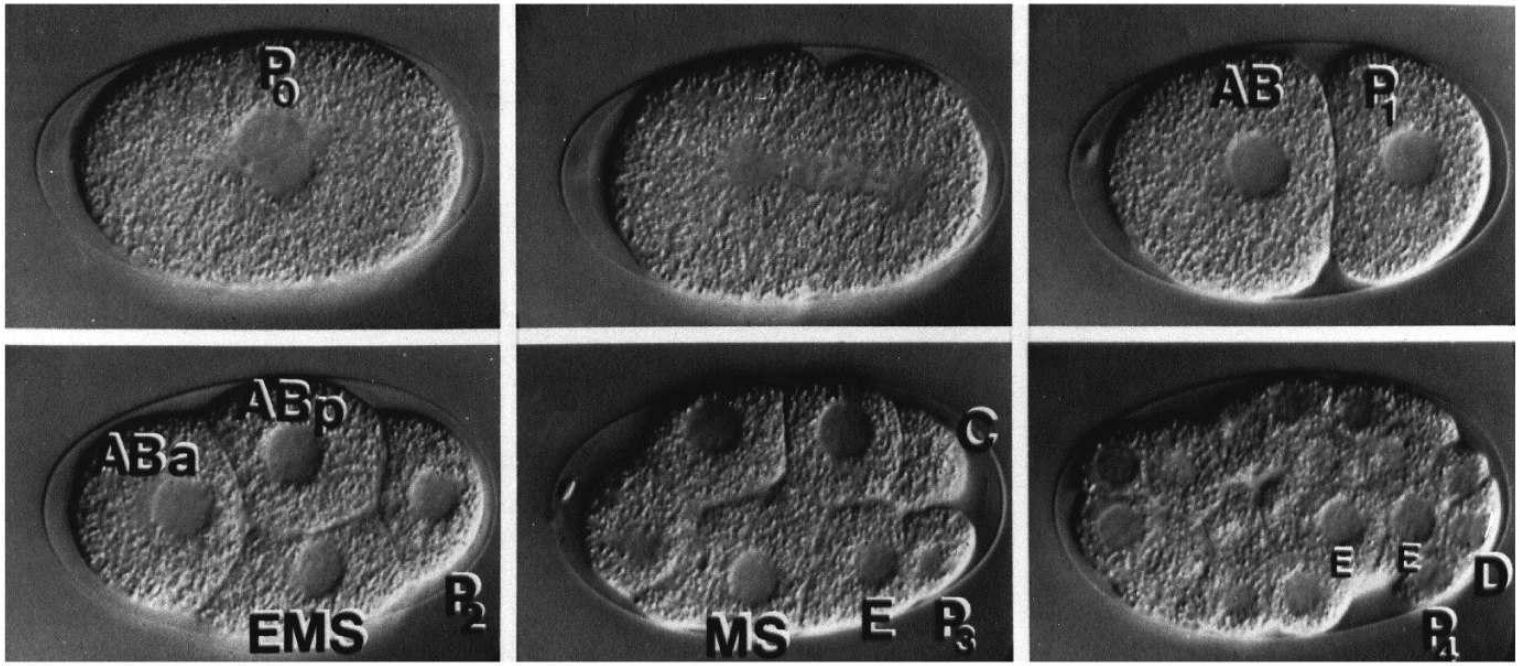


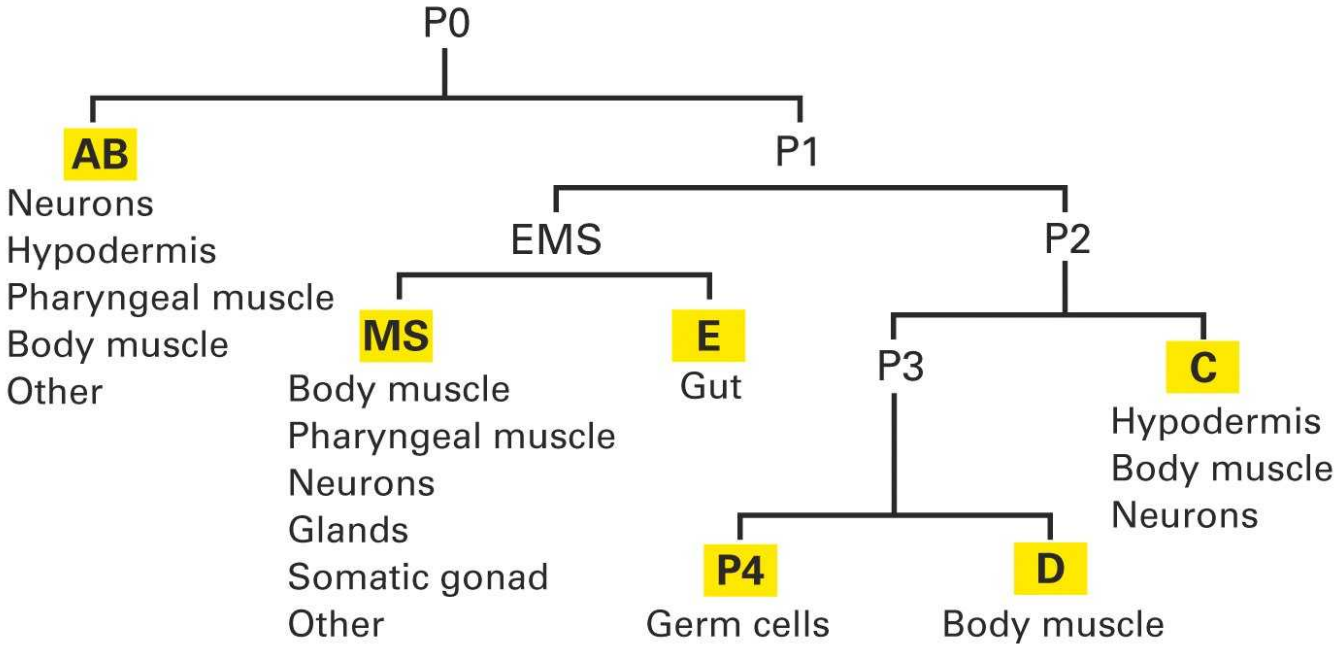
John Sulston



Molecular Cell Biology. 2004. Lodish et al. 5th Ed. WH Freeman and Co.

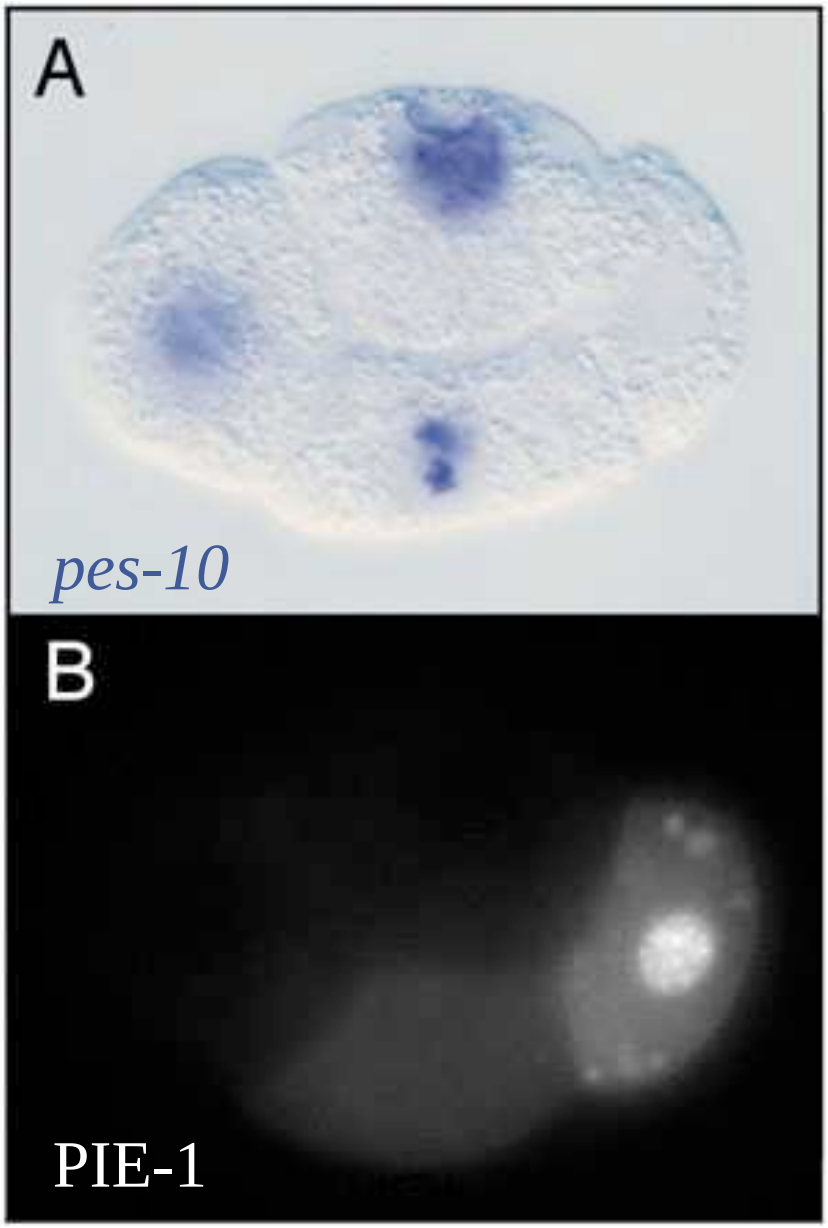
P4 dá origem as células germinativas primordiais (PGCs)

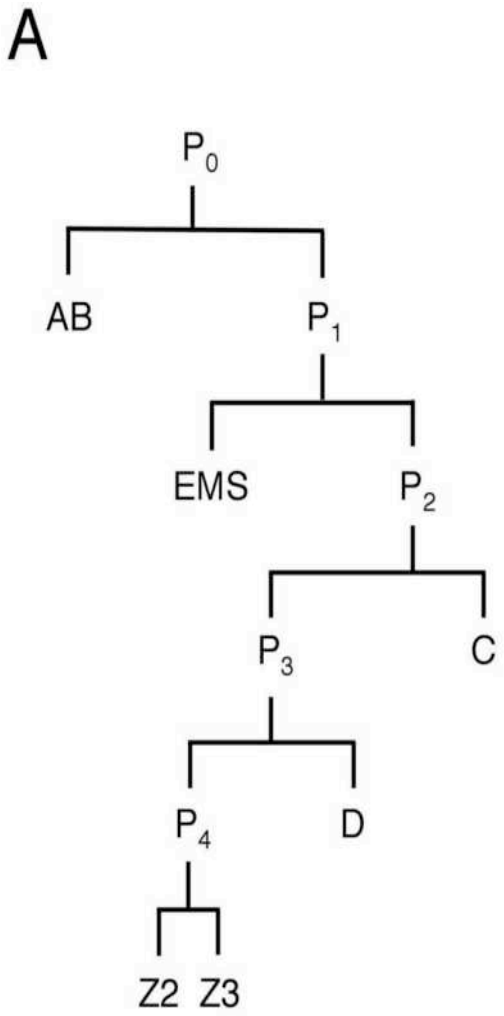


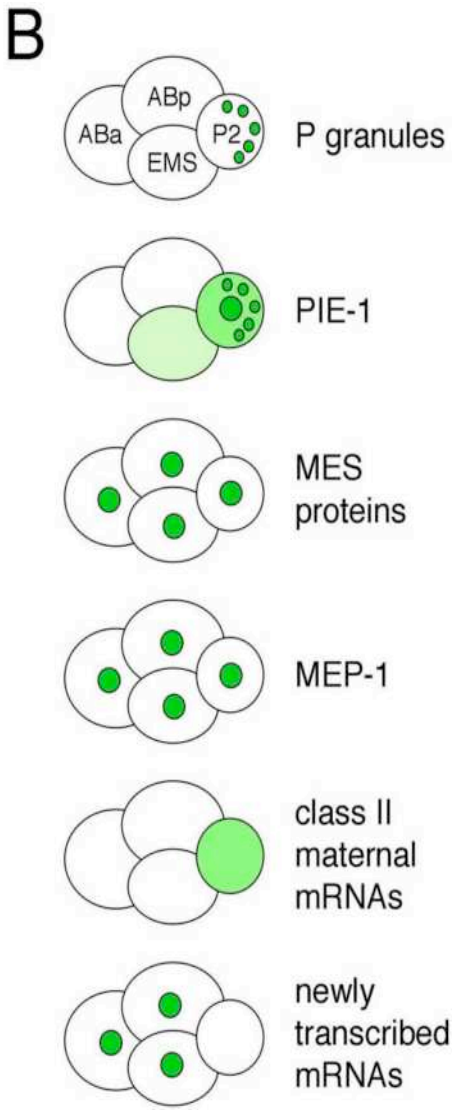


Molecular Cell Biology. 2004. Lodish et al. 5th Ed. WH Freeman and Co.

Inibição da transcrição em precursores das células germinativas de *C. elegans*

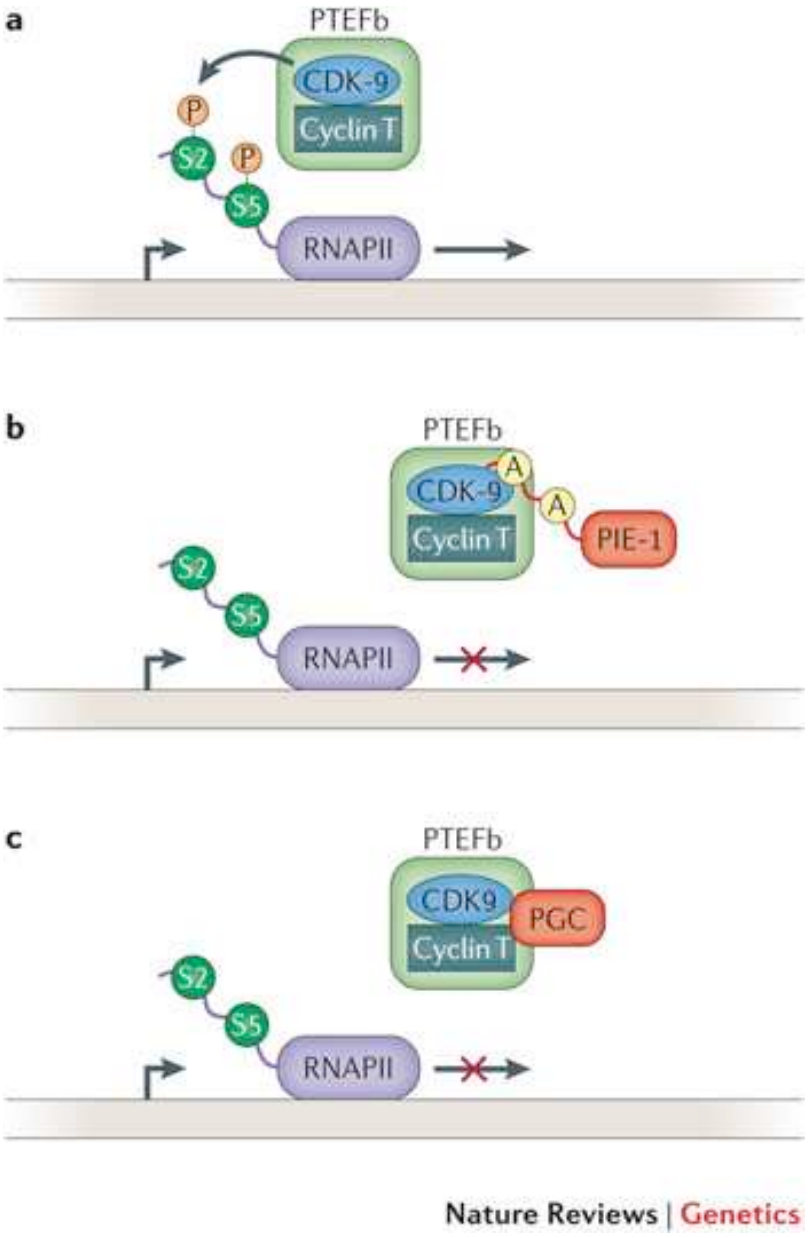




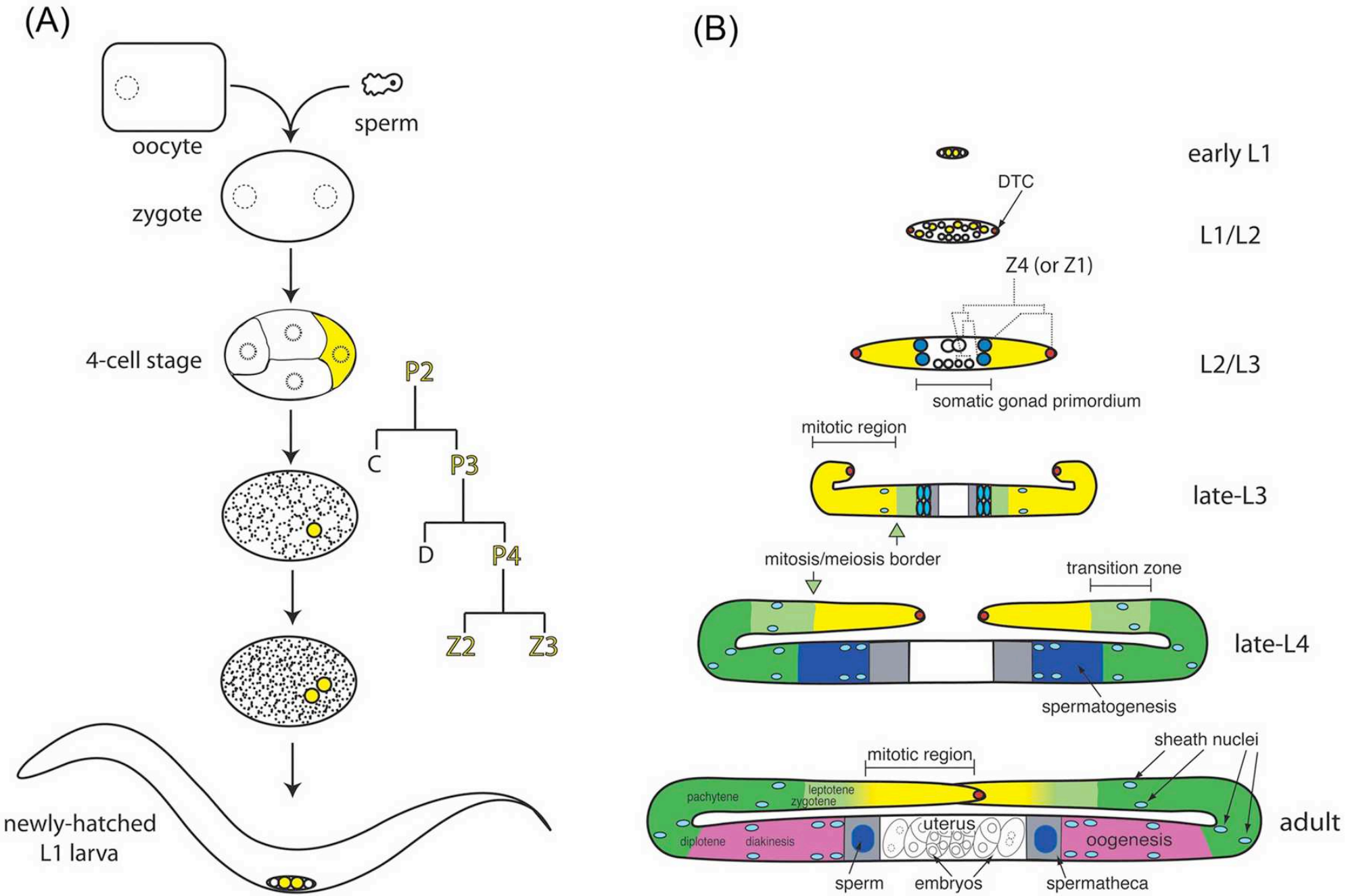


G. Seydoux

Inibição da transcrição

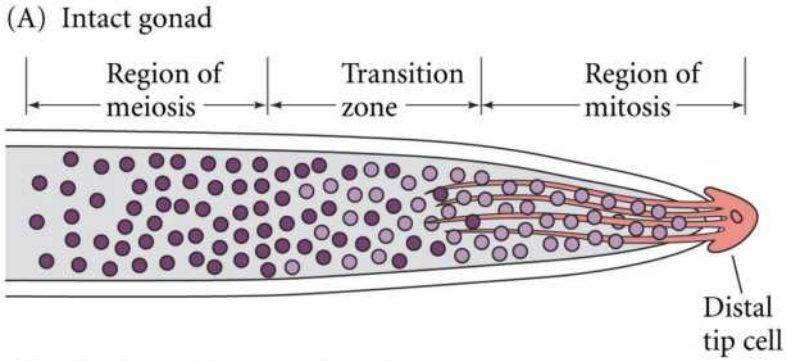


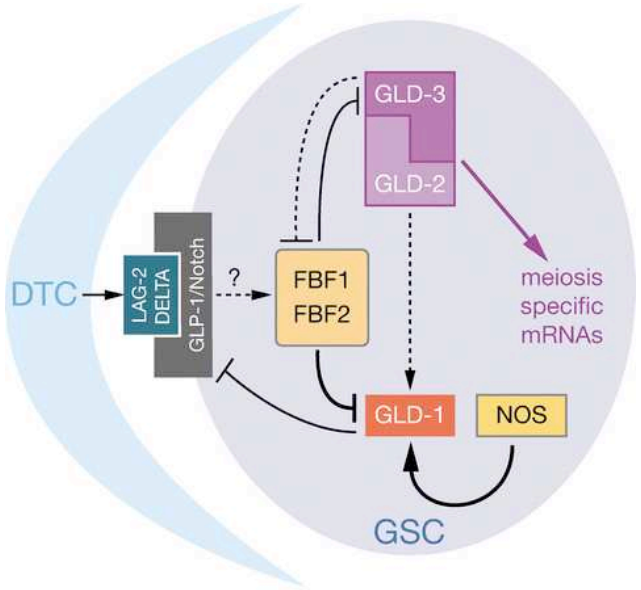
Linhagem germinativa de *C. elegans*

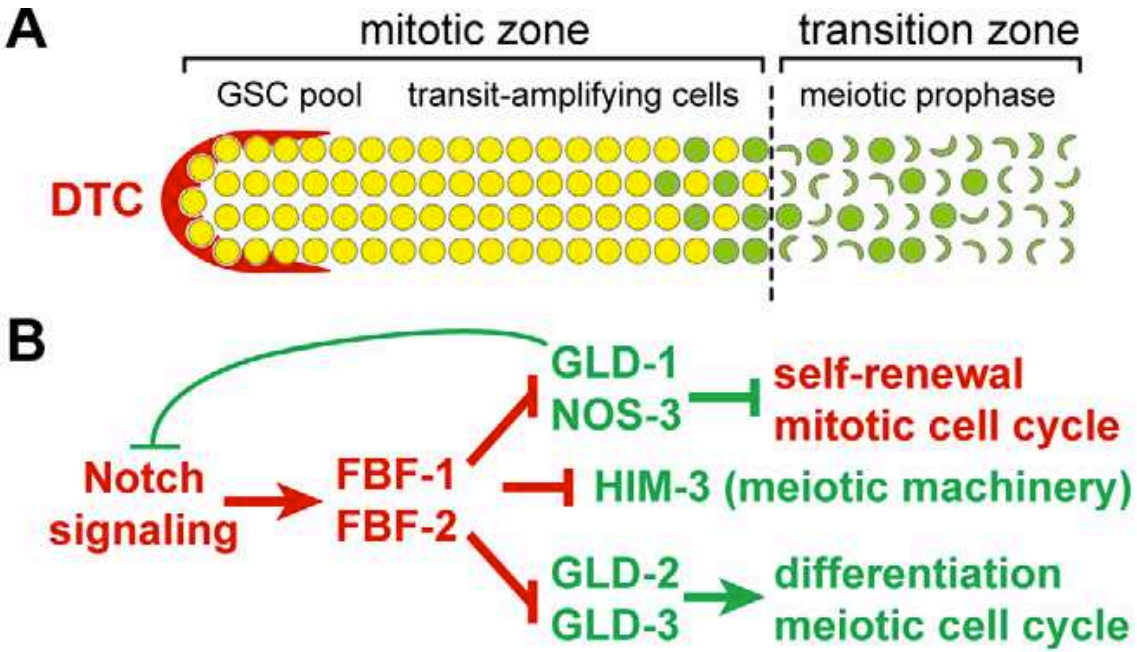


http://www.wormatlas.org/movies/Germlinedev.swf

Regulação da decisão de mitose-meiose pela ponta distal em *C. elegans*, ovotestis celular (Parte I)

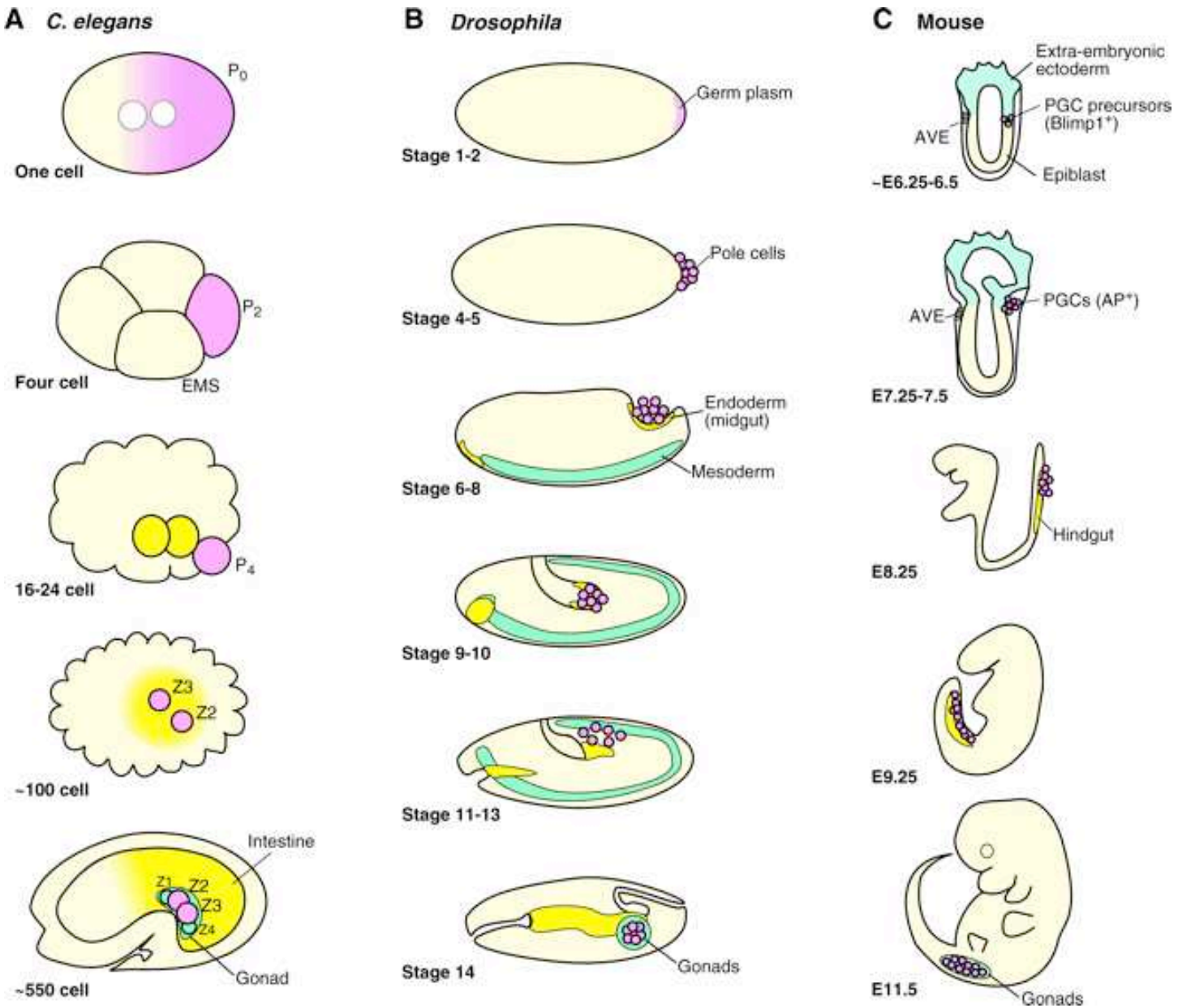






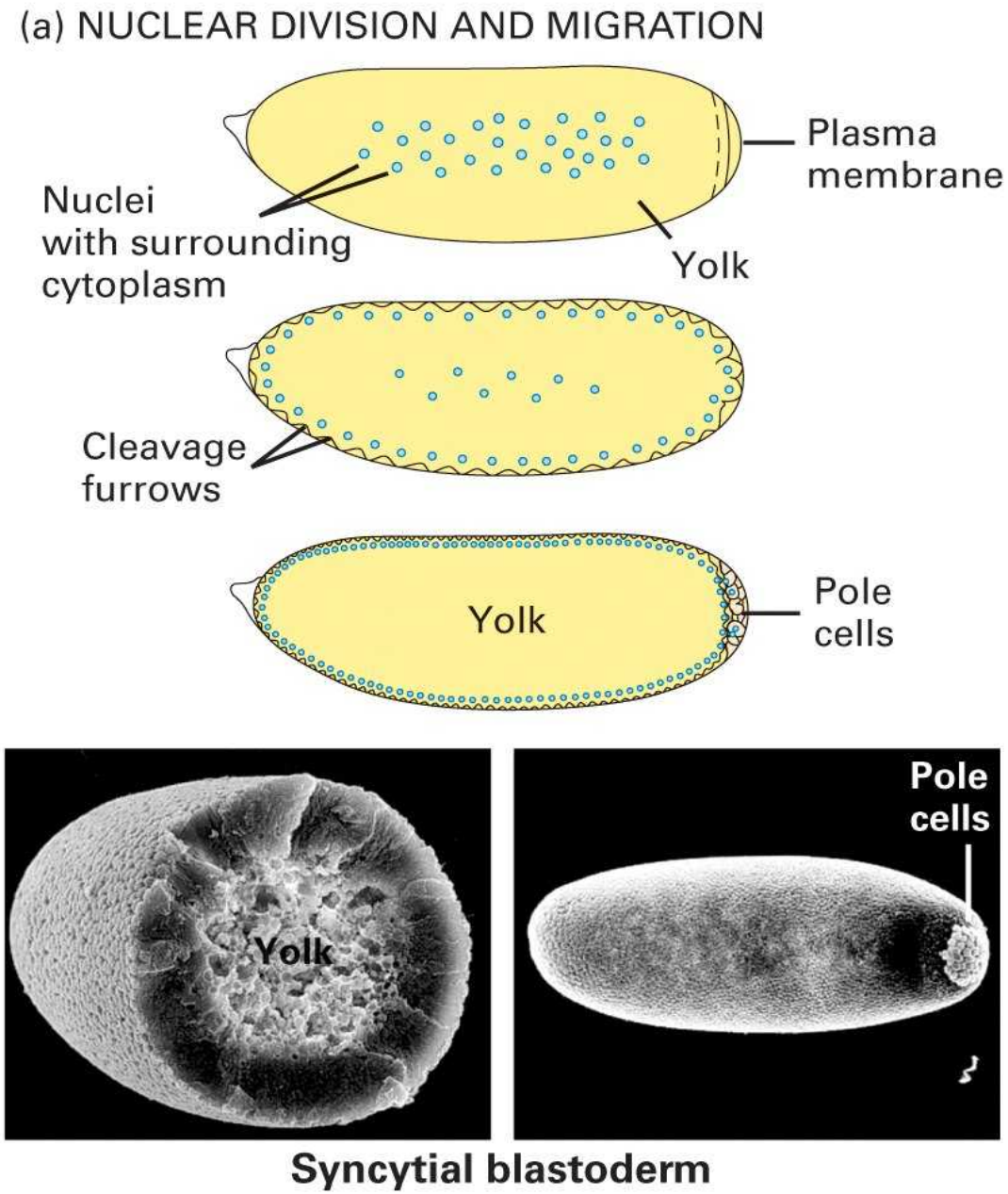
Wong MD, et al. 2005.
Annu. Rev. Genet. 39:173–95

Formas de determinação das células germinativas em modelos animais



Nakamura & Seydoux, 2008

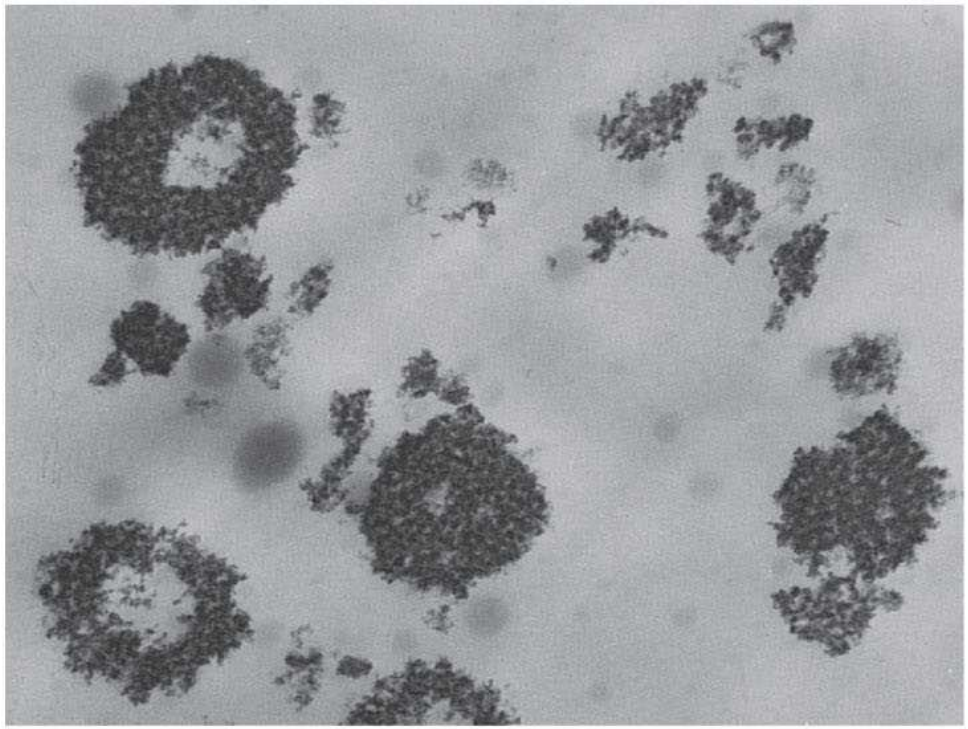
Linhagem germinativa em *Drosophila*



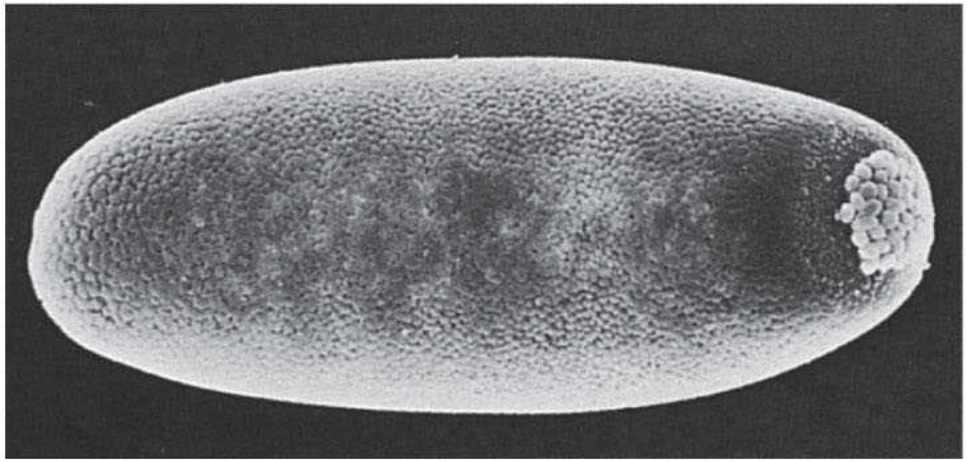
Molecular Cell Biology. 2004. Lodish et al. 5th Ed. WH Freeman and Co.

O plasma polar de *Drosophila*

(A)

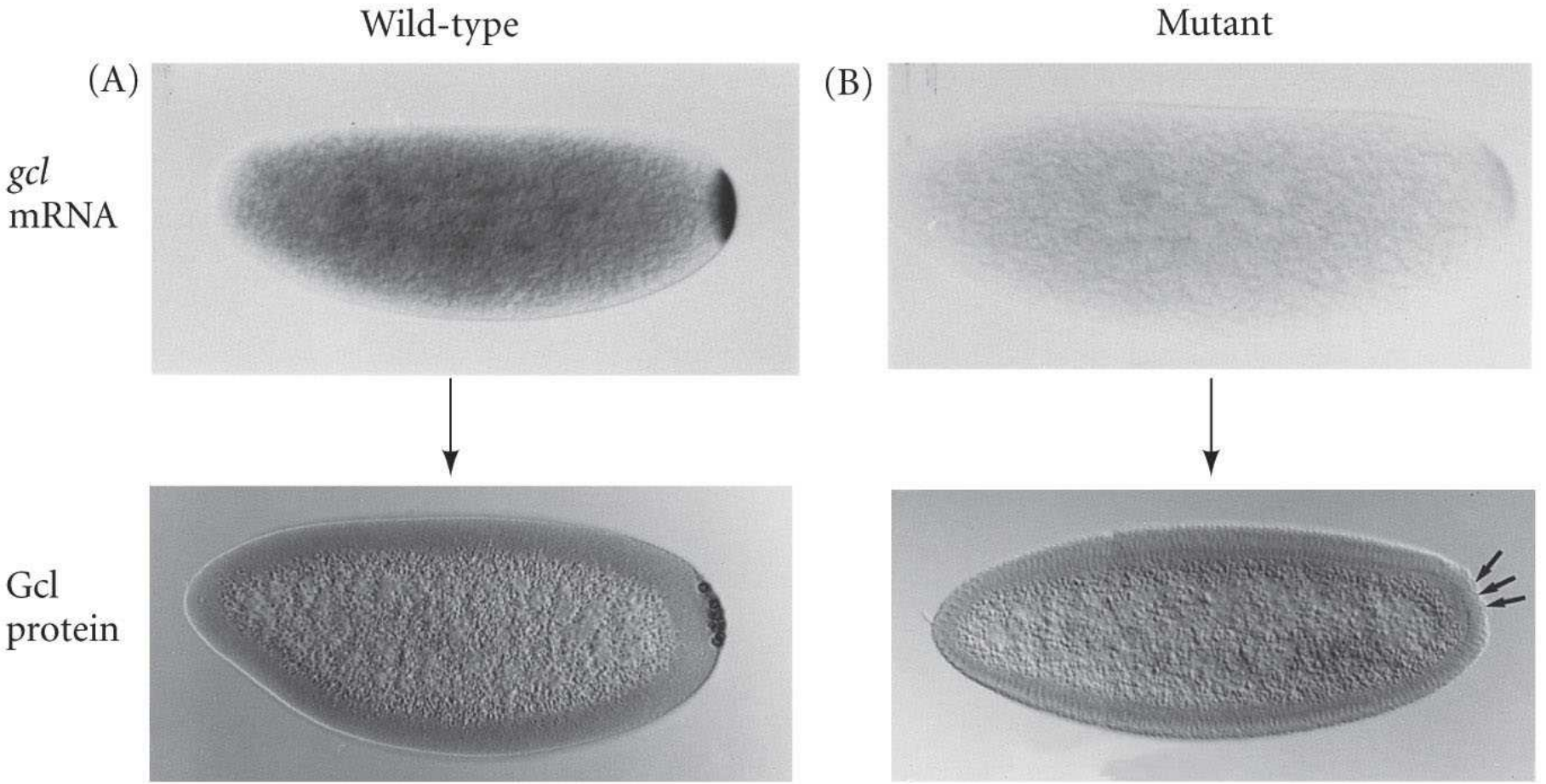


(B)



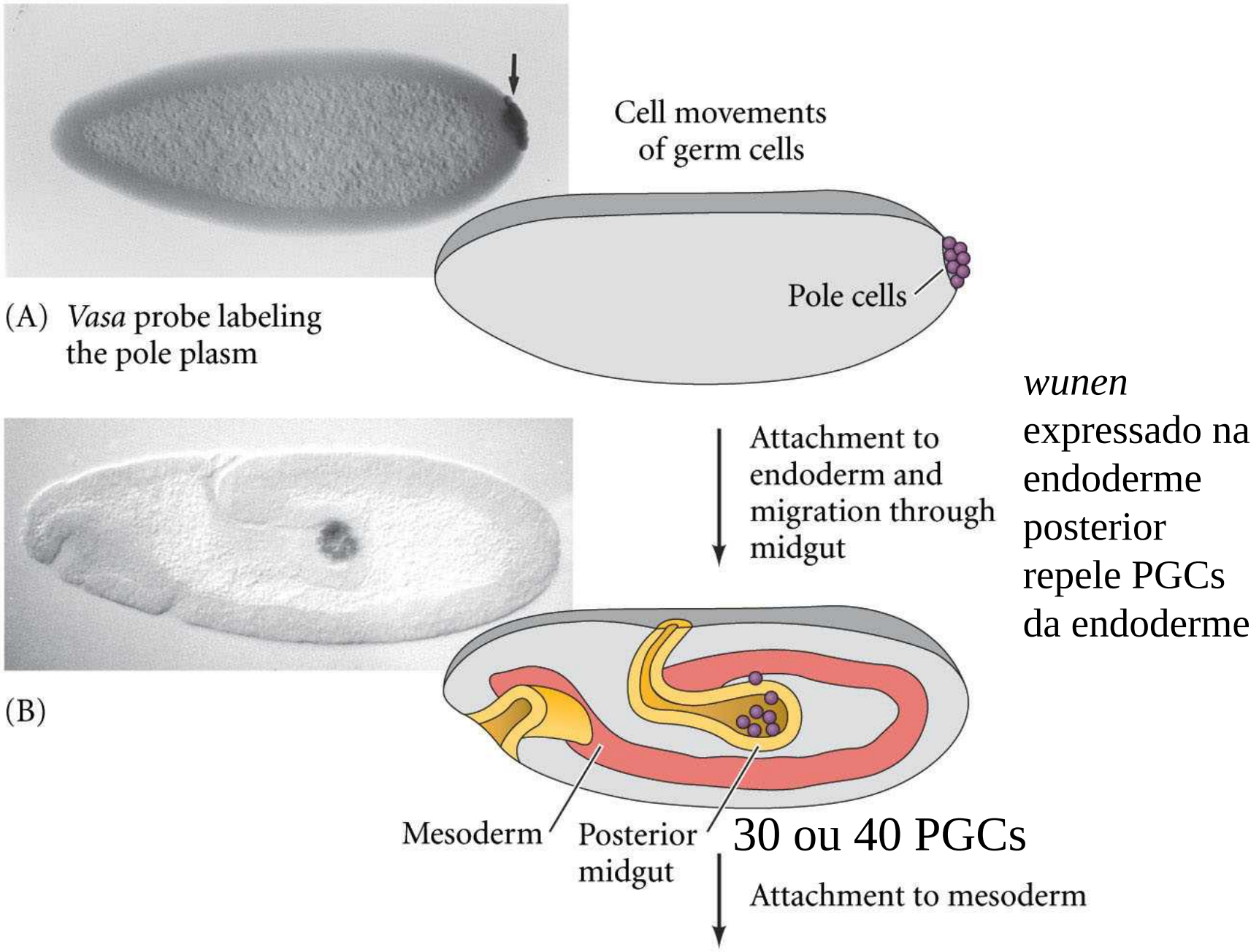
***DEVELOPMENTAL BIOLOGY, Eighth Edition,* Figure 19.3**

Localização da expressão do gene *germ cell-less* na região posterior do zigoto e embrião



***DEVELOPMENTAL BIOLOGY, Eighth Edition,* Figure 19.5** © 2006 Sinauer Associates, Inc.

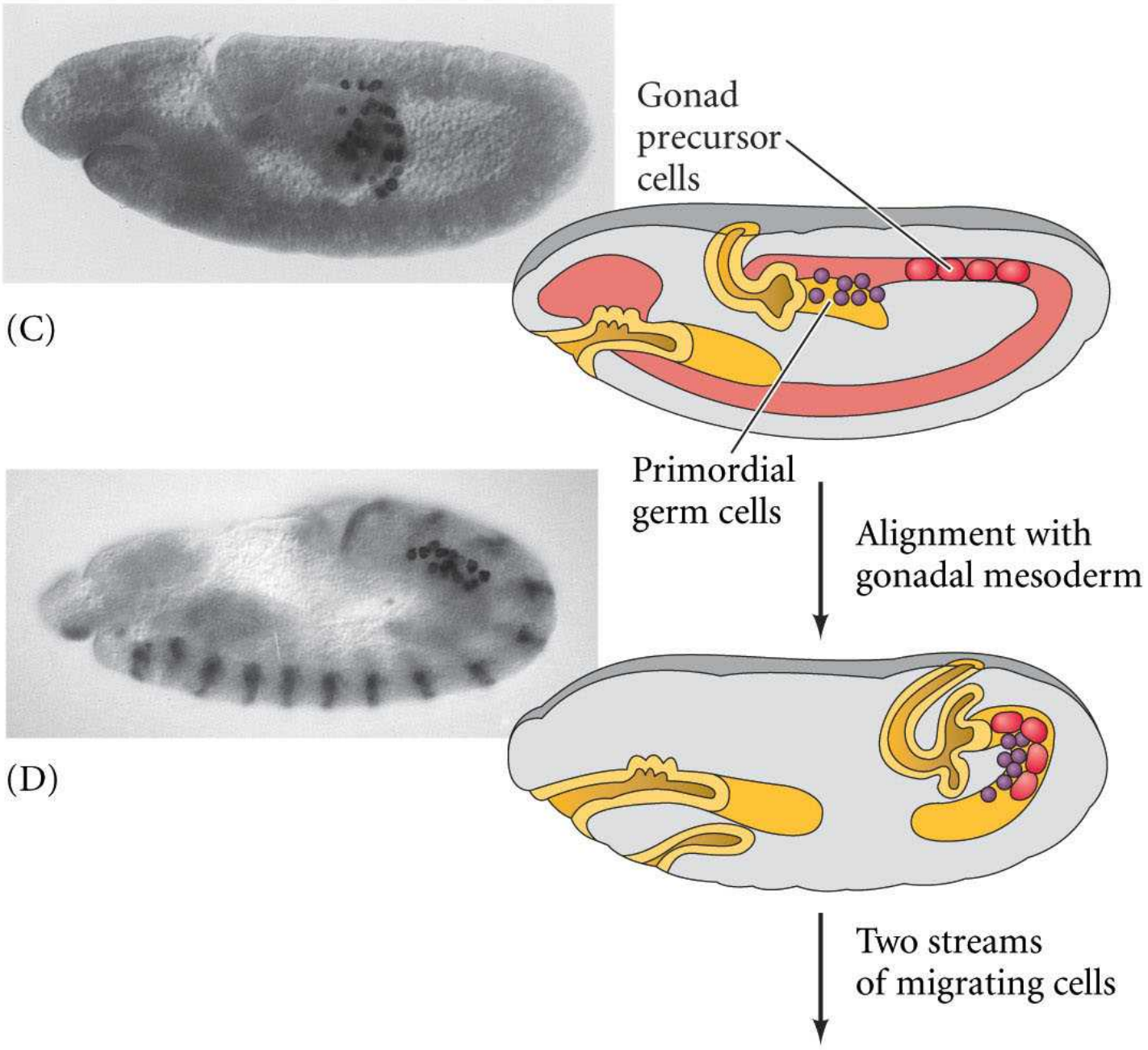
Migração das células germinativas no embrião de *Drosophila* (Parte I)



wunen expressado na endoderme posterior repele PGCs da endoderme

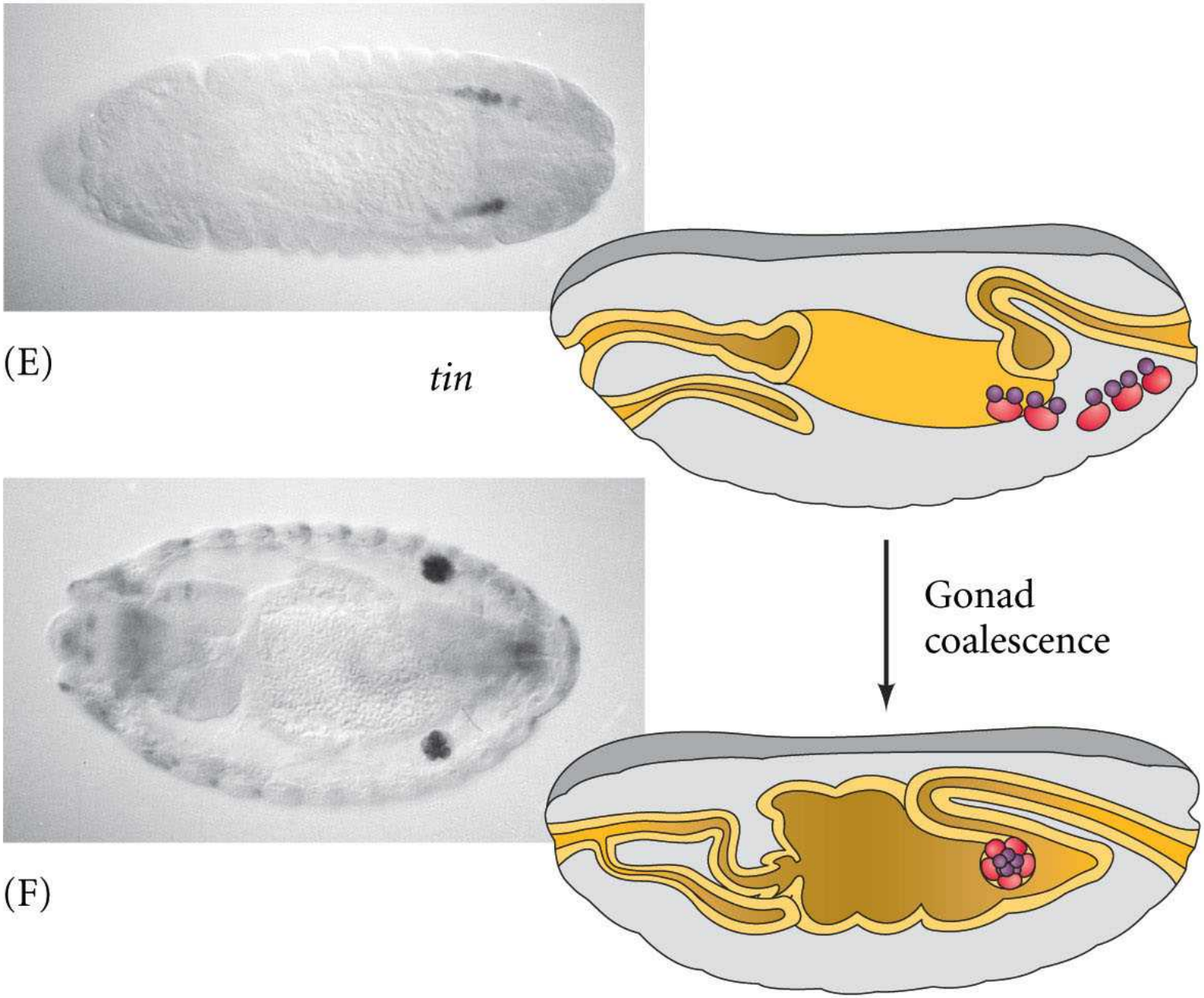
DEVELOPMENTAL BIOLOGY, Eighth Edition, Figure 19.11 (Part 1) © 2006 Sinauer Associates, Inc.

Migração das células germinativas no embrião de *Drosophila (*Parte II)



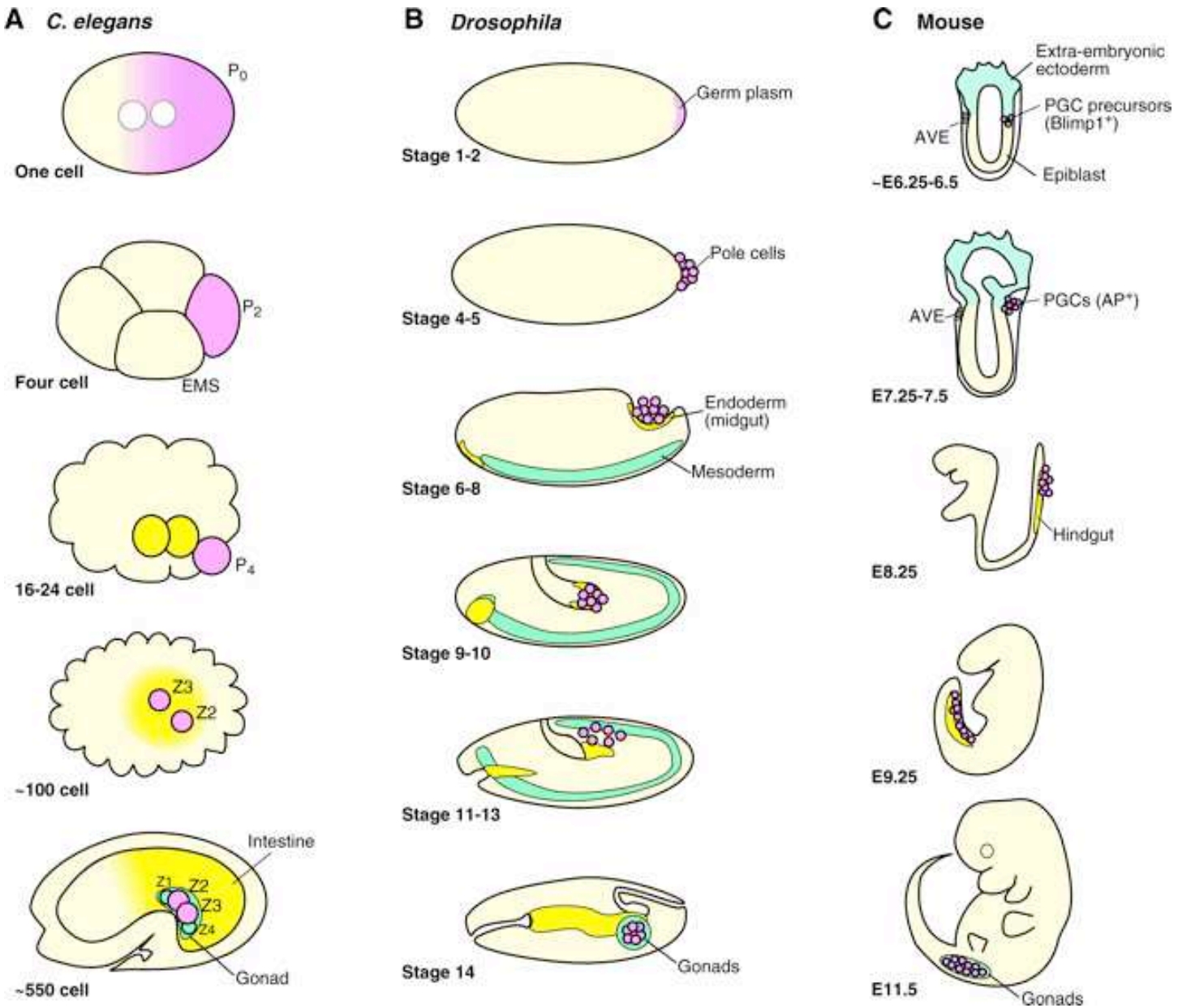
Hedgehog e *columbus* (expressados nas gônadas) atraem as PGC até as gônadas

Migracão das GCs e coalescencia com SGPs (precursor gonadal somático) na *Drosophila*, Parte III



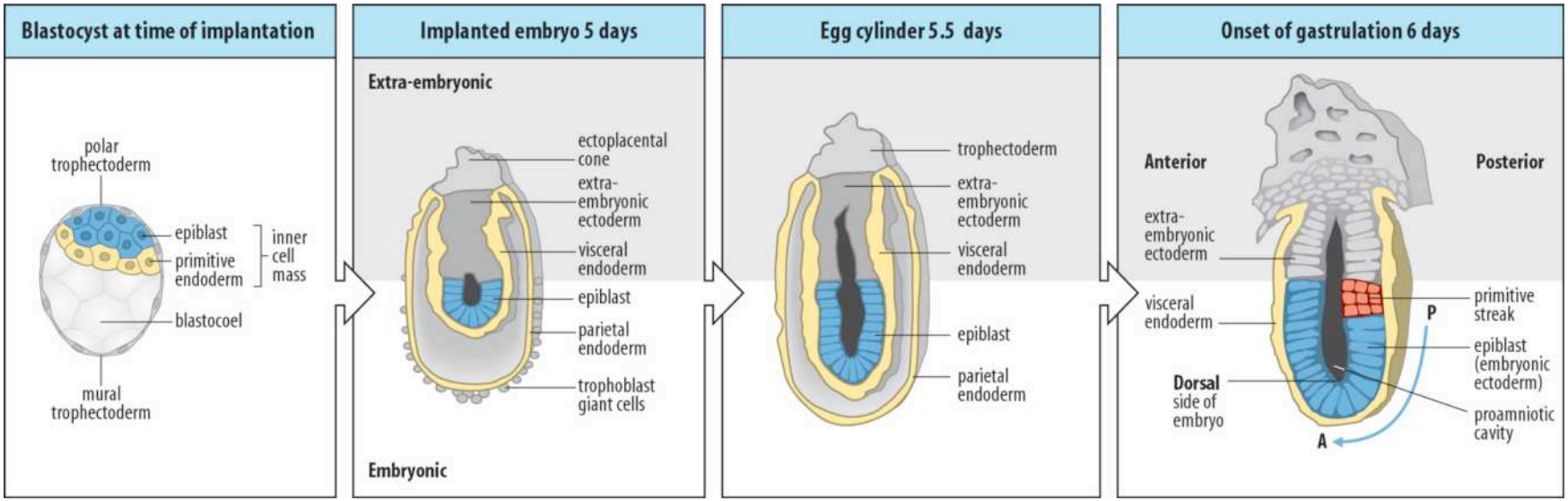
***DEVELOPMENTAL BIOLOGY, Eighth Edition,* Figure 19.11 (Part 3)**

Formas de determinação das células germinativas em modelos animais

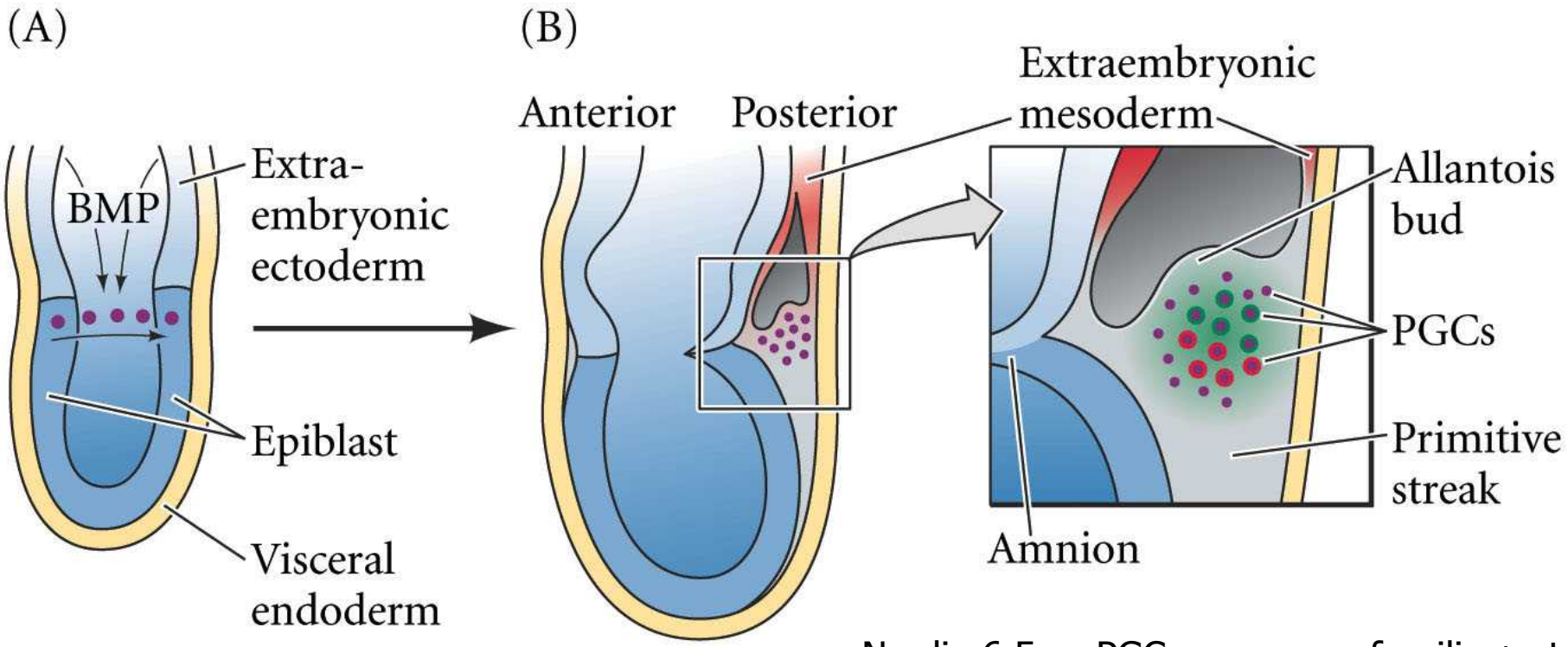


Nakamura & Seydoux, 2008

Desenvolvimento do camundongo

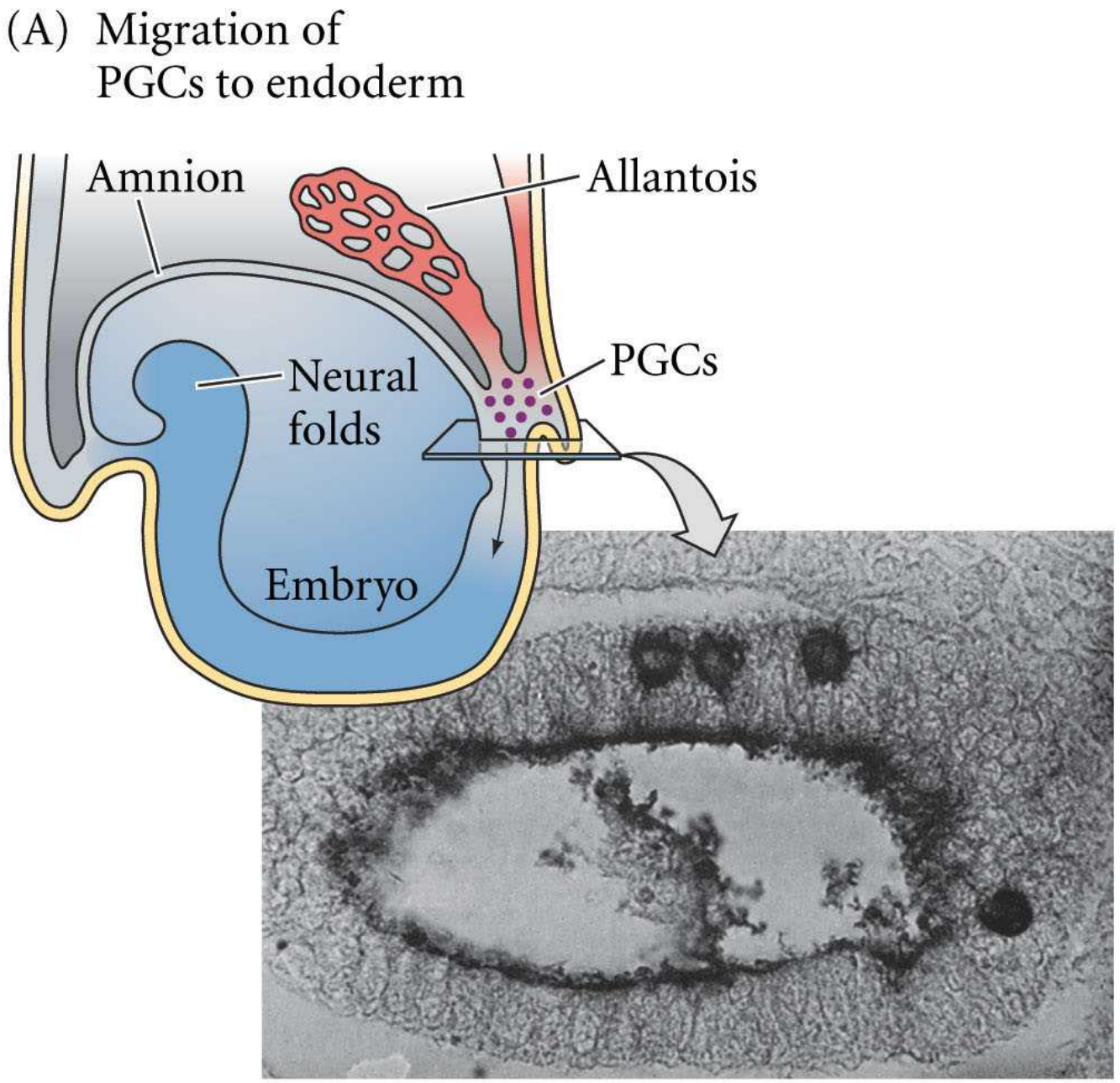


Especificação e migração das células germinativas primordias em camundongo



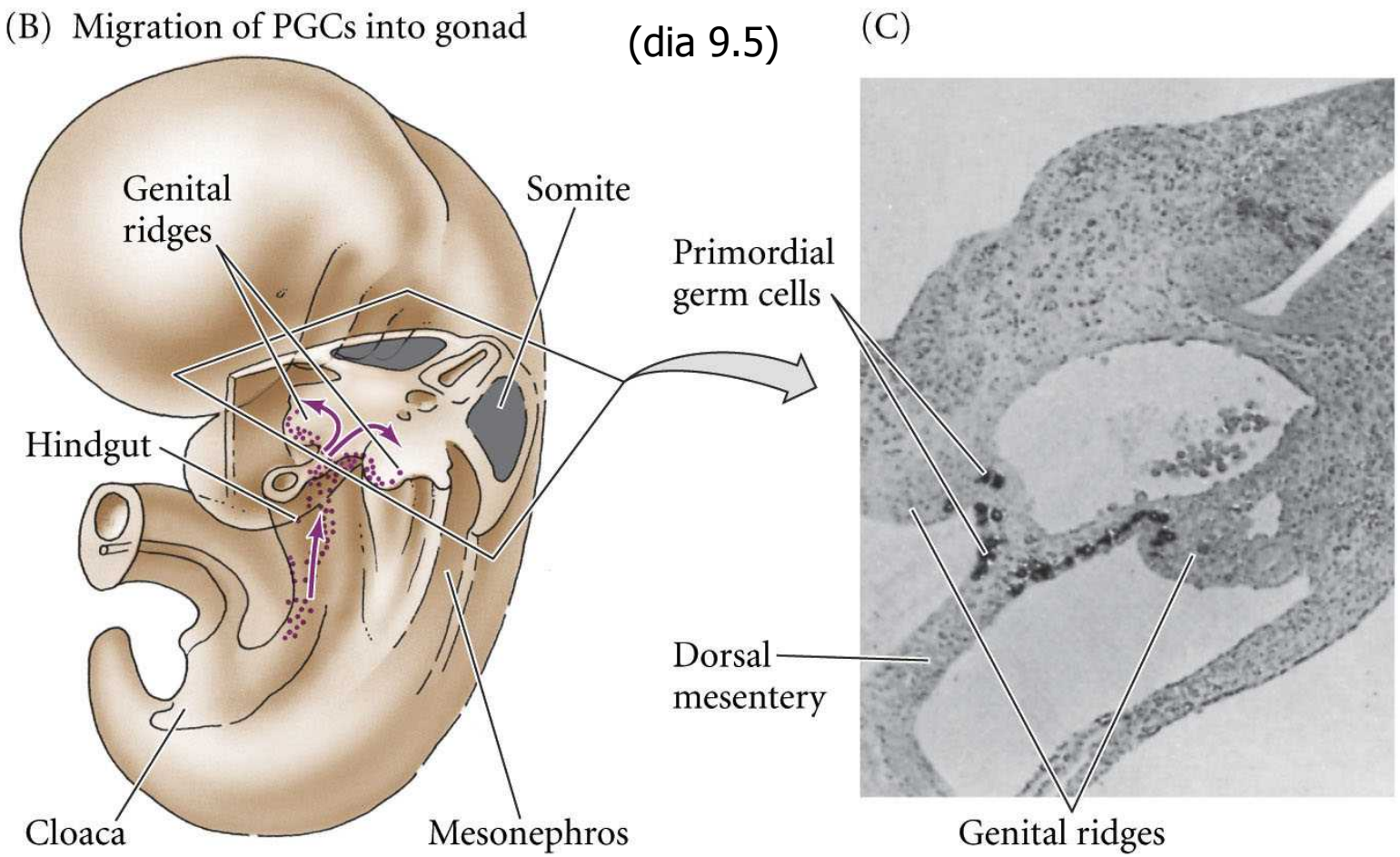
No dia 6.5 as PGCs expresam fragilis + stella

Migração das células germinativas primordias em camundongo (Parte I)



DEVELOPMENTAL BIOLOGY, Eighth Edition, **Figure 19.14 (Part 1)**

Migração das células germinativas primordias em camundongo (Parte II)

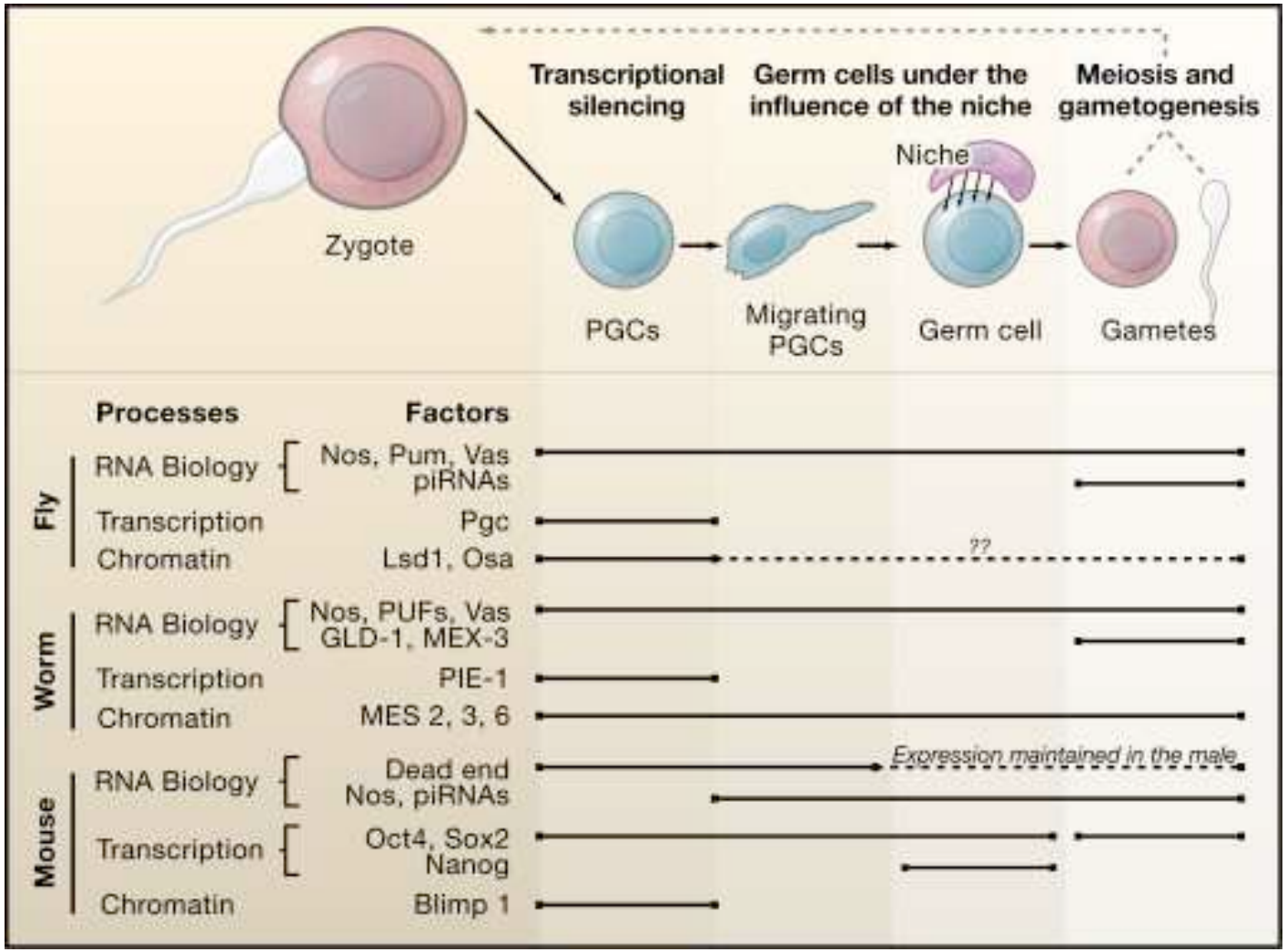


a) Totipotência mantida por Oct4.

b) Mais tarde no desenvolvimento, migração ativa através de gradientes de atração de TGFbeta produzidos pelas cristas genitais.

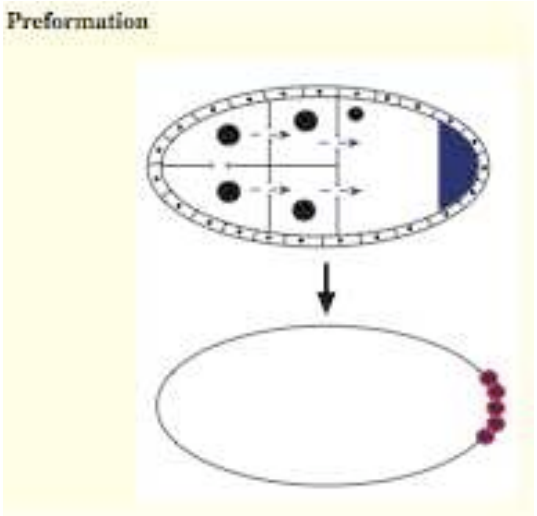
c) Proliferação de PGCs reguladas por Stem Cell Factor SCF e c-kit (receptor expreso nas PGCs).

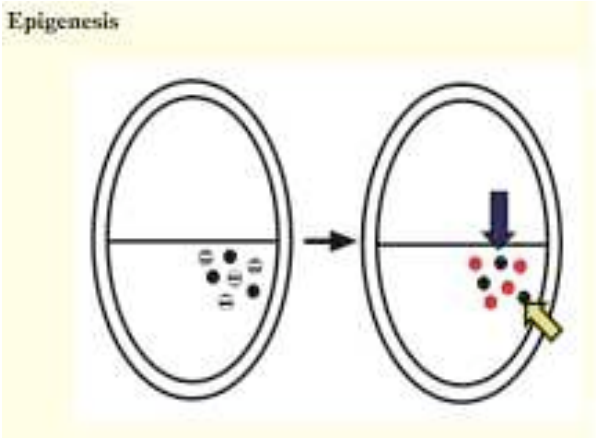
RESUMO: Generalidades das células germinativas nos diferentes modelos animais.

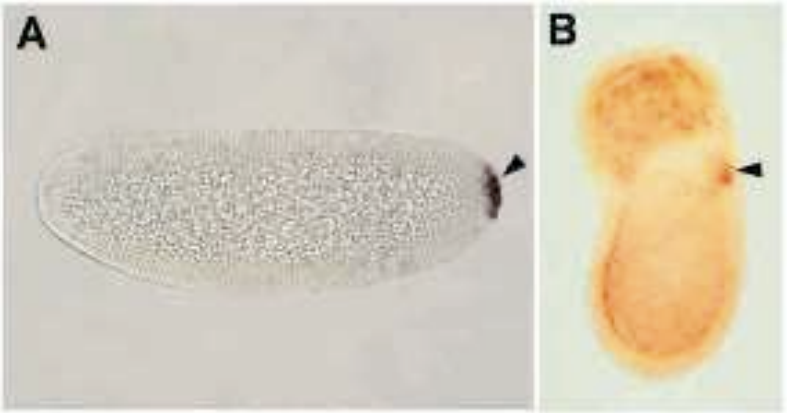


Cinalli et al. 2008

Duas formas extremas que formam as células germinativas em animais modelo

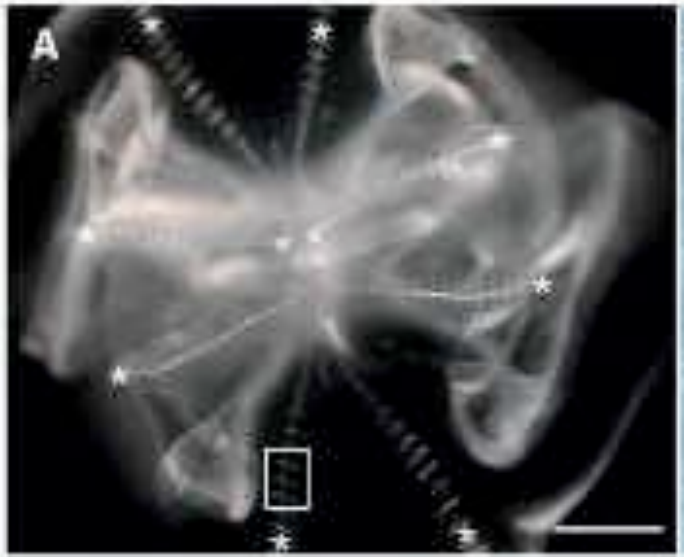




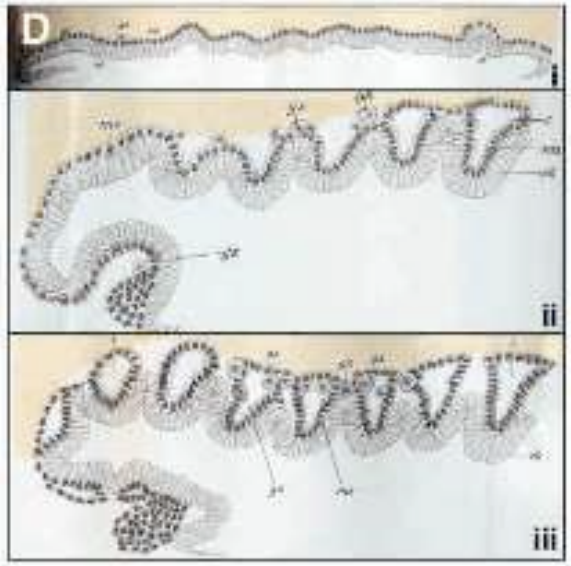


Extavour, 2003

O que dizer das espécies que não são modelos animais?

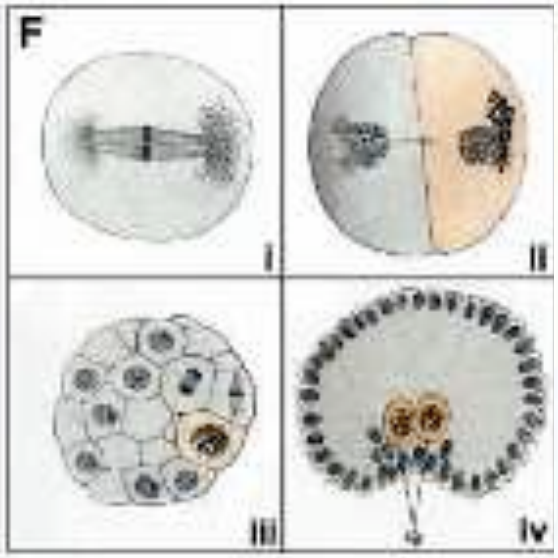


Ctenóforo *Mnemiopsis leidyi*

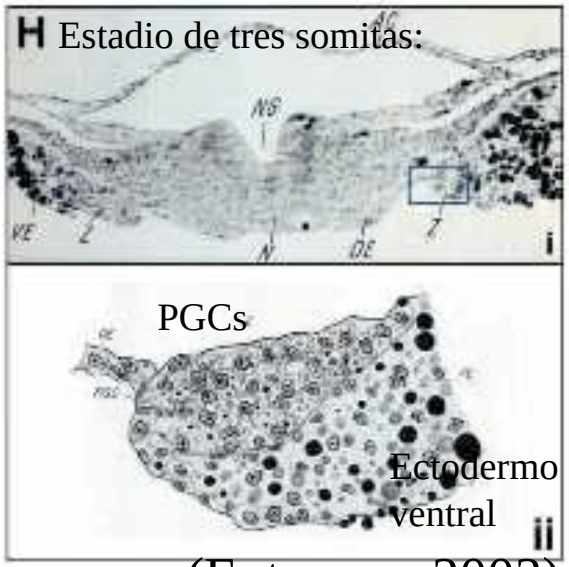


Barata *Blatta germanica*

Copépodo *Cyclops fuscusi*

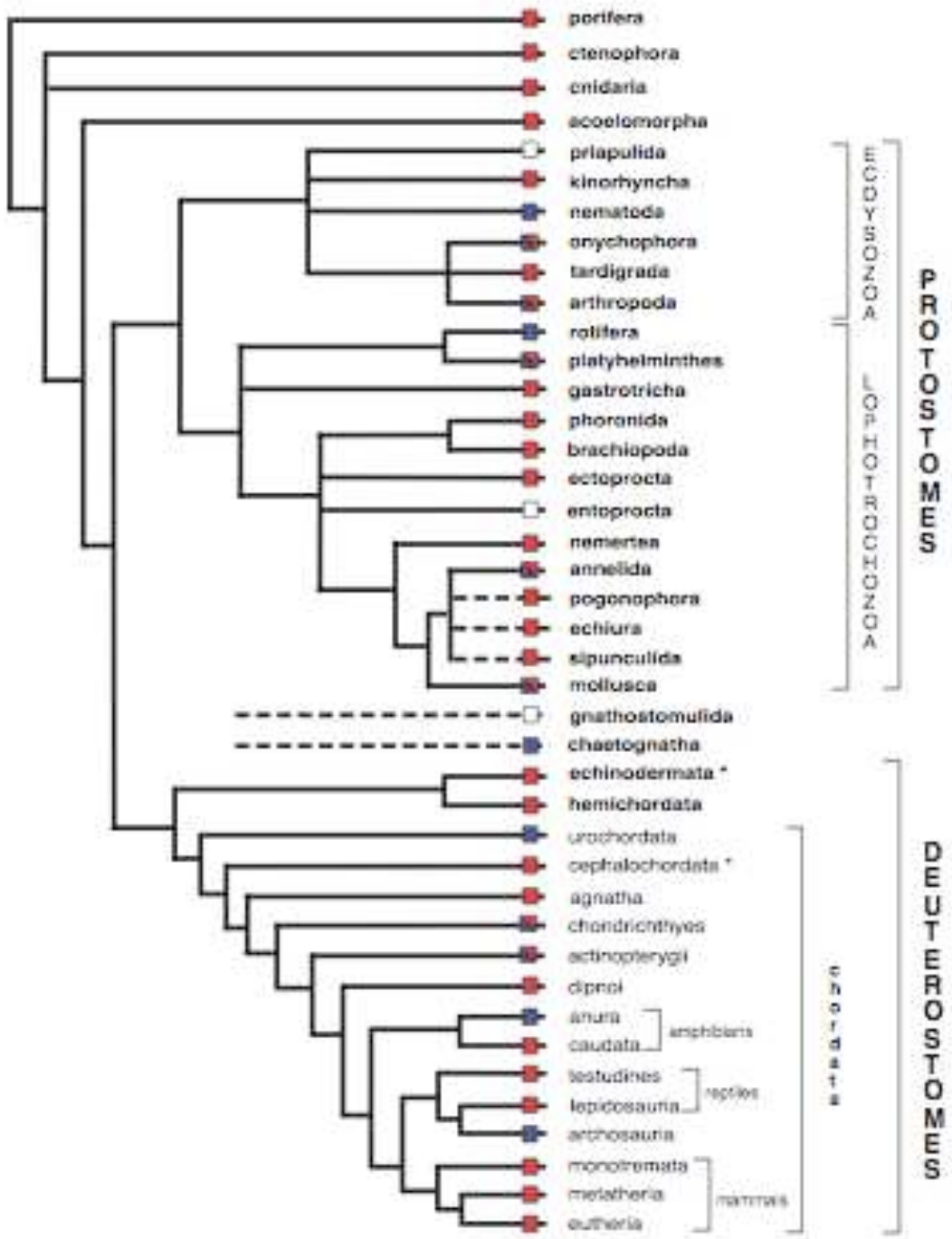


Tartaruga *Sternoterus odoratus*



(Extavour, 2003)

O que dizer das espécies que não são modelos animais?

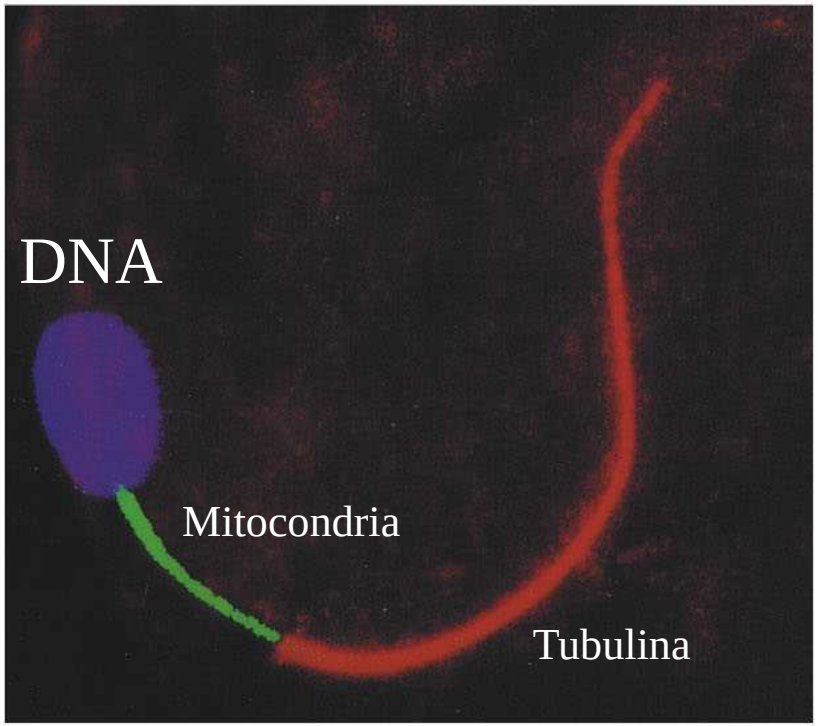


epigênese

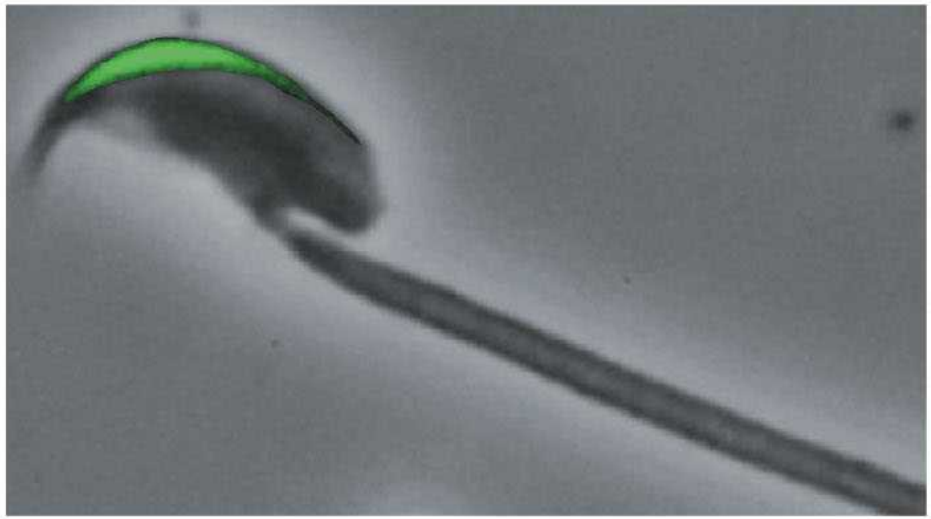
Pre-formação

(Extavour, 2003)

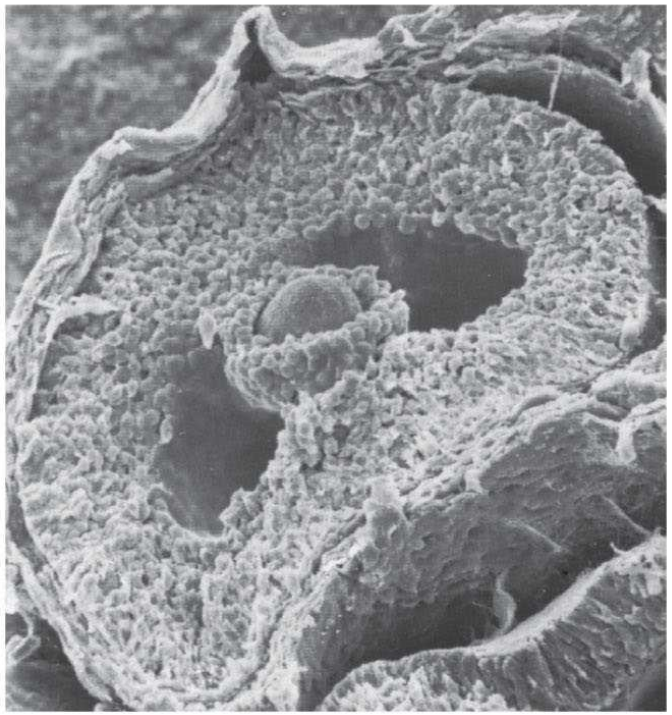
Gametogênese: Esperma de mamíferos



Touro

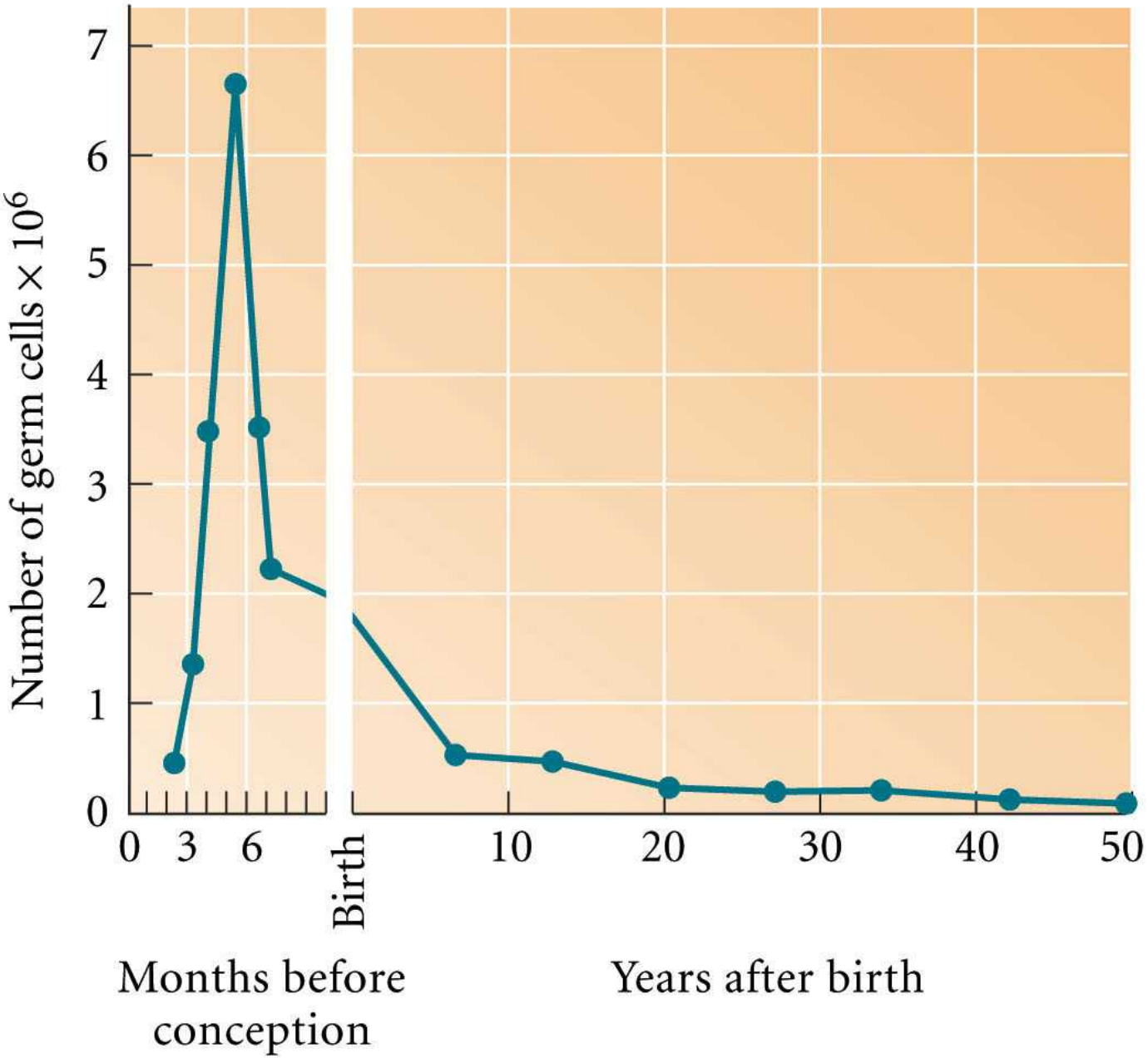


Acrossoma de rato

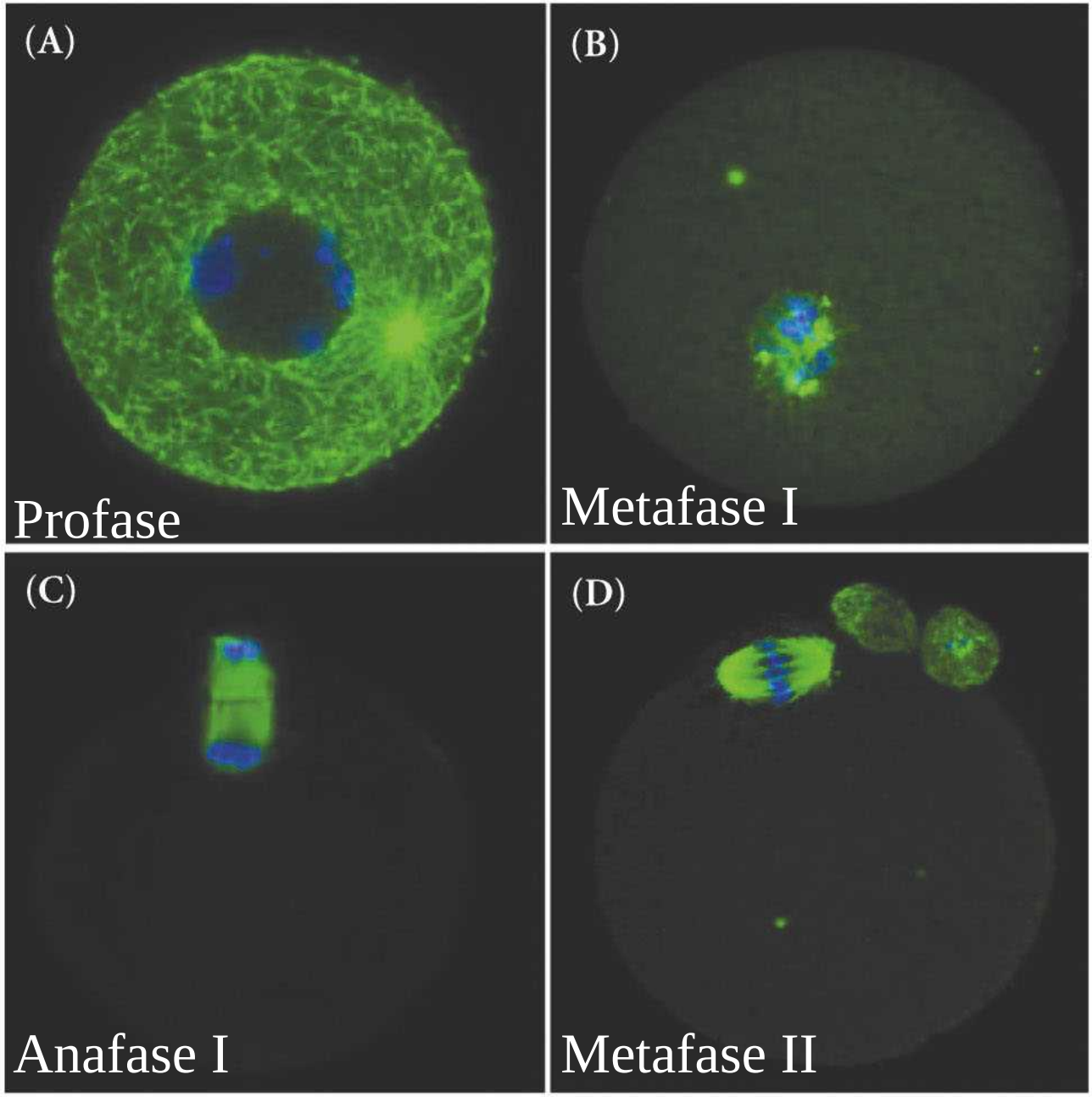


Folículo do ovário de mamífero

As alterações no número de células germinativas do ovário humano ao longo do período da vida

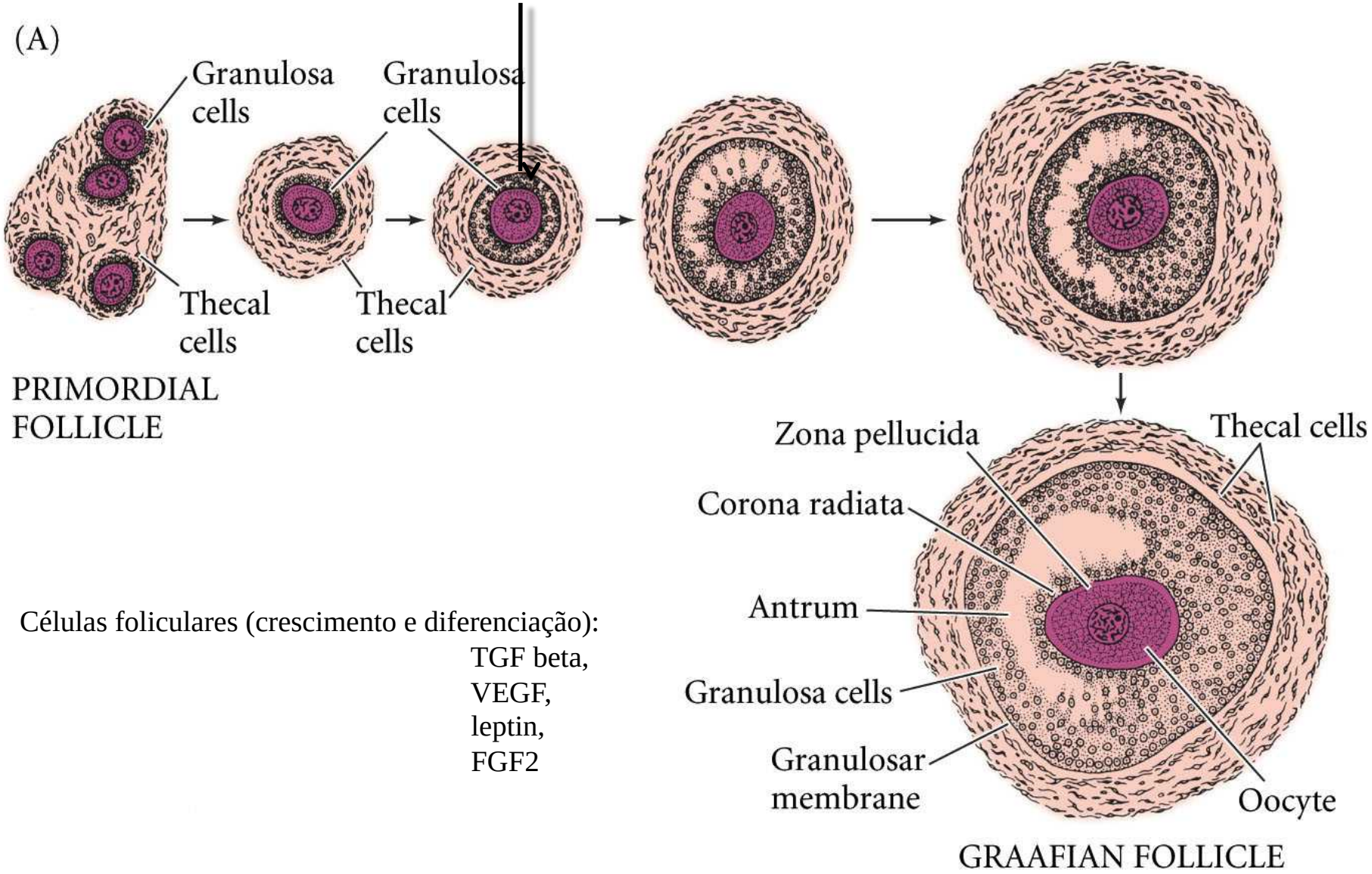


A meiose no oócito de camundongo



O folículo ovariano de mamíferos (crescimento e maturação do oócito)

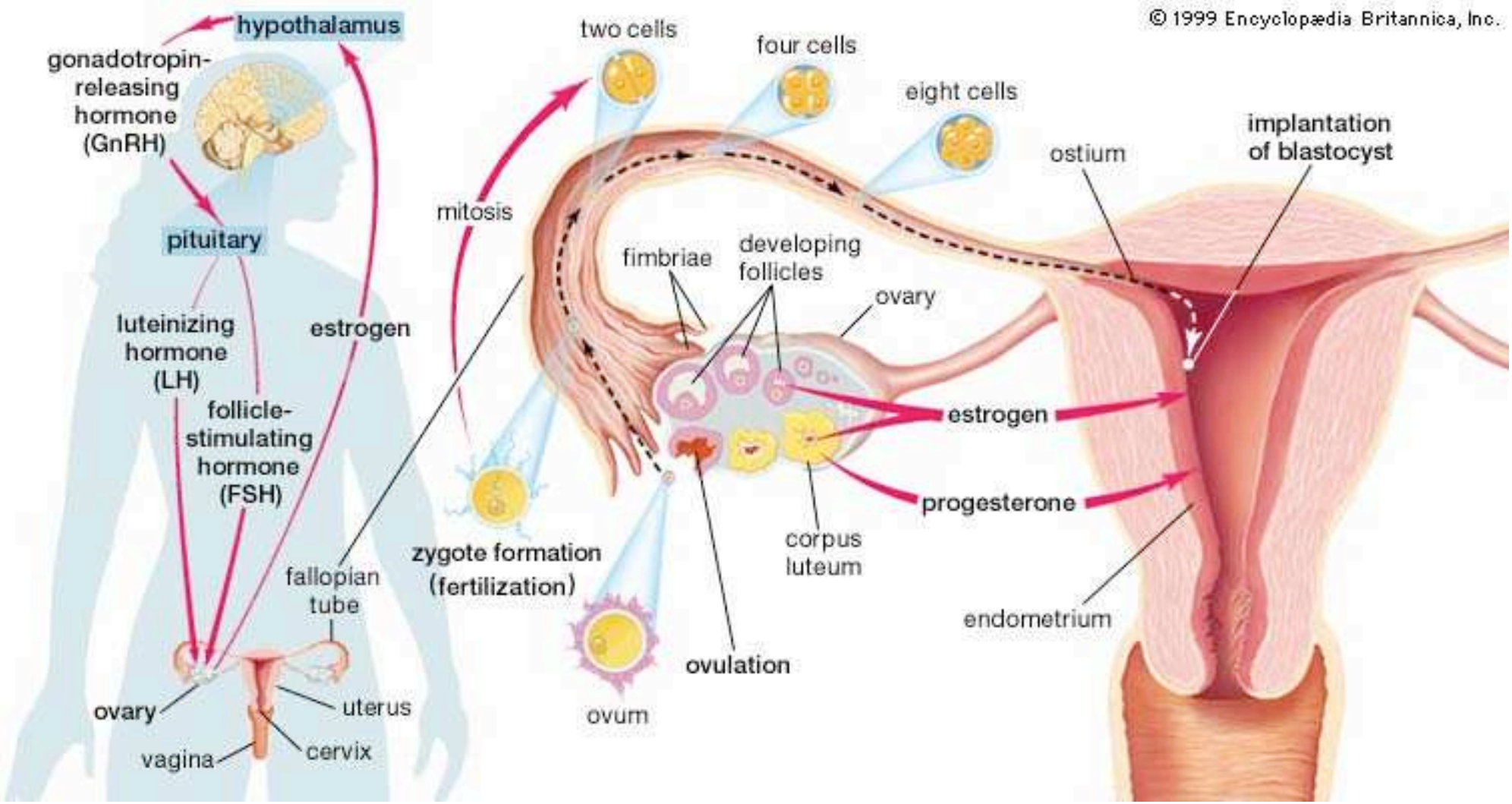
Oócitos expressam GDF9 (TGF beta) que induz porliferação de células foliculares



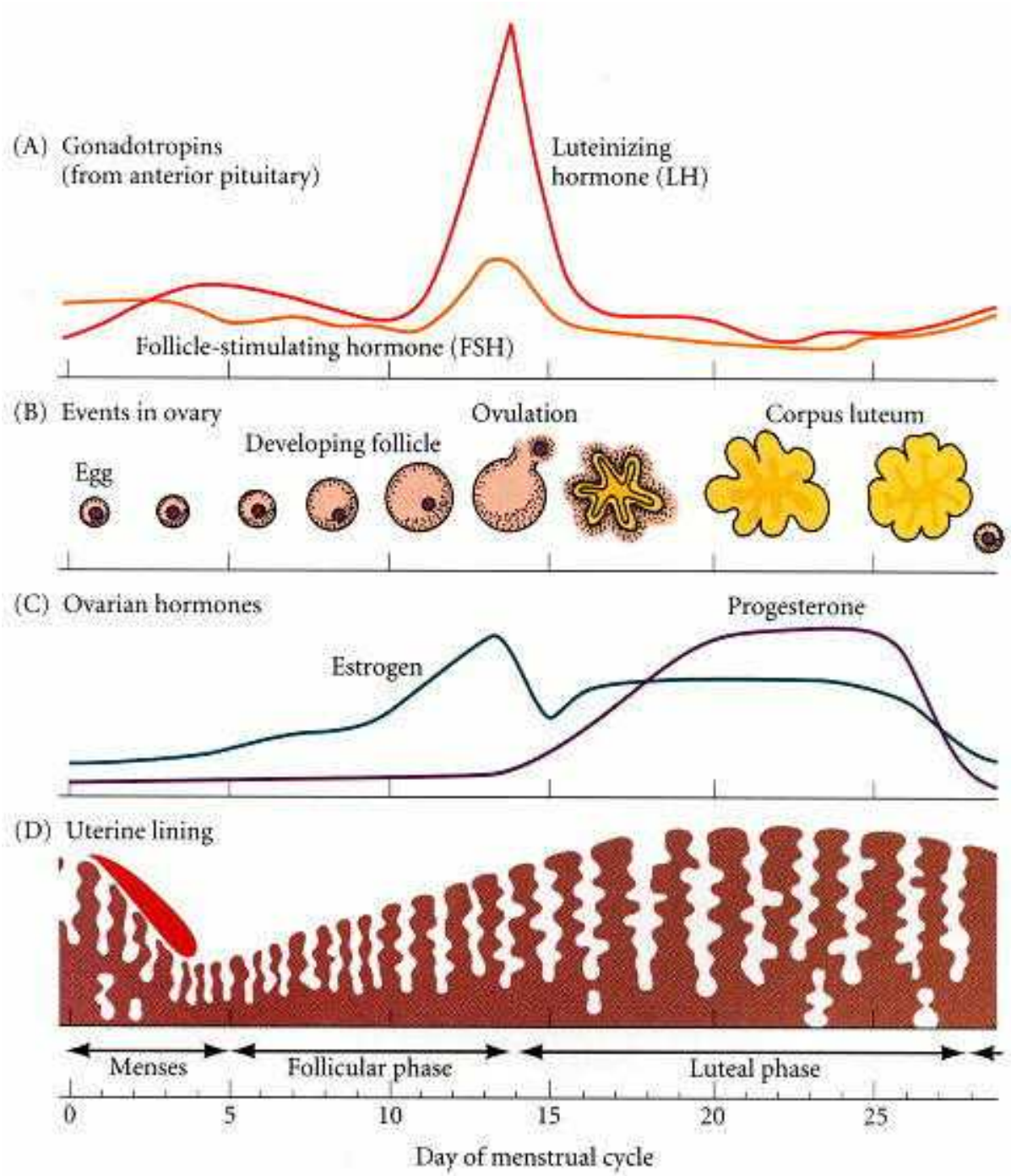
Células foliculares (crescimento e diferenciação):

TGF beta,
VEGF,
leptin,
FGF2

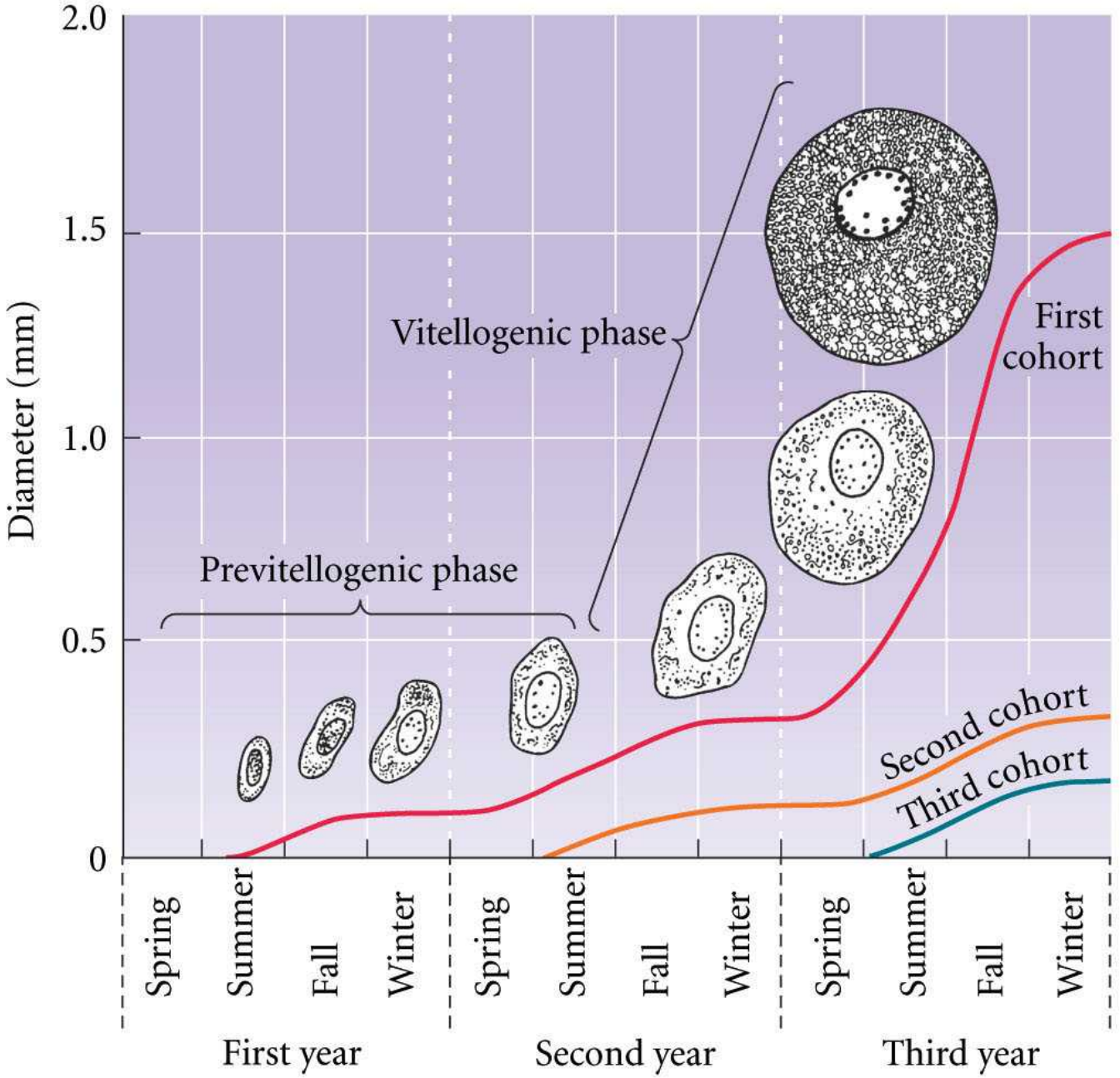
O ciclo menstrual humano



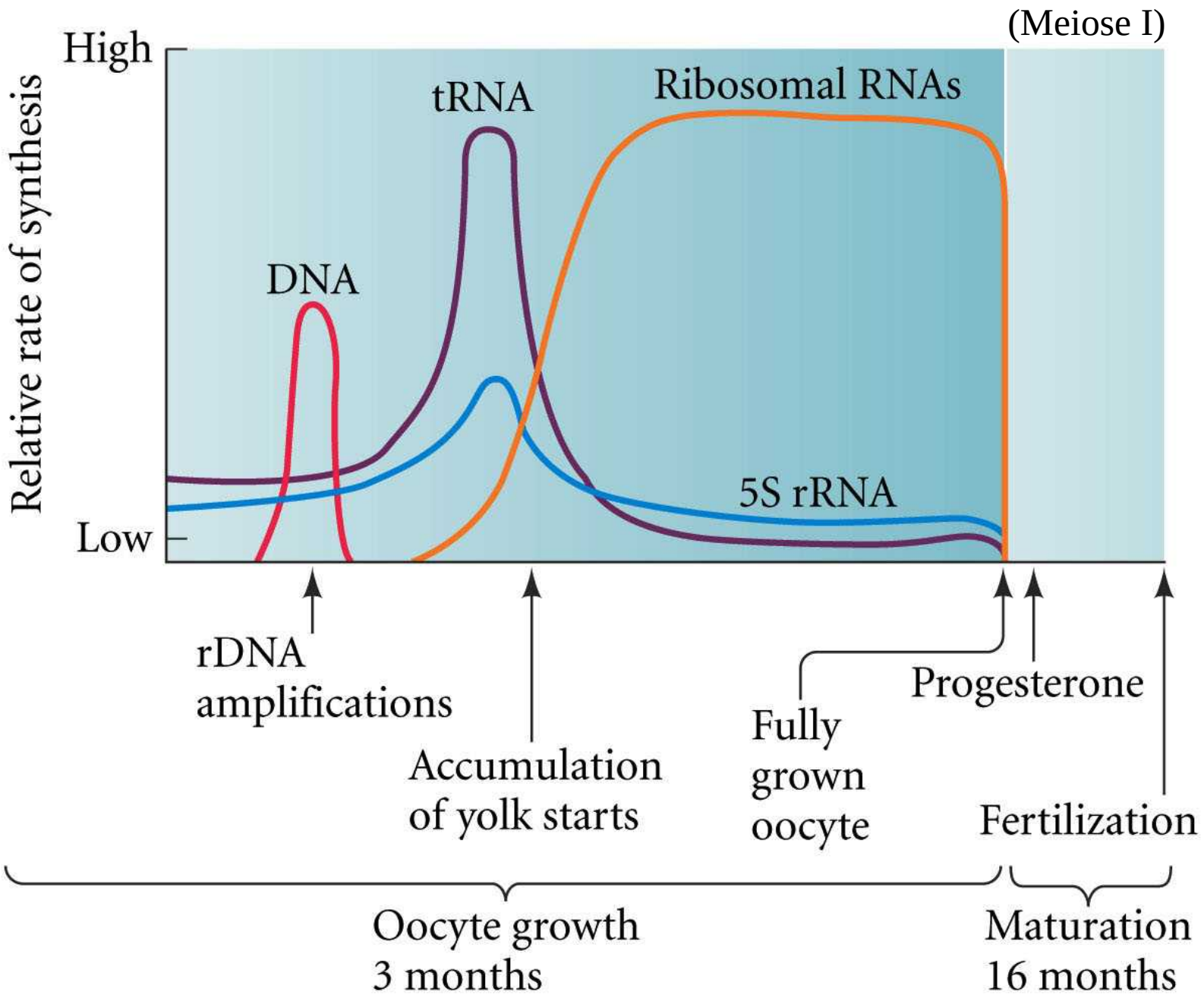
O ciclo menstrual humano



Crescimento de oócitos na rã

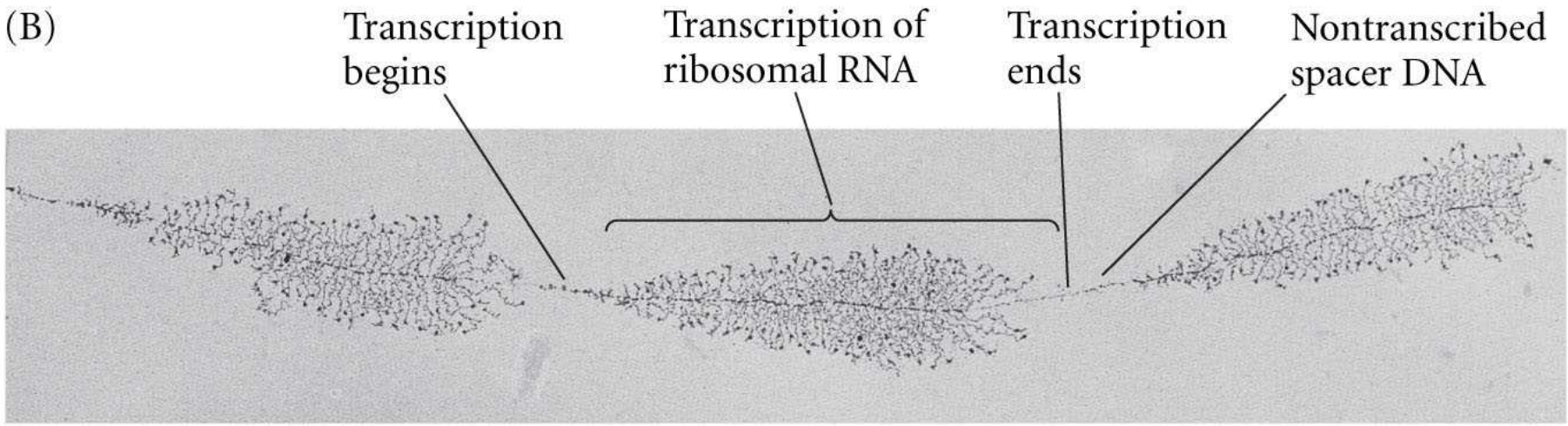


Produção de RNA ribossômico em oócitos de *Xenopus*



DEVELOPMENTAL BIOLOGY, Eighth Edition, **Figure 19.28 (Part 1)** © 2006 Sinauer Associates, Inc.

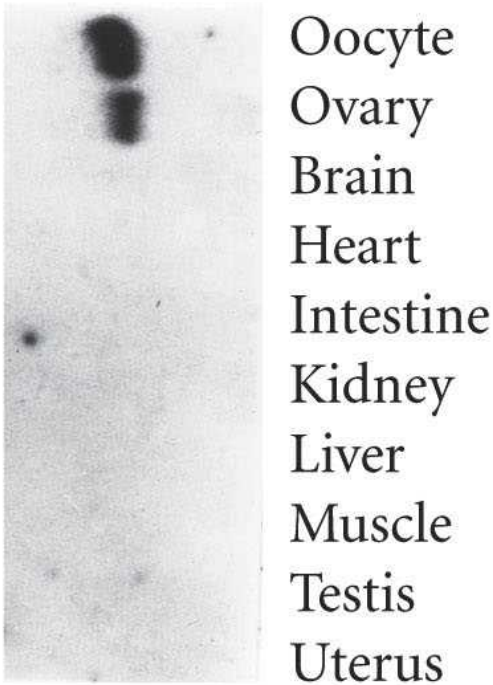
Produção de RNA ribossomal em oócitos de *Xenopus*



***DEVELOPMENTAL BIOLOGY, Eighth Edition,* Figure 19.28 (Part 2)**

A expressão do gene ZP3 no oócito de camundongo em desenvolvimento

(A)



(B)

(C)

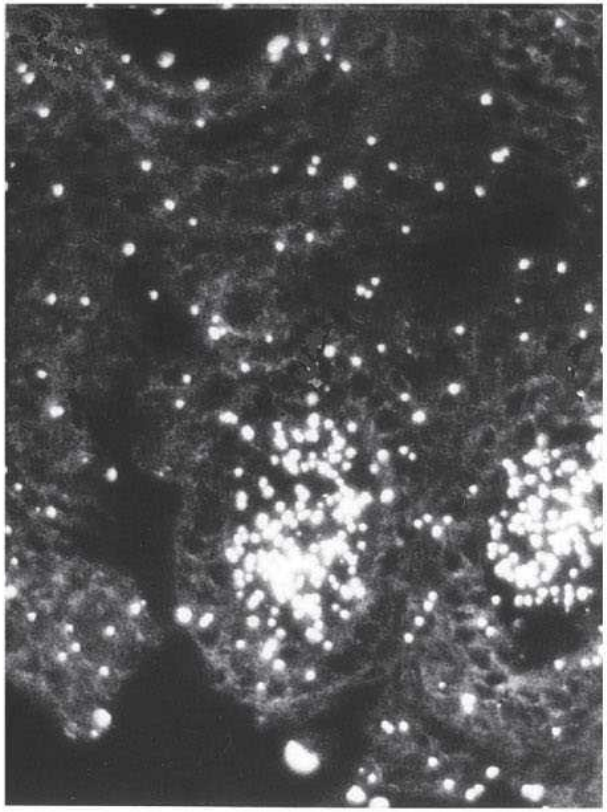


TABLE 19.2 Cellular components stored in the mature oocyte of *Xenopus laevis*

Component	Approximate excess over amount in larval cells
Mitochondria	100,000
RNA polymerases	60,000–100,000
DNA polymerases	100,000
Ribosomes	200,000
tRNA	10,000
Histones	15,000
Deoxyribonucleoside triphosphates	2,500

Source: After Laskey 1979.

Representação esquemática da maturação de oócitos de Xenopus, mostrando a regulação da divisão celular da meiose pela progesterona e a fertilização

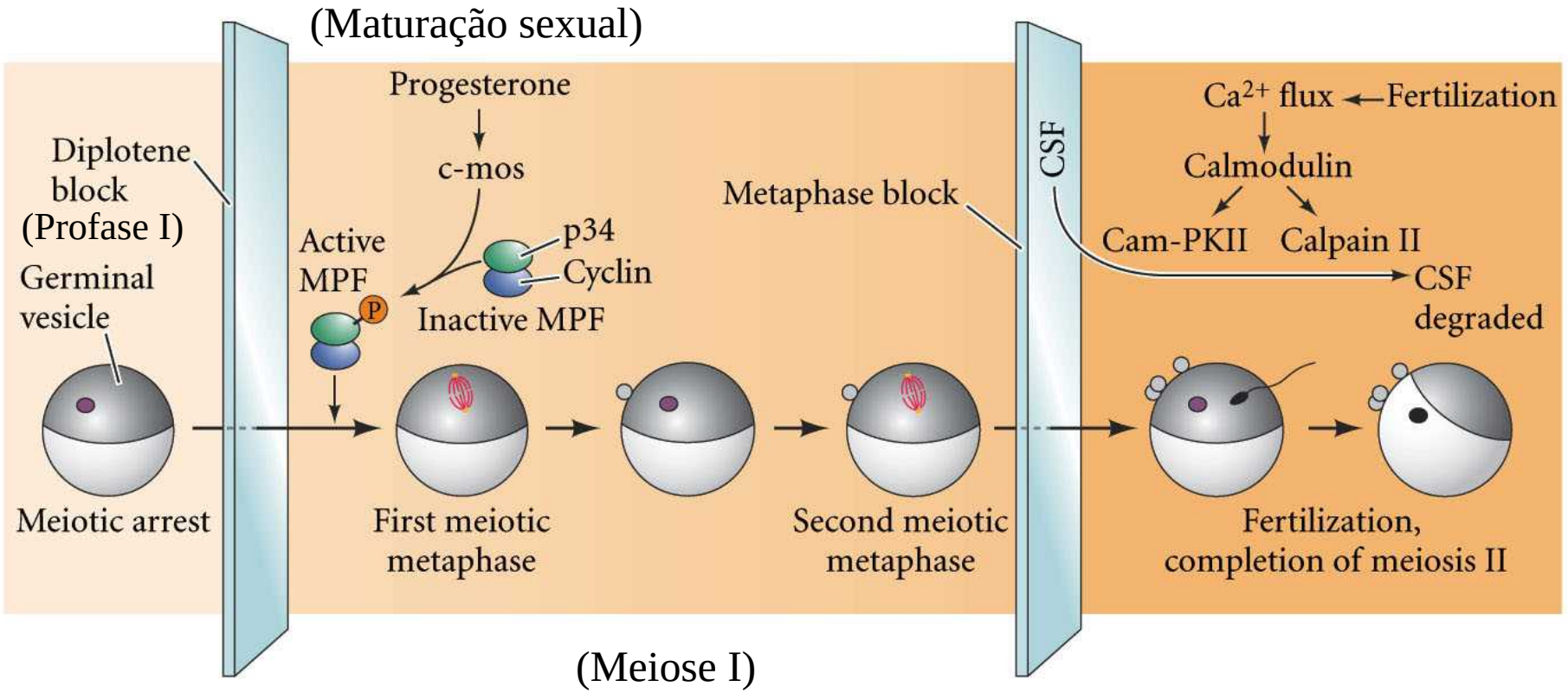


TABLE 19.1 Sexual dimorphism in mammalian meioses

Female oogenesis
Meiosis initiated once in a finite population of cells
One gamete produced per meiosis
Completion of meiosis delayed for months or years
Meiosis arrested at first meiotic prophase and reinitiated in a smaller population of cells
Differentiation of gamete occurs while diploid, in first meiotic prophase
All chromosomes exhibit equivalent transcription and recombination during meiotic prophase

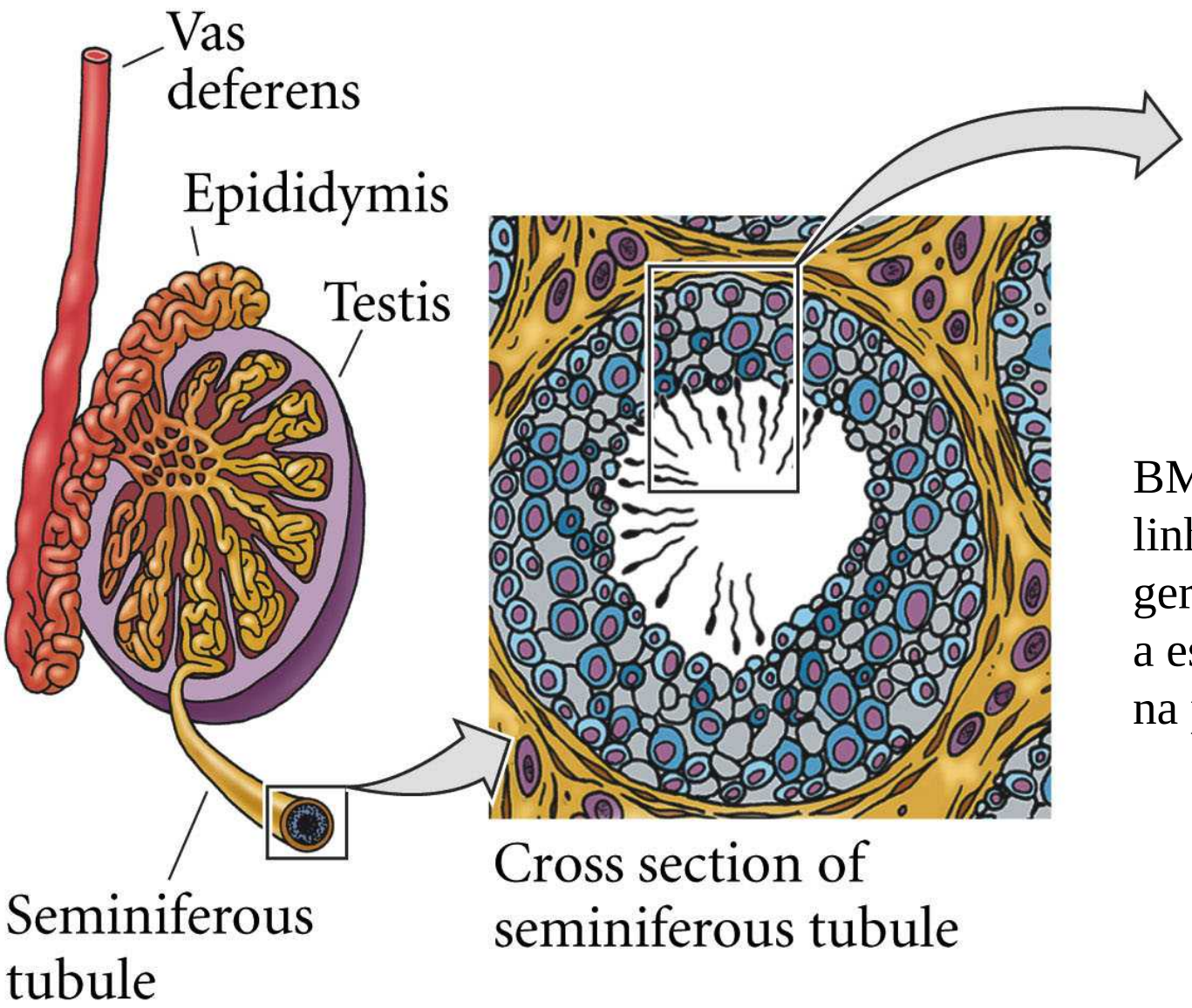
Source: Handel and Eppig 1998.

TABLE 19.1 Sexual dimorphism in mammalian meioses

Female oogenesis	Male spermatogenesis
Meiosis initiated once in a finite population of cells	
One gamete produced per meiosis	
Completion of meiosis delayed for months or years	
Meiosis arrested at first meiotic prophase and reinitiated in a smaller population of cells	
Differentiation of gamete occurs while diploid, in first meiotic prophase	
All chromosomes exhibit equivalent transcription and recombination during meiotic prophase	

Source: Handel and Eppig 1998.

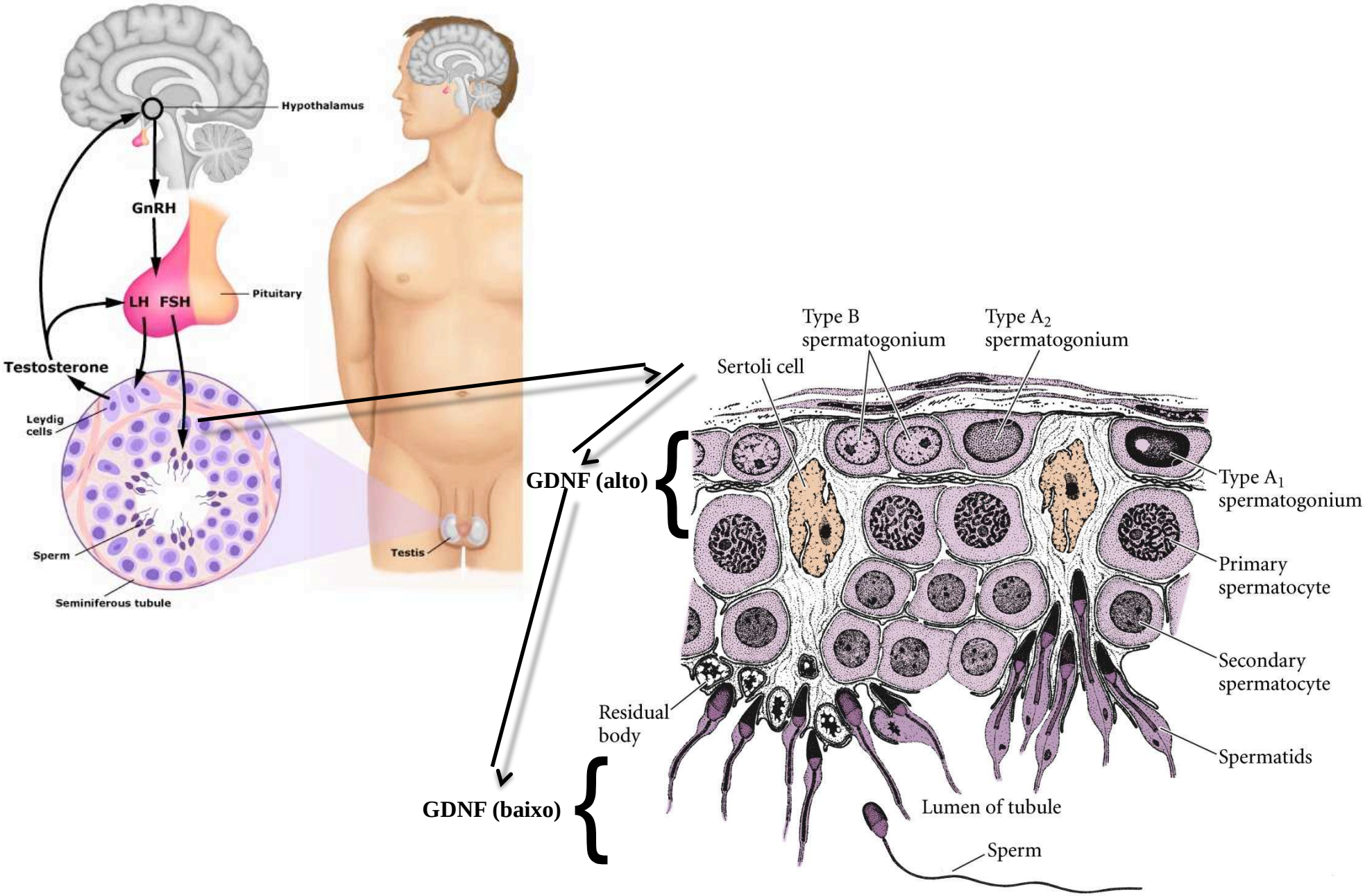
Secção do túbulo seminífero, mostrando a relação entre as células de Sertoli e o desenvolvimento do esperma



BMP8b da linhagem germinativa inicia a espermatogênese na puberdade

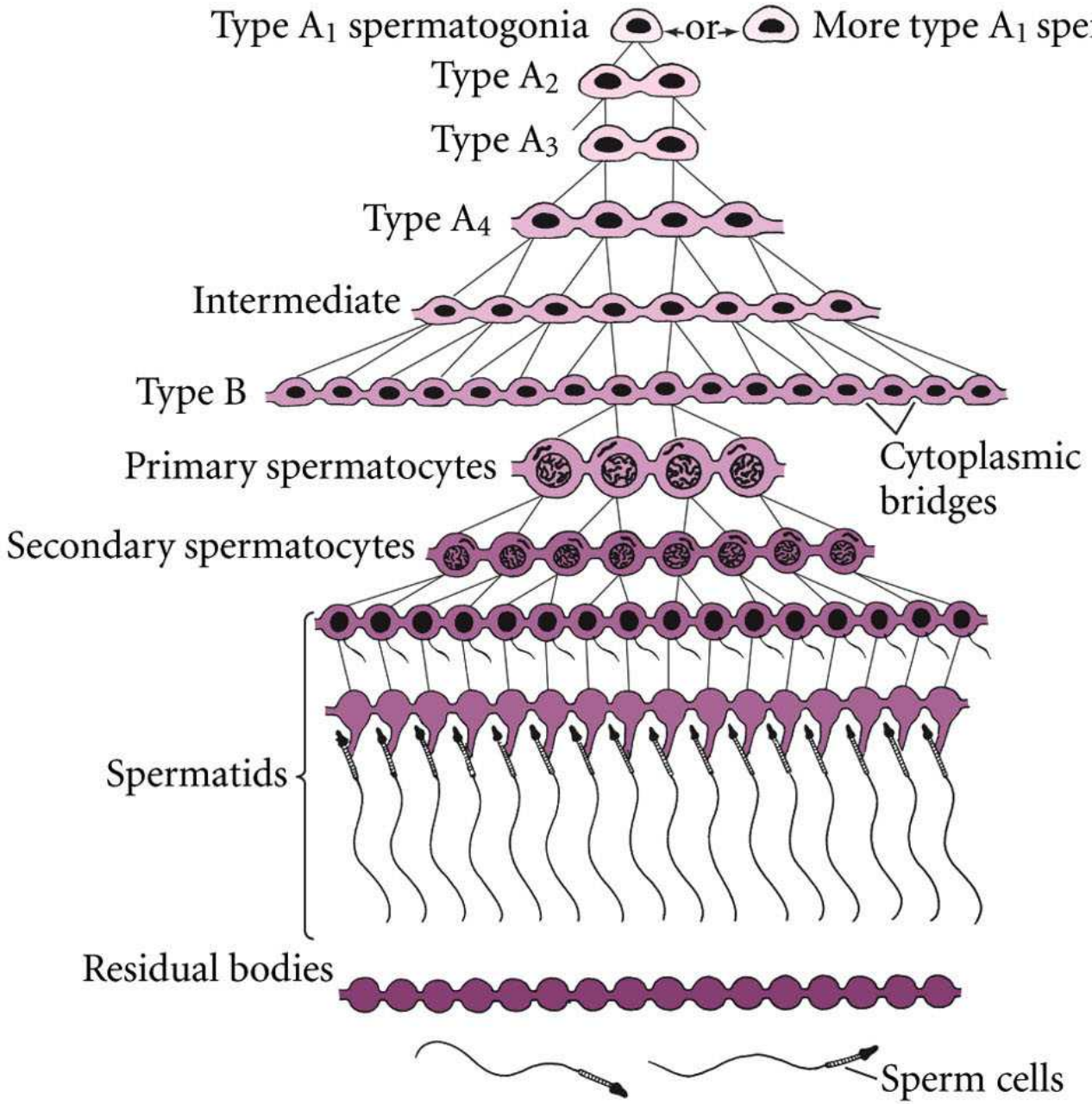
DEVELOPMENTAL BIOLOGY, Eighth Edition, **Figure 19.21 (Part 1)**

Secção do túbulo seminífero, mostrando a relação entre as células de Sertoli e o desenvolvimento do esperma



A formação de clones sinciciais de células germinativas do macho de humanos

65 dias



Dados interessantes:

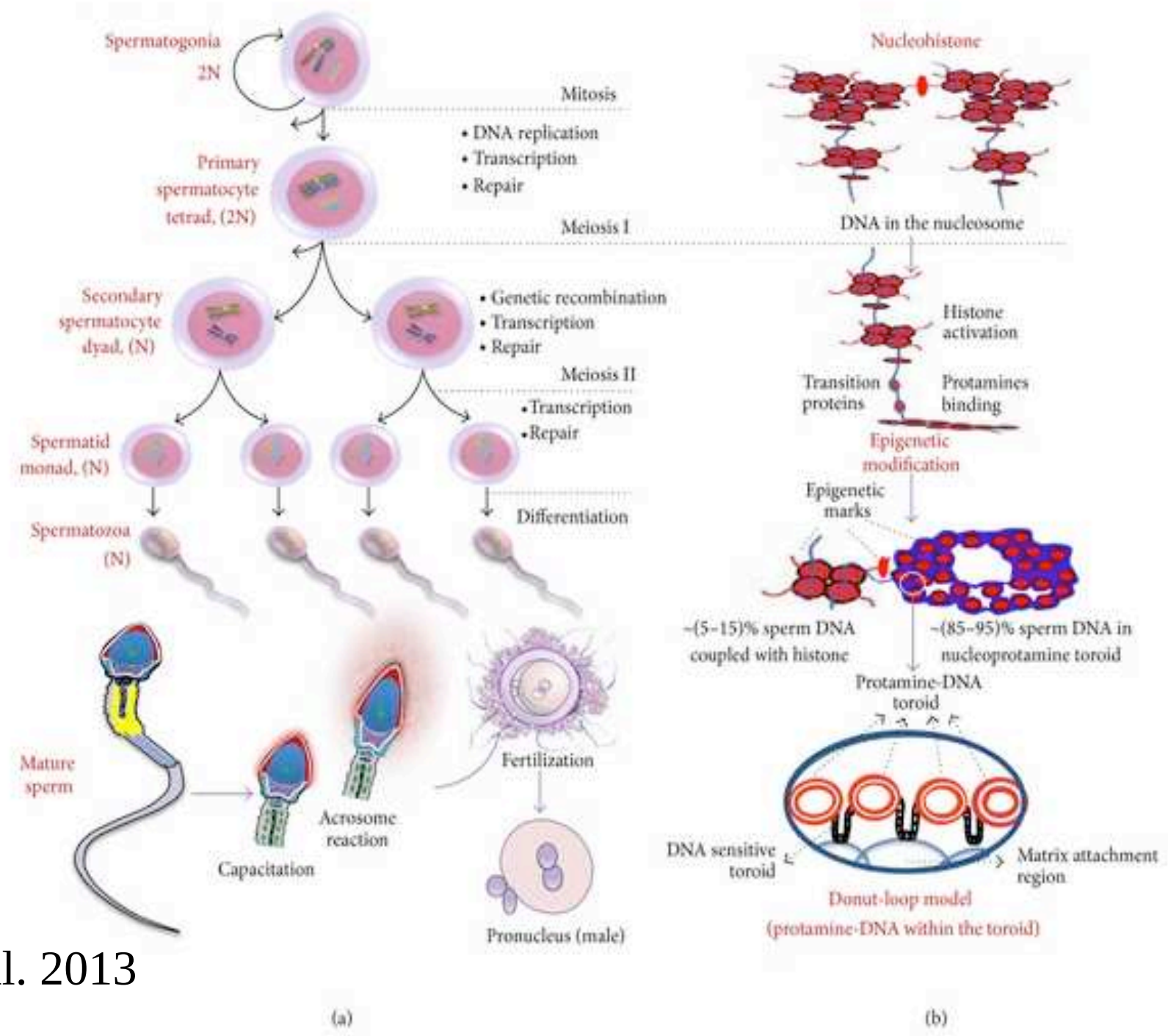
•100 milhões de espermatozoides / dia

•200 milhões de espermatozoides / ejaculação

DEVELOPMENTAL BIOLOGY, Eighth Edition, **Figure 19.22** © 2006 Sinauer Associates, Inc.

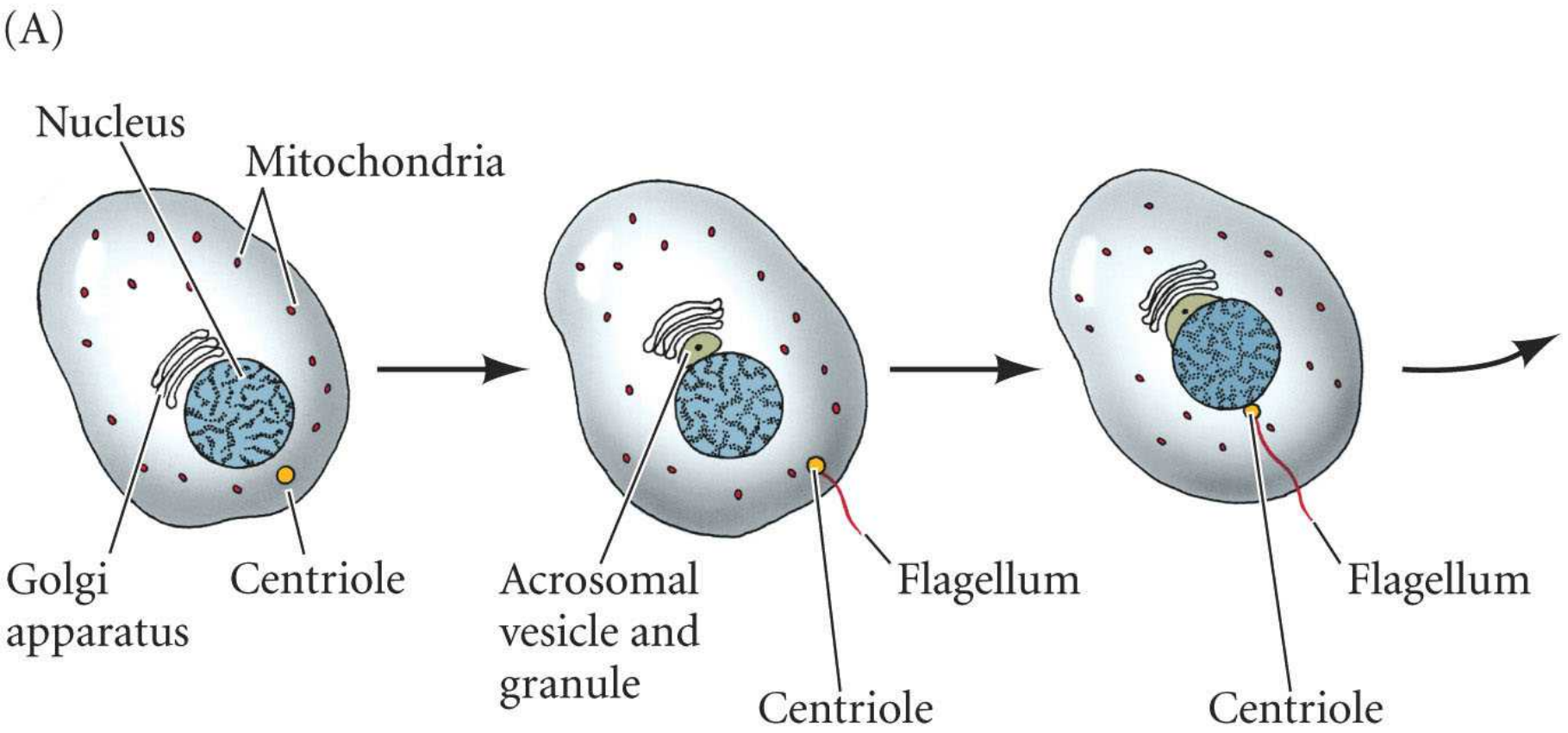
Ultra compactação do DNA nos espermatozóides

Protaminas: possuem a função de compactar, estabilizar e proteger o material genético no núcleo do espermatozóide

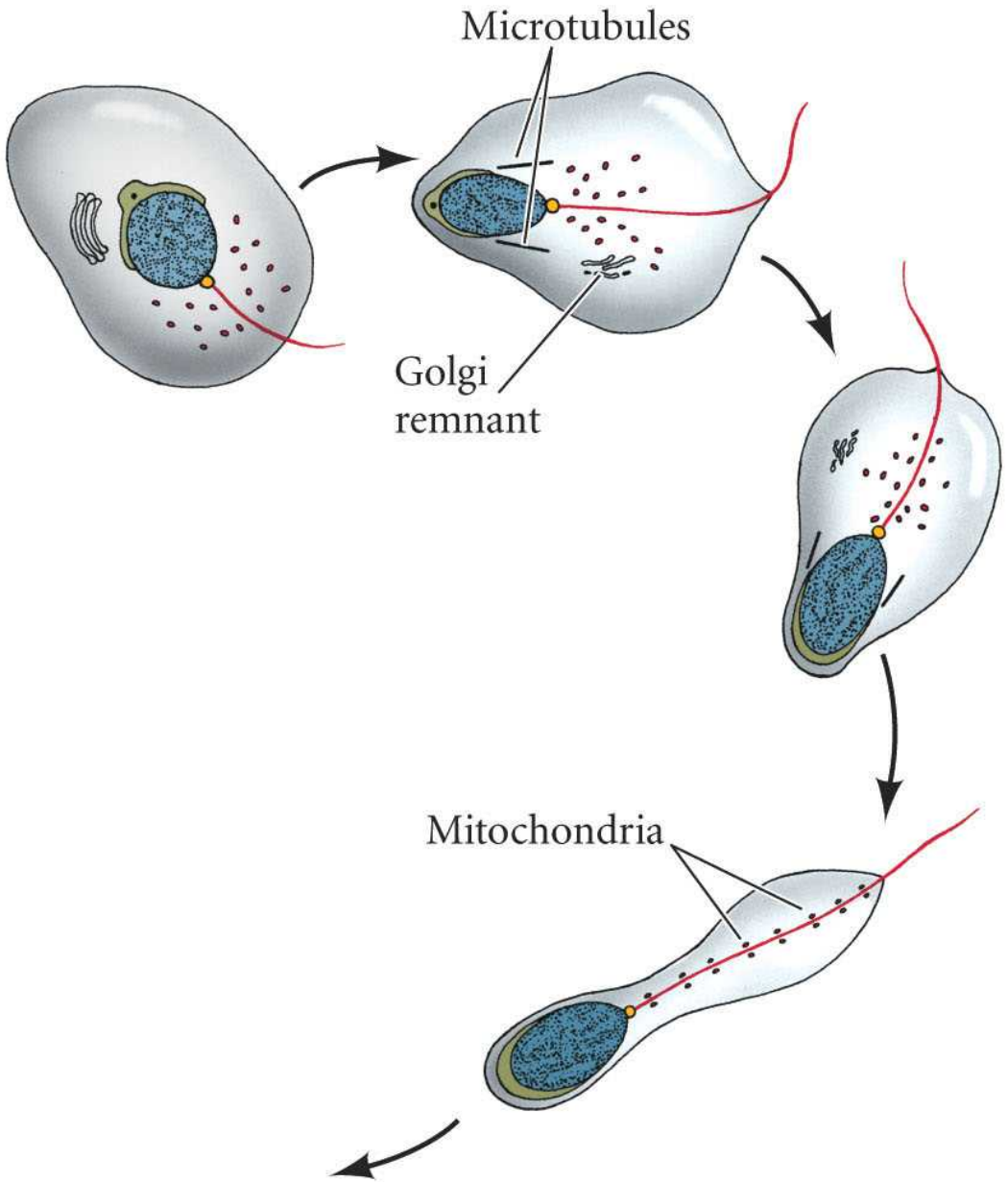


Rahman et al. 2013

Espermiogênese ou maturacão das espermátides (Parte I)

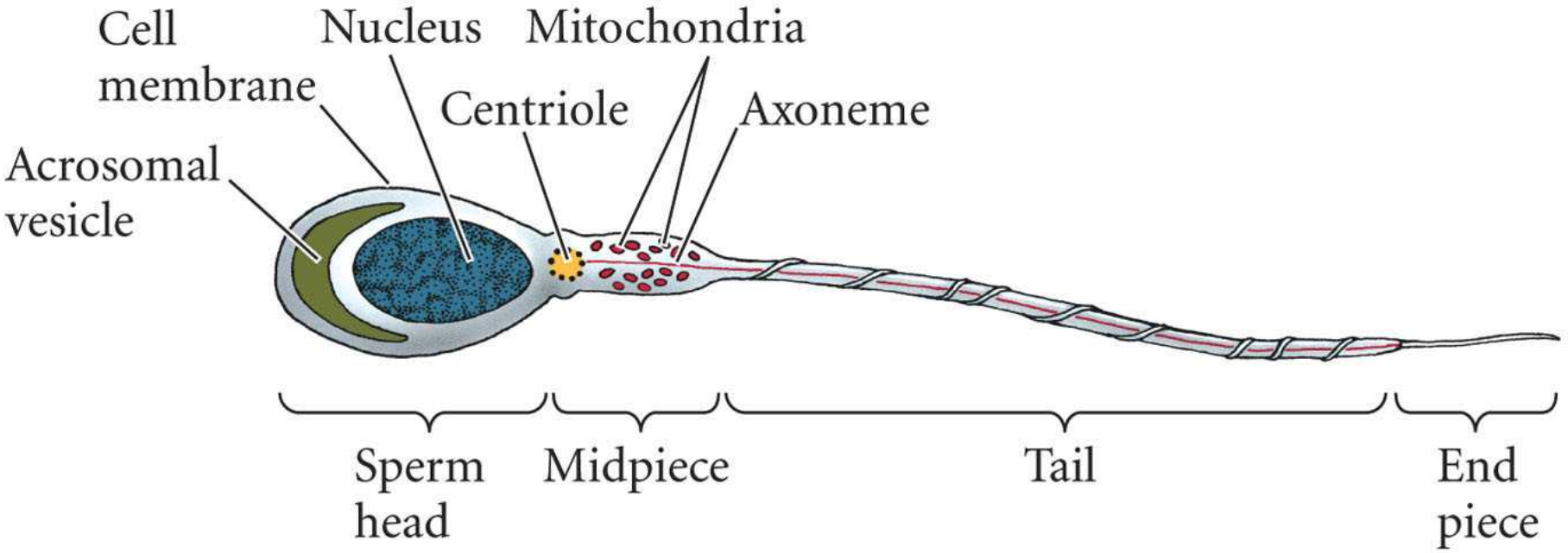


Espermiogênese ou maturacão das espermátides (Parte II)



DEVELOPMENTAL BIOLOGY, Eighth Edition, **Figure 7.2 (Part 2)**

Espermiogênese ou maturacão das espermátides (Parte III)



DEVELOPMENTAL BIOLOGY, Eighth Edition, **Figure 7.2 (Part 3)**

TABLE 19.1 Sexual dimorphism in mammalian meioses

Female oogenesis	Male spermatogenesis
Meiosis initiated once in a finite population of cells	Meiosis initiated continuously in a mitotically dividing stem cell population
One gamete produced per meiosis	Four gametes produced per meiosis
Completion of meiosis delayed for months or years	Meiosis completed in days or weeks
Meiosis arrested at first meiotic prophase and reinitiated in a smaller population of cells	Meiosis and differentiation proceed continuously without cell cycle arrest
Differentiation of gamete occurs while diploid, in first meiotic prophase	Differentiation of gamete occurs while haploid, after meiosis ends
All chromosomes exhibit equivalent transcription and recombination during meiotic prophase	Sex chromosomes excluded from recombination and transcription during first meiotic prophase

Source: Handel and Eppig 1998.

Próxima aula (08/04):

1. Apresentação da edição de Wikipedia:

   Alguns ótimos exemplos:

   https://pt.wikipedia.org/wiki/Via_de_sinaliza%C3%A7%C3%A3o_Wnt
   https://pt.wikipedia.org/wiki/Desdiferencia%C3%A7%C3%A3o_celular
   https://pt.wikipedia.org/wiki/Desenvolvimento_do_sistema_end%C3%B3crino_humano
   https://pt.wikipedia.org/wiki/Simbiose

2. Entrega da proposta do mini-projeto.

   Uma (1) página com:

   a) pergunta (opcional) e hipótese
   b) metodologia proposta deve incluir o desenho experimental e analise
   c) resultados esperados