

Time Scales and Stopwatches

Bio322

Heirarchy of time scales

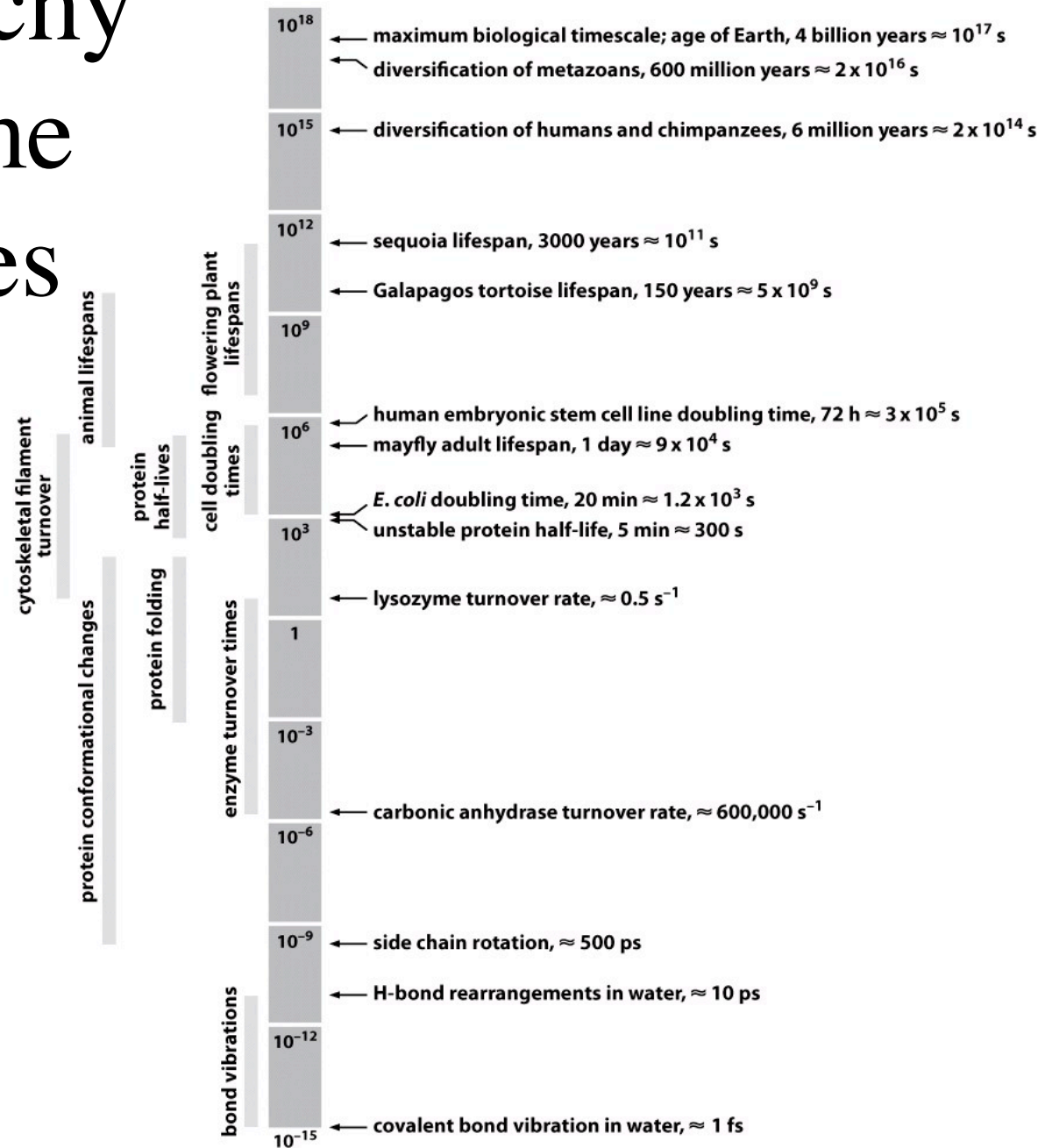


Figure 3.1 Physical Biology of the Cell (© Garland Science 2009)

Drosophila Development

development of *Drosophila*

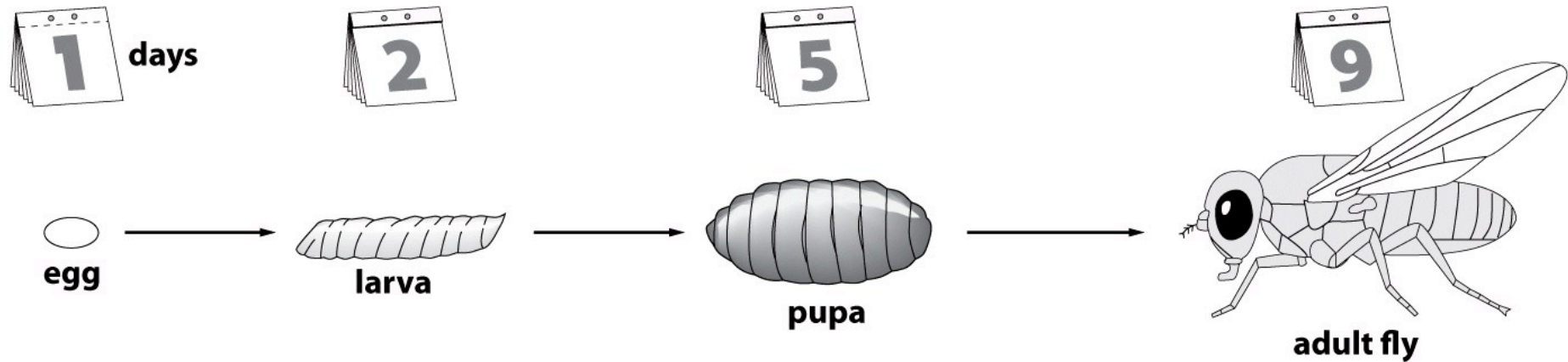


Figure 3.2a Physical Biology of the Cell (© Garland Science 2009)

Drosophila Development 10x faster

early development of *Drosophila* embryo

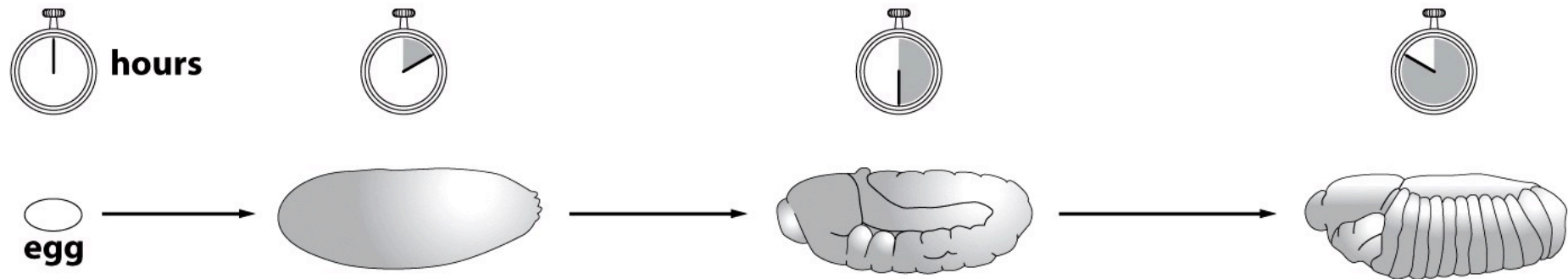


Figure 3.2b Physical Biology of the Cell (© Garland Science 2009)

bacterial cell division

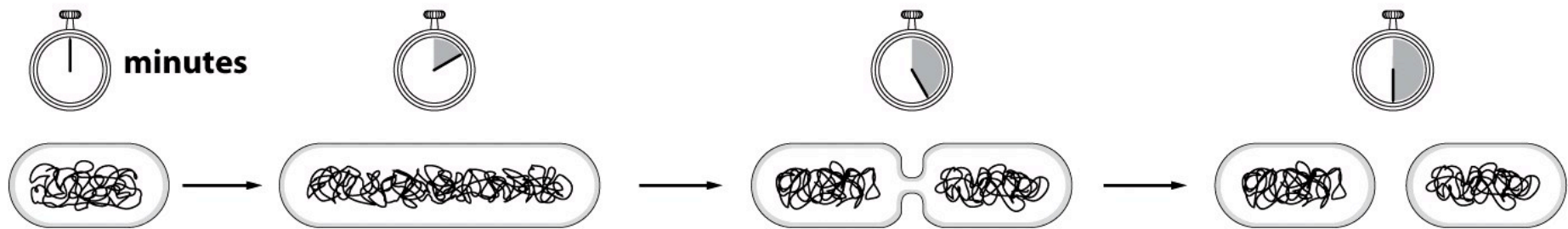


Figure 3.2c Physical Biology of the Cell (© Garland Science 2009)

cell movements

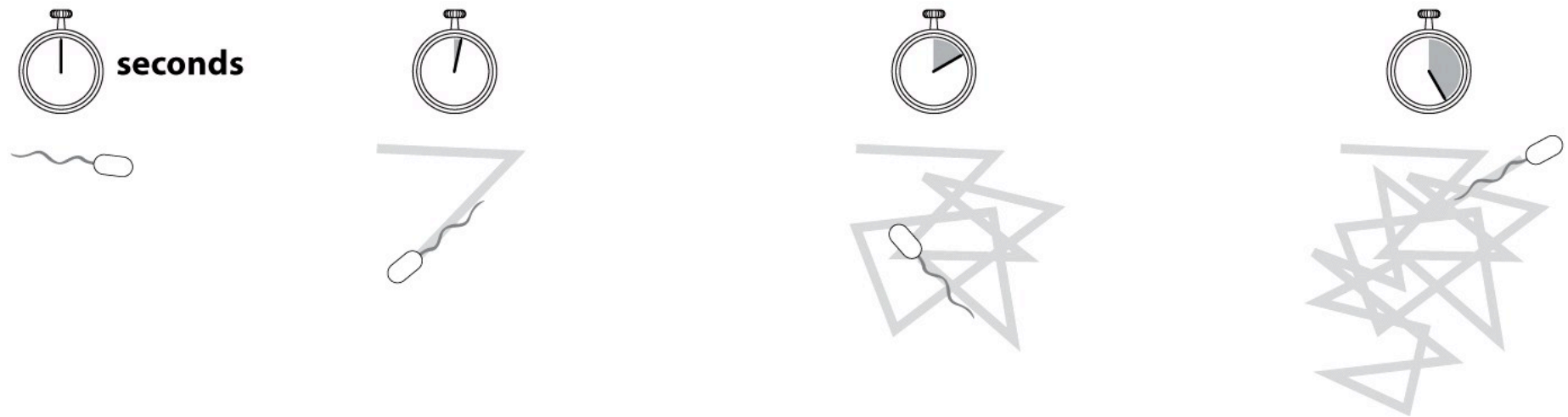


Figure 3.2d Physical Biology of the Cell (© Garland Science 2009)

protein synthesis

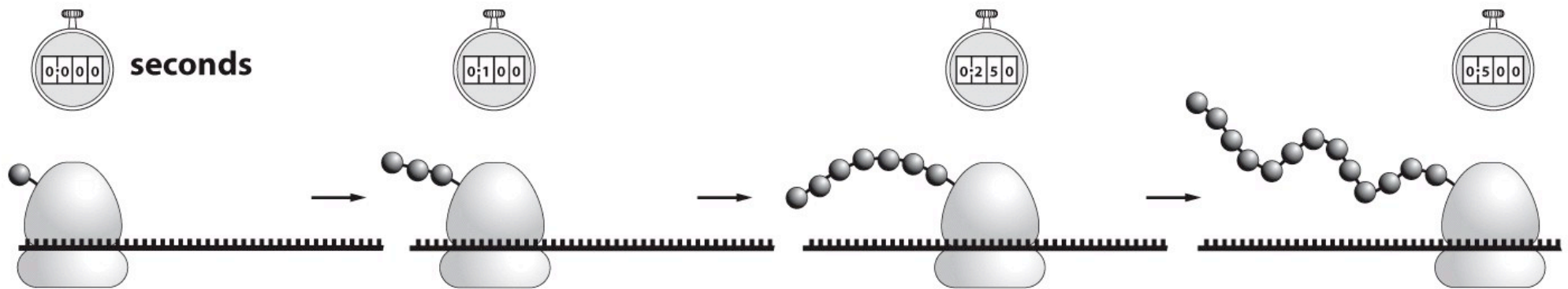


Figure 3.2e Physical Biology of the Cell (© Garland Science 2009)

transcription

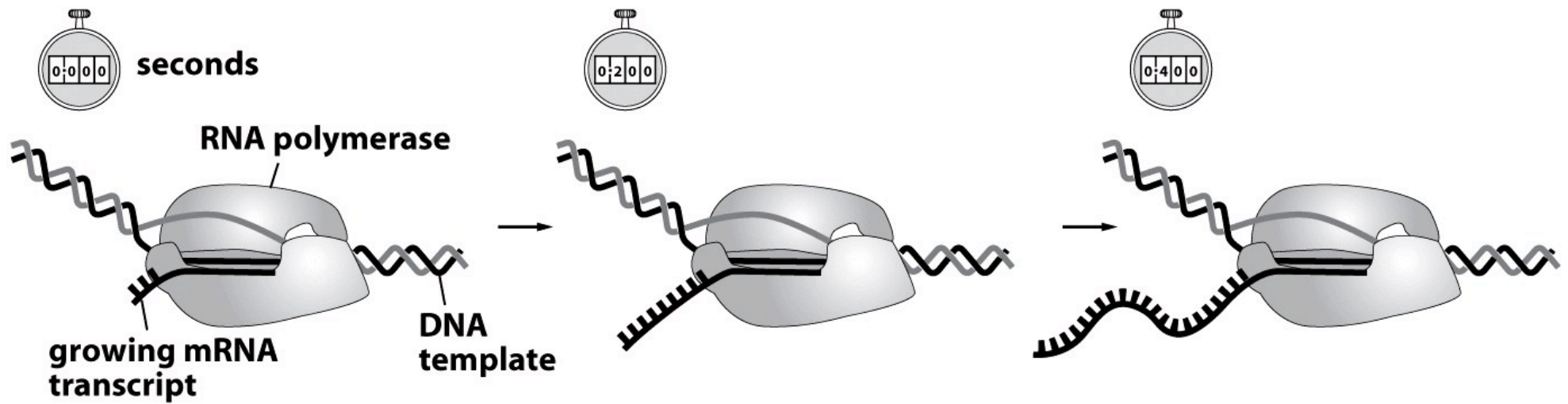


Figure 3.2f Physical Biology of the Cell (© Garland Science 2009)

gating of ion channels

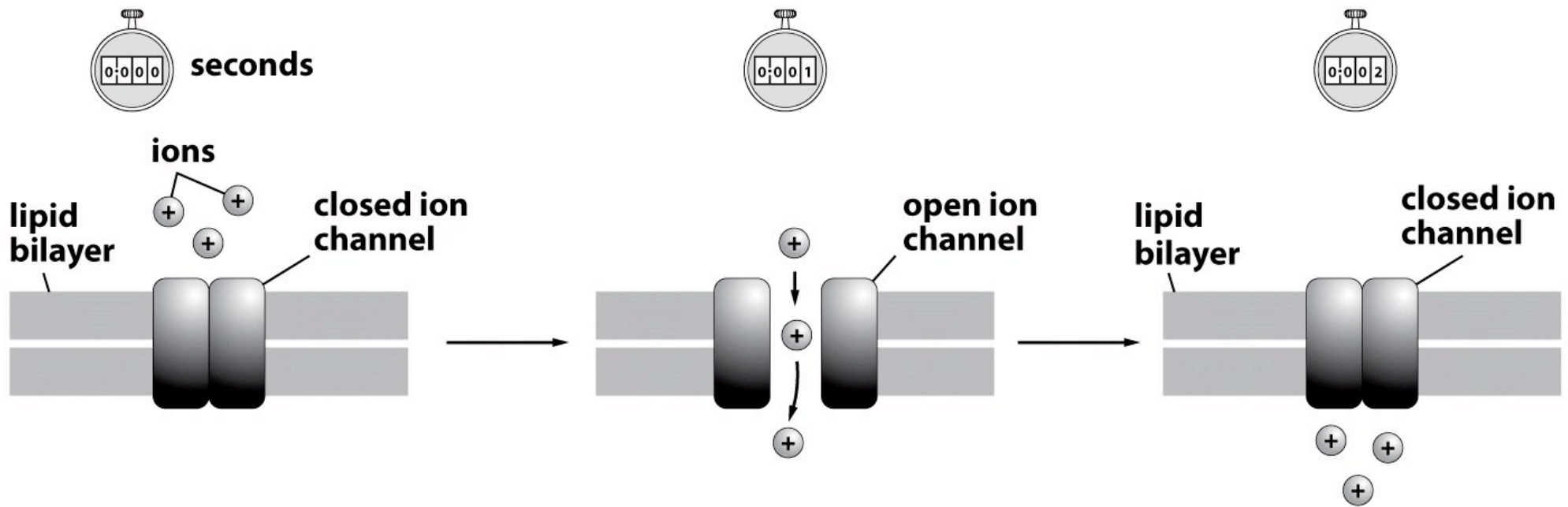


Figure 3.2g Physical Biology of the Cell (© Garland Science 2009)

enzyme catalysis

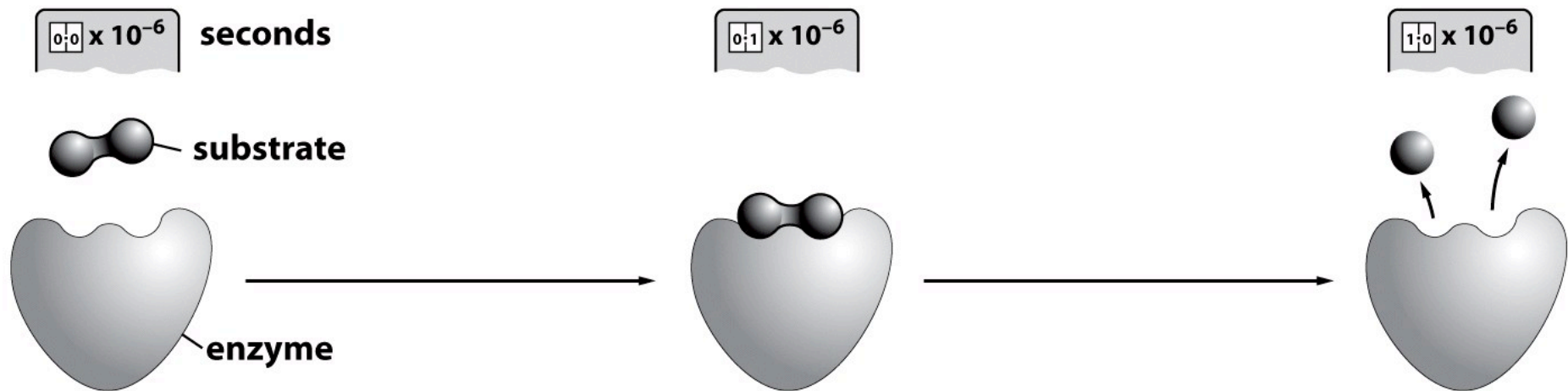


Figure 3.2h Physical Biology of the Cell (© Garland Science 2009)

Bacterial Division Clock

minutes

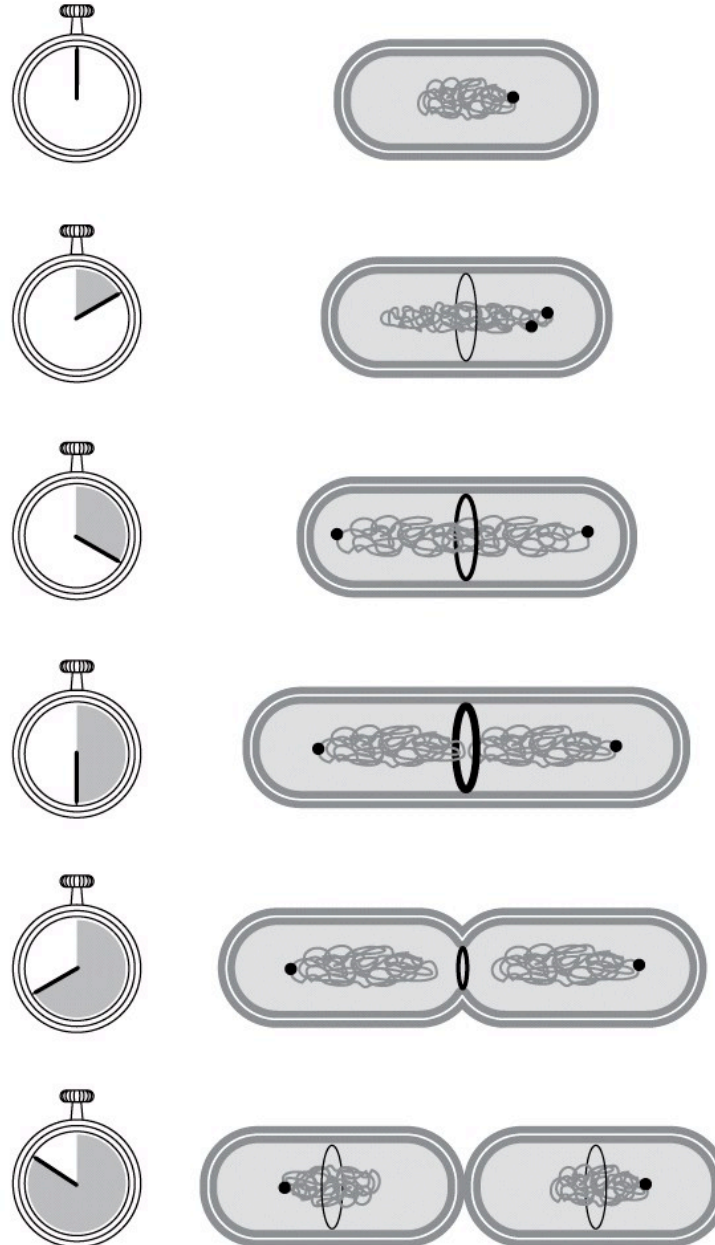
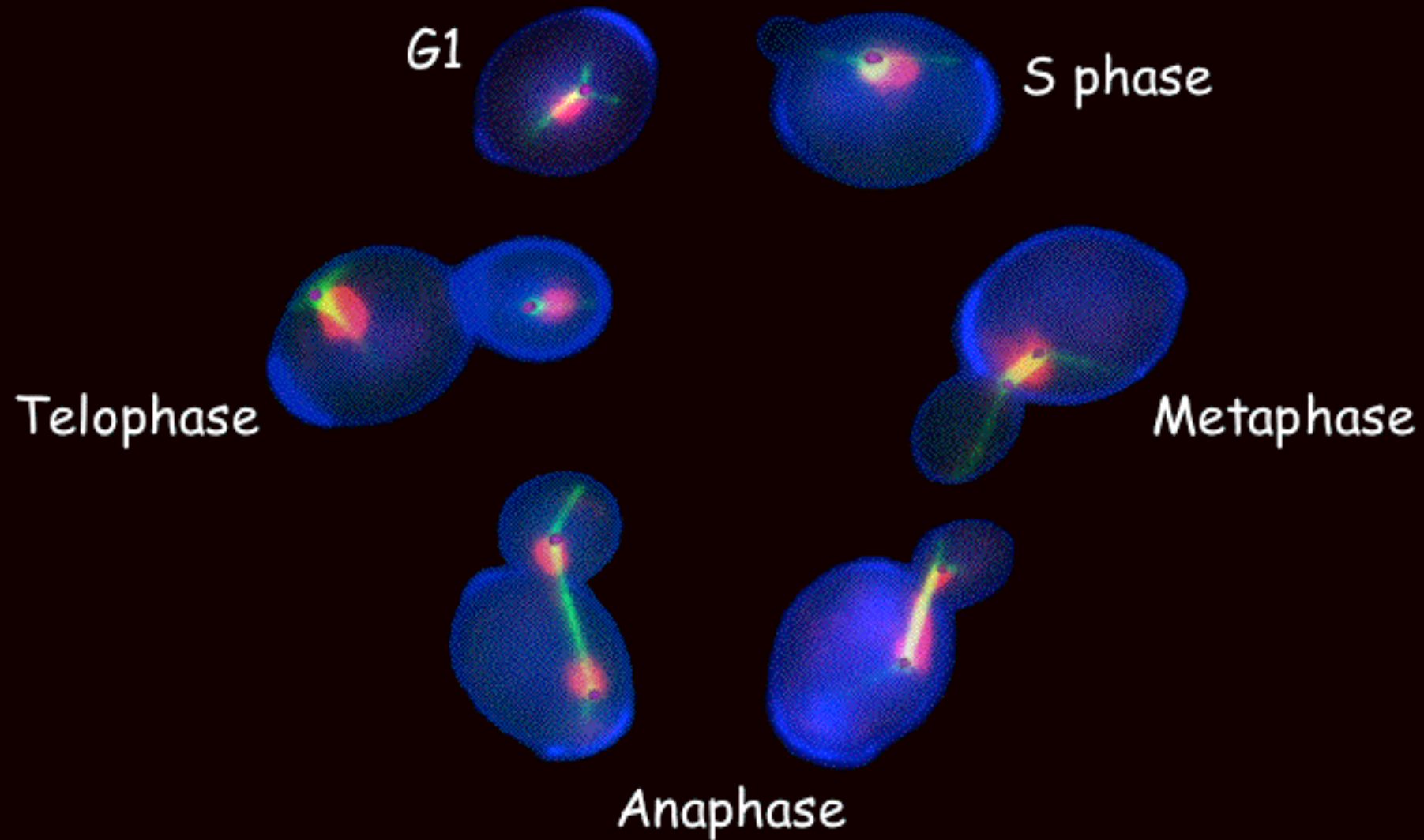


Figure 3.7 Physical Biology of the Cell (© Garland Science 2009)

Budding Yeast Cell Cycle



(D.W. Hailey, Yeast Resource Center, University of Washington)

The Cell Cycle

- Nobel Prize for Medicine or Physiology 2001:
- Hartwell: cell cycle start, checkpoint (*Saccharomyces cerevisiae*)
- Hunt: Cyclin discovery (Sea urchin *Arbacia*)
- Nurse: Cyclin dependent kinase (Cdk) discovery (*Schizosaccharomyces pombe*)

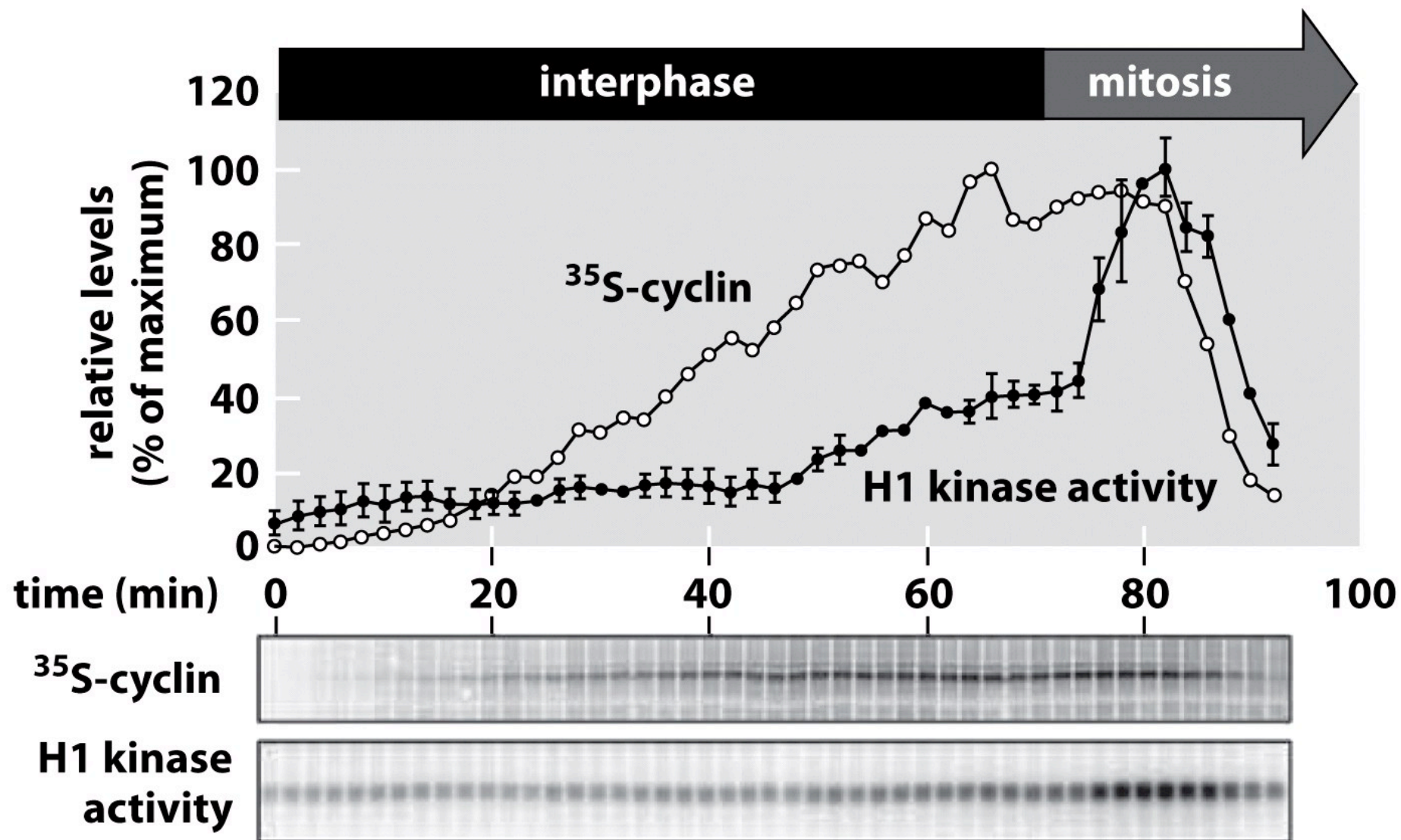


Figure 3.10b Physical Biology of the Cell (© Garland Science 2009)

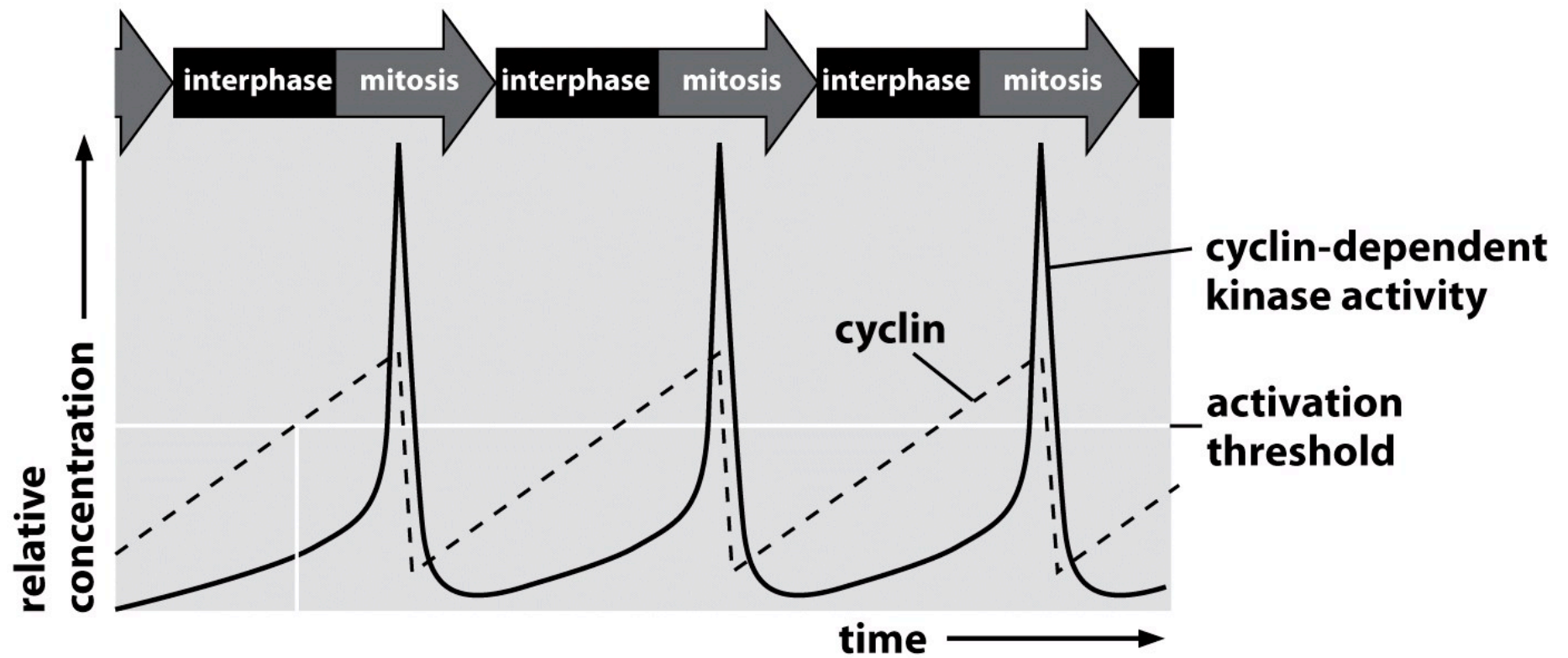


Figure 3.10a Physical Biology of the Cell (© Garland Science 2009)

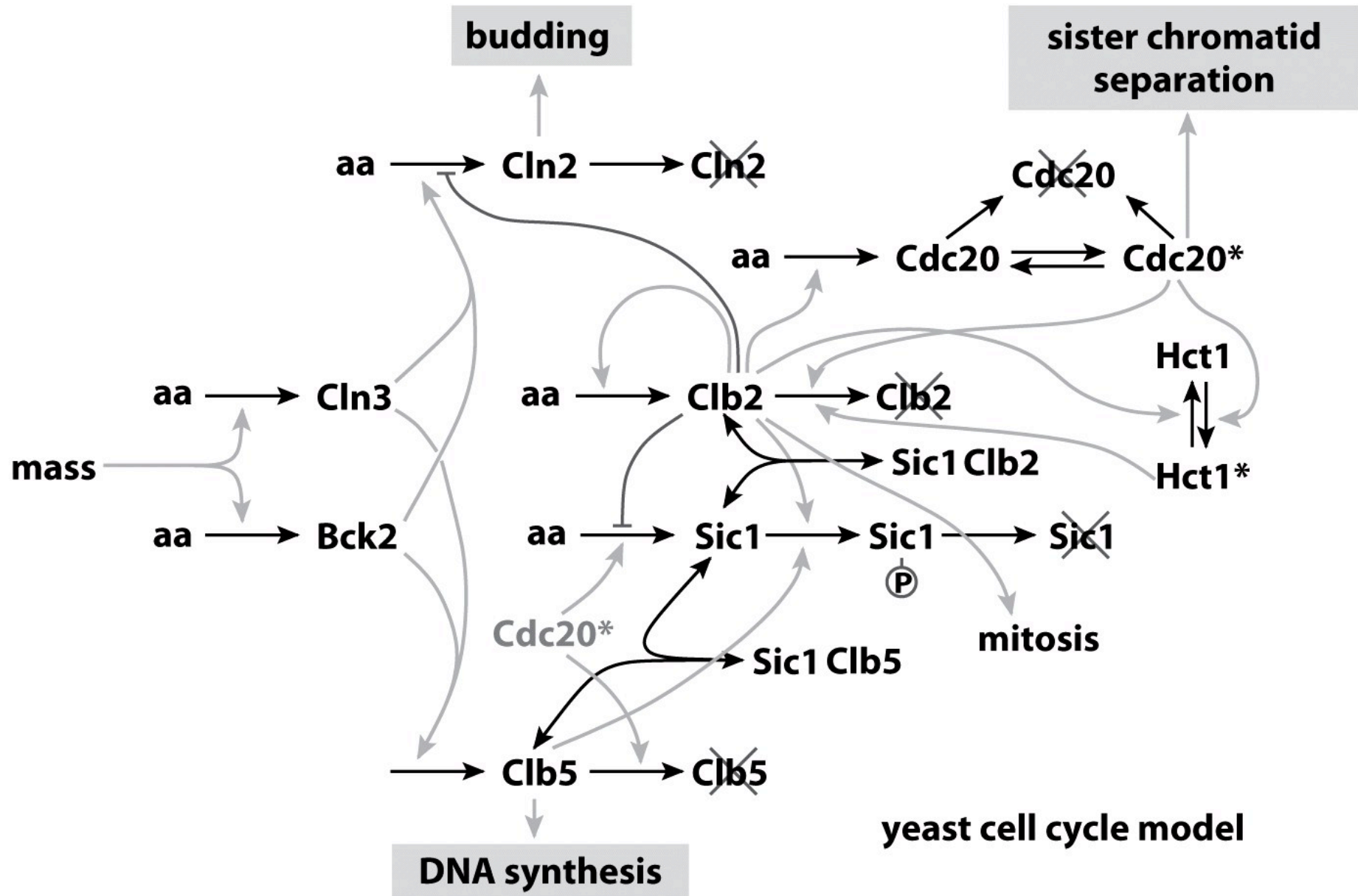
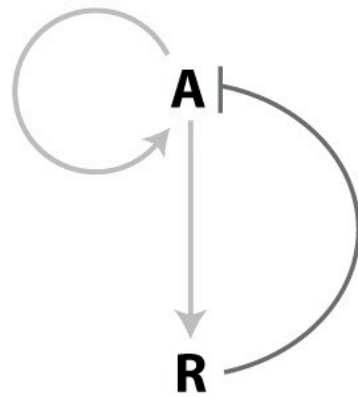
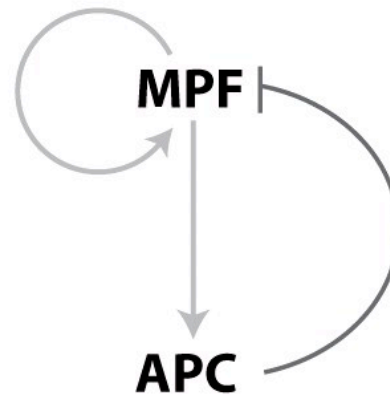


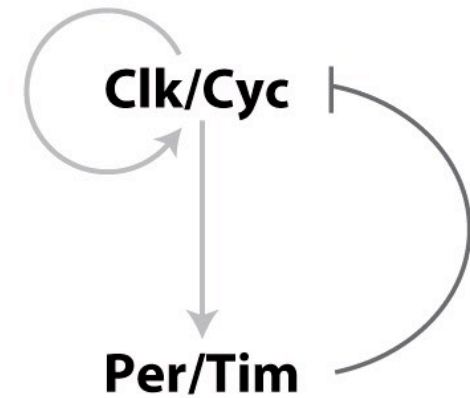
Figure 3.11b Physical Biology of the Cell (© Garland Science 2009)



**minimal oscillator
description**

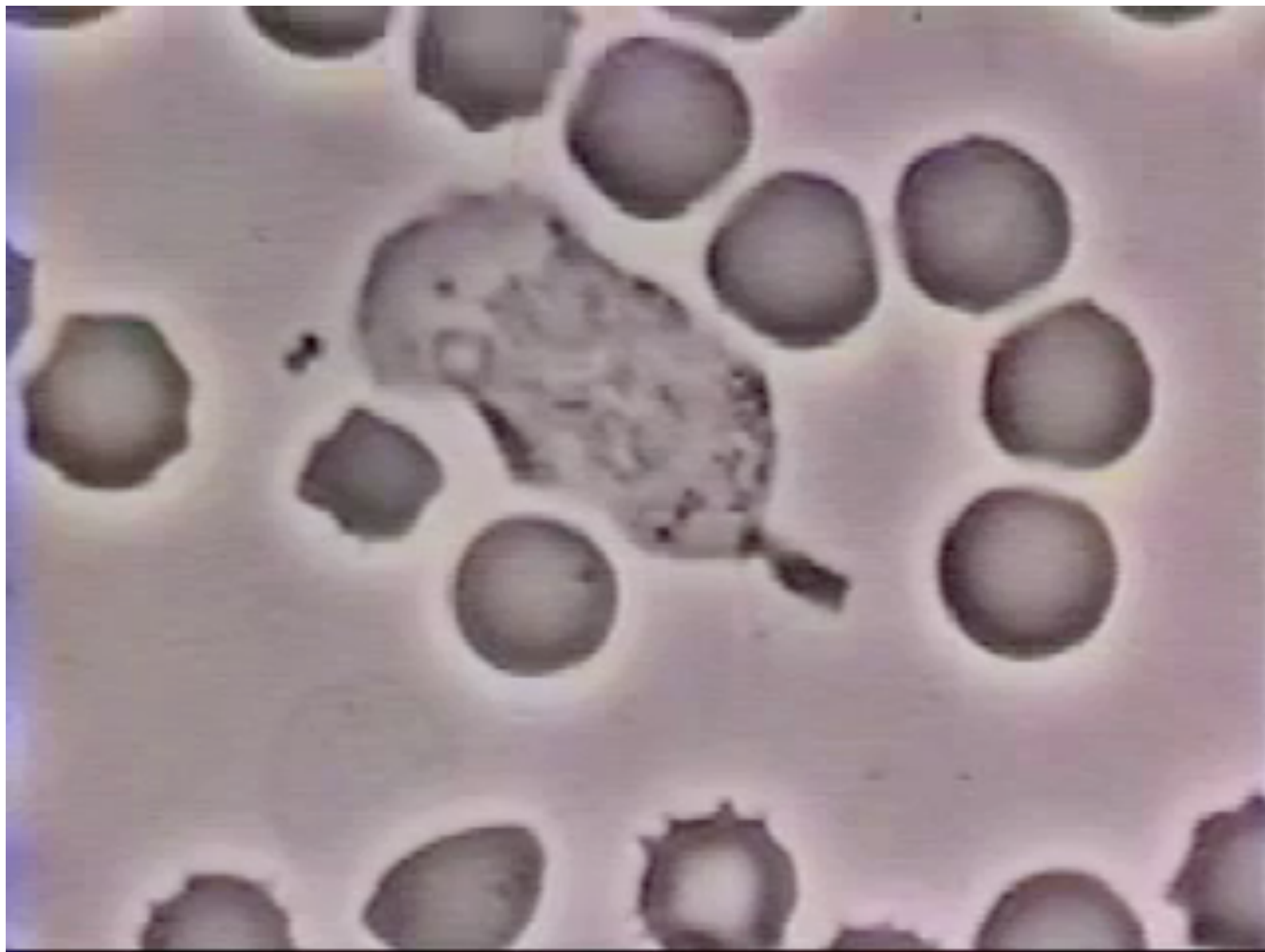


**embryonic cell
cycle oscillator**



**circadian
oscillator**

Figure 3.11a Physical Biology of the Cell (© Garland Science 2009)

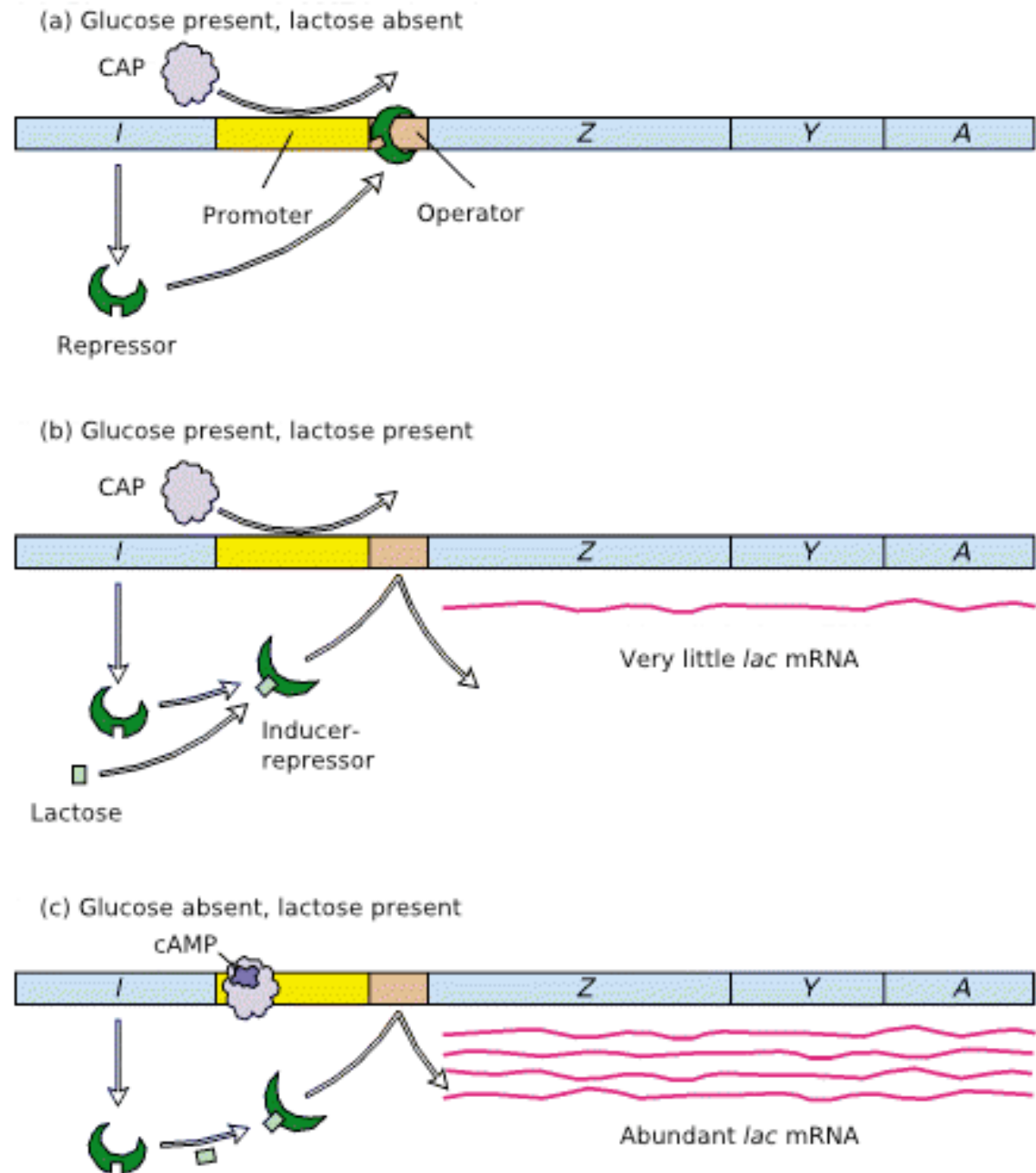


Lac Operon: The H-Atom of Gene Circuits

- Jacob, Monod, Lwoff
- Nobel Prize 1965



Lac Operon: 3 Modes of Regulation



Literature Review

Yildirim & Mackey (2003) Feedback
Regulation in the Lactose Operon: A
Mathematical Modeling Study and
Comparison with Experimental Data
Biophysical J. Vol. 84, p 2841

Time in Biology

- Procedural time
 - Bacterial growth
 - Circadian clock
- Relative time
 - Sequential events: DNA replication, segregation, cell division
- Manipulated time
 - Spore formation
 - Enzyme catalysis

Procedural Time

E. coli

- 2 DNA replication forks
- Rate of DNA synthesis?
- Polymerase rates 250-1000 bps/s
- *E. coli* can replicate in 1000s on rich media. How?

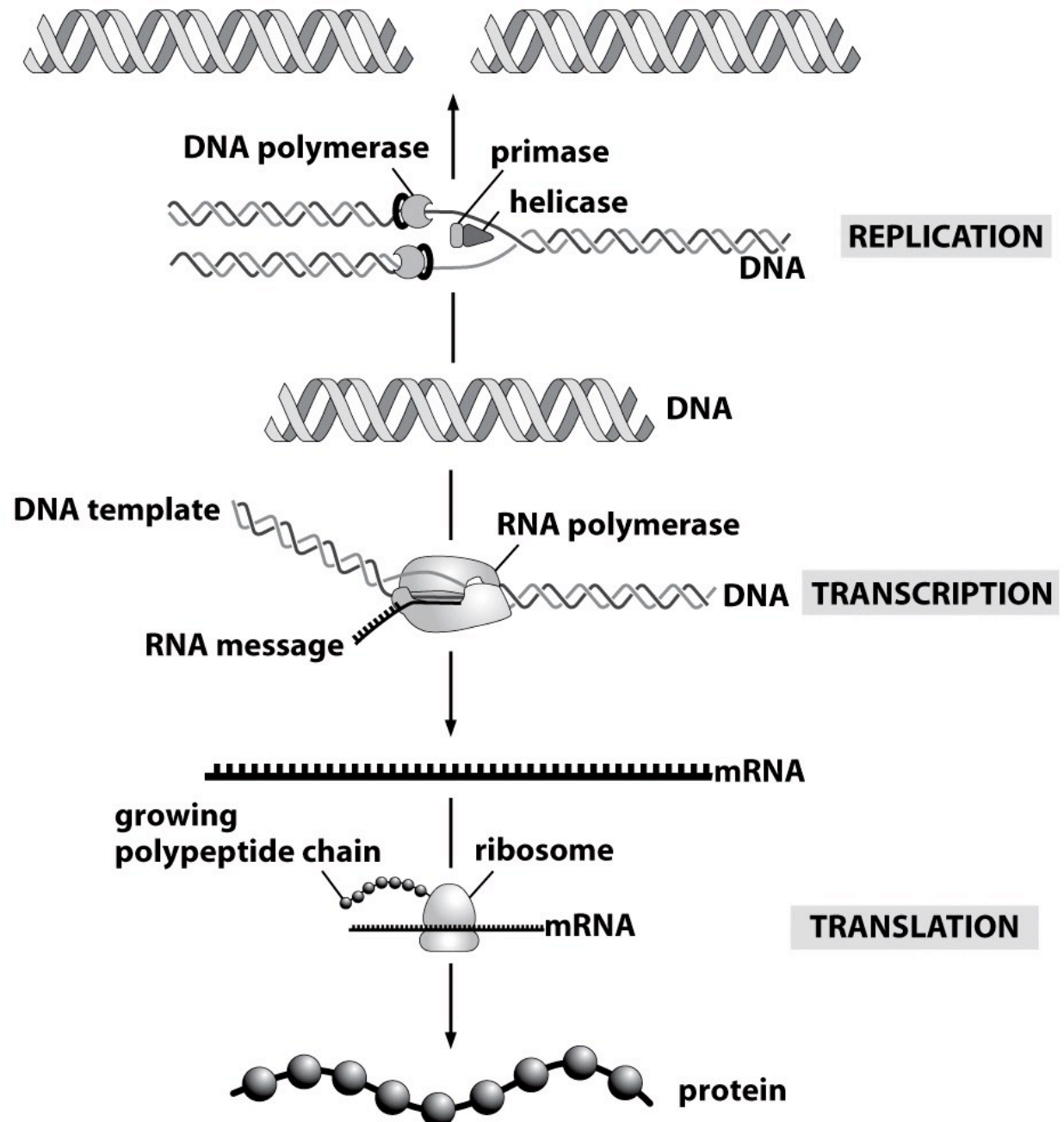


Figure 3.8 Physical Biology of the Cell (© Garland Science 2009)

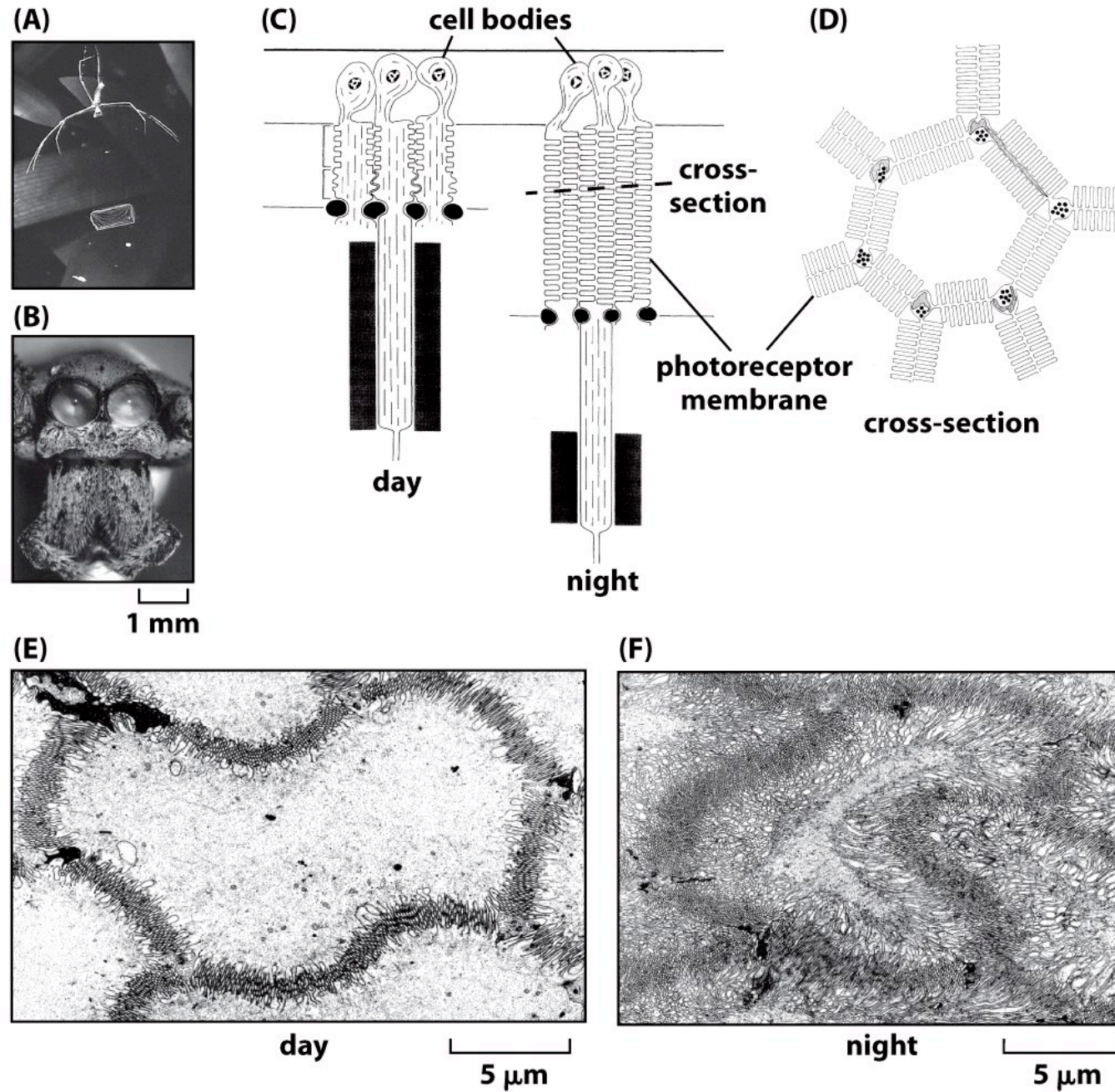


Figure 3.12 Physical Biology of the Cell (© Garland Science 2009)

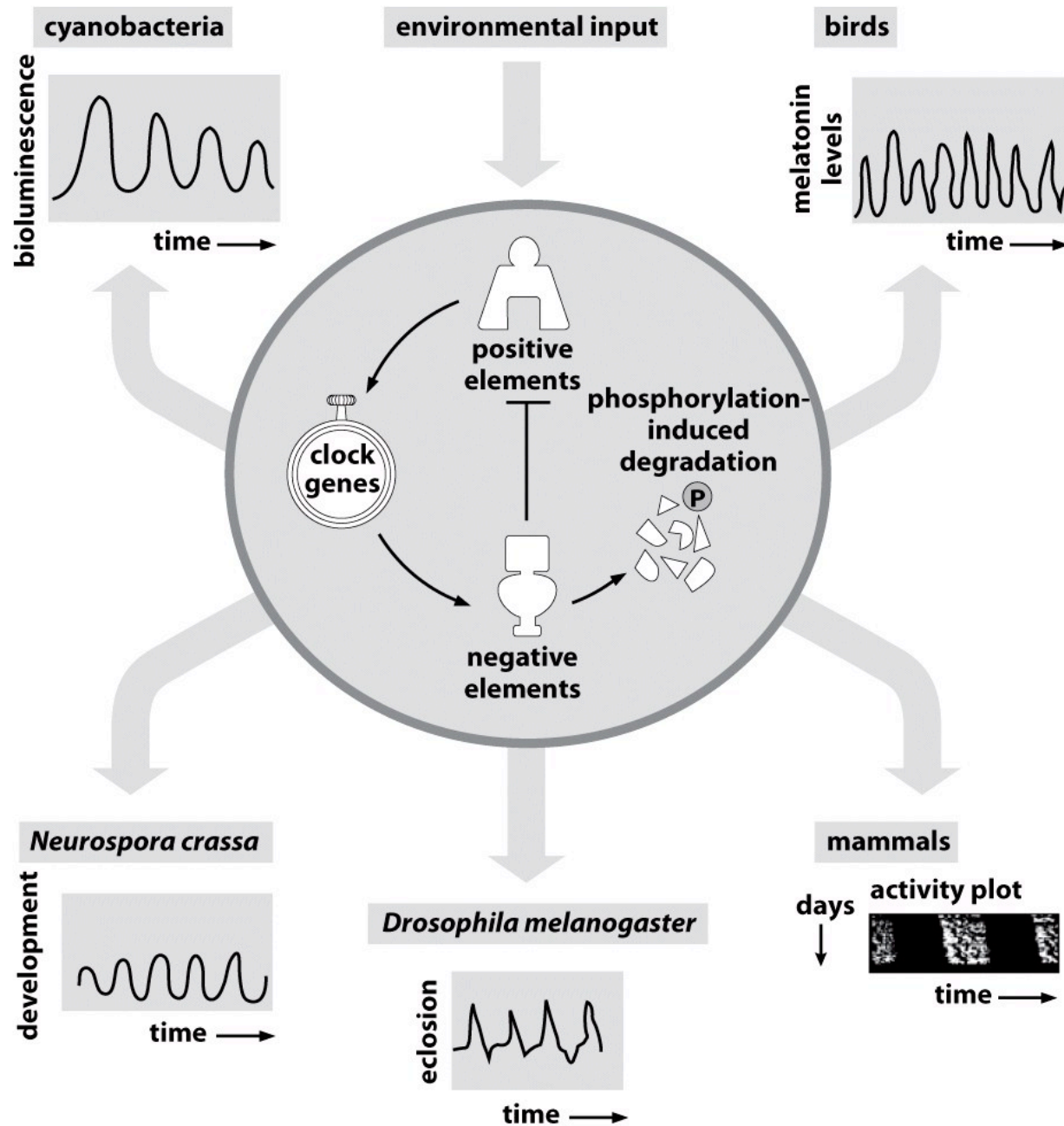
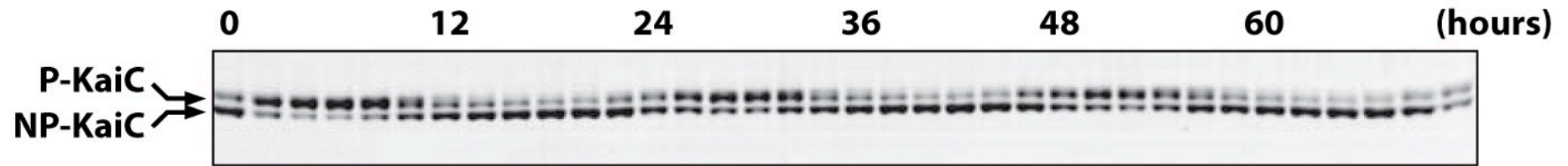
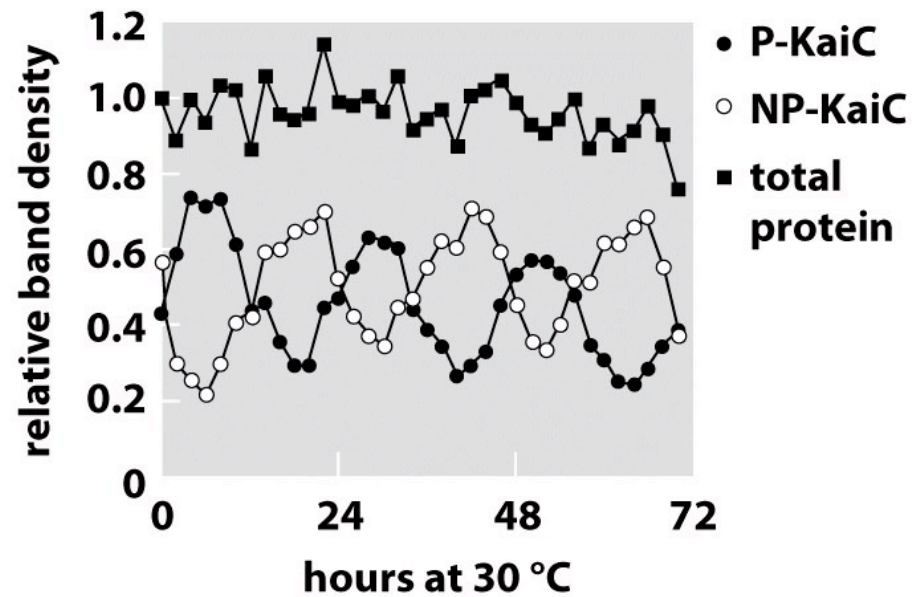


Figure 3.13 Physical Biology of the Cell (© Garland Science 2009)

(A)



(B)



(C)

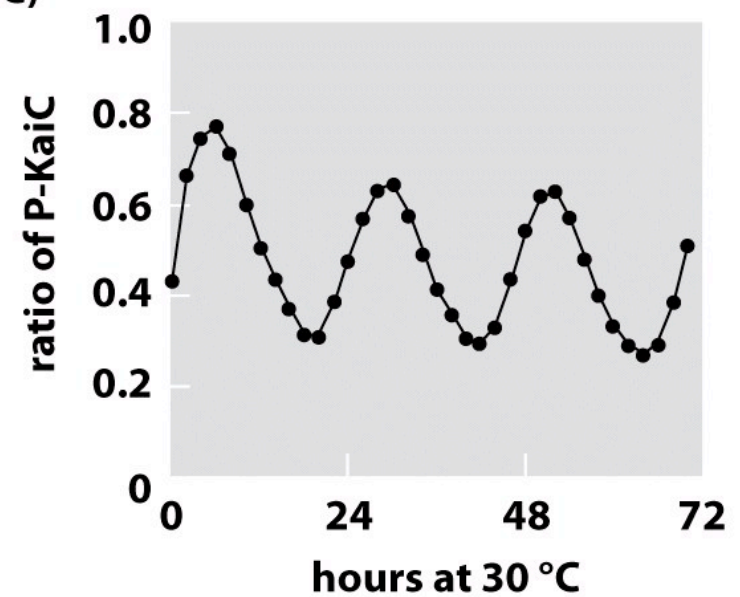


Figure 3.14 Physical Biology of the Cell (© Garland Science 2009)

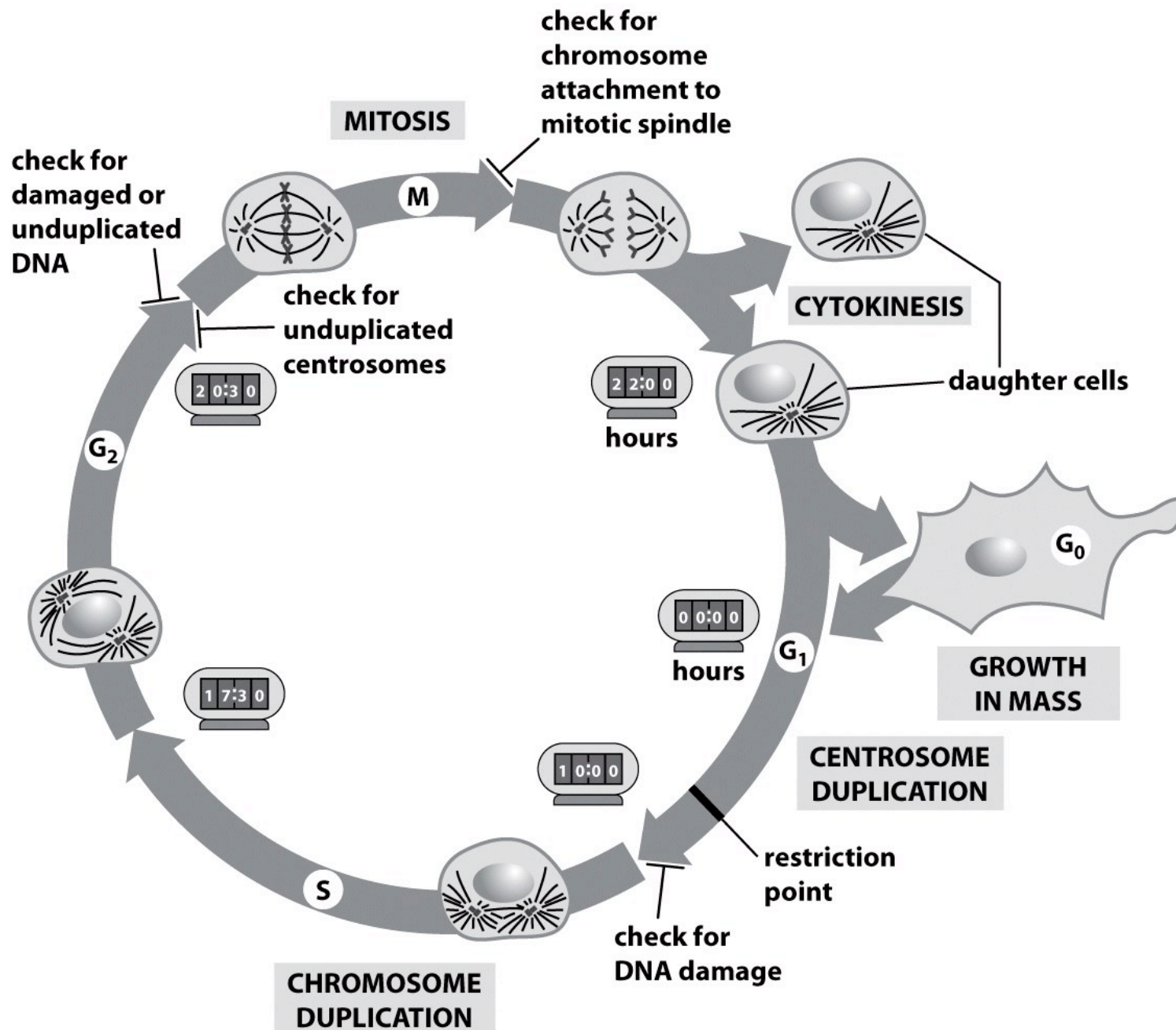


Figure 3.15a Physical Biology of the Cell (© Garland Science 2009)

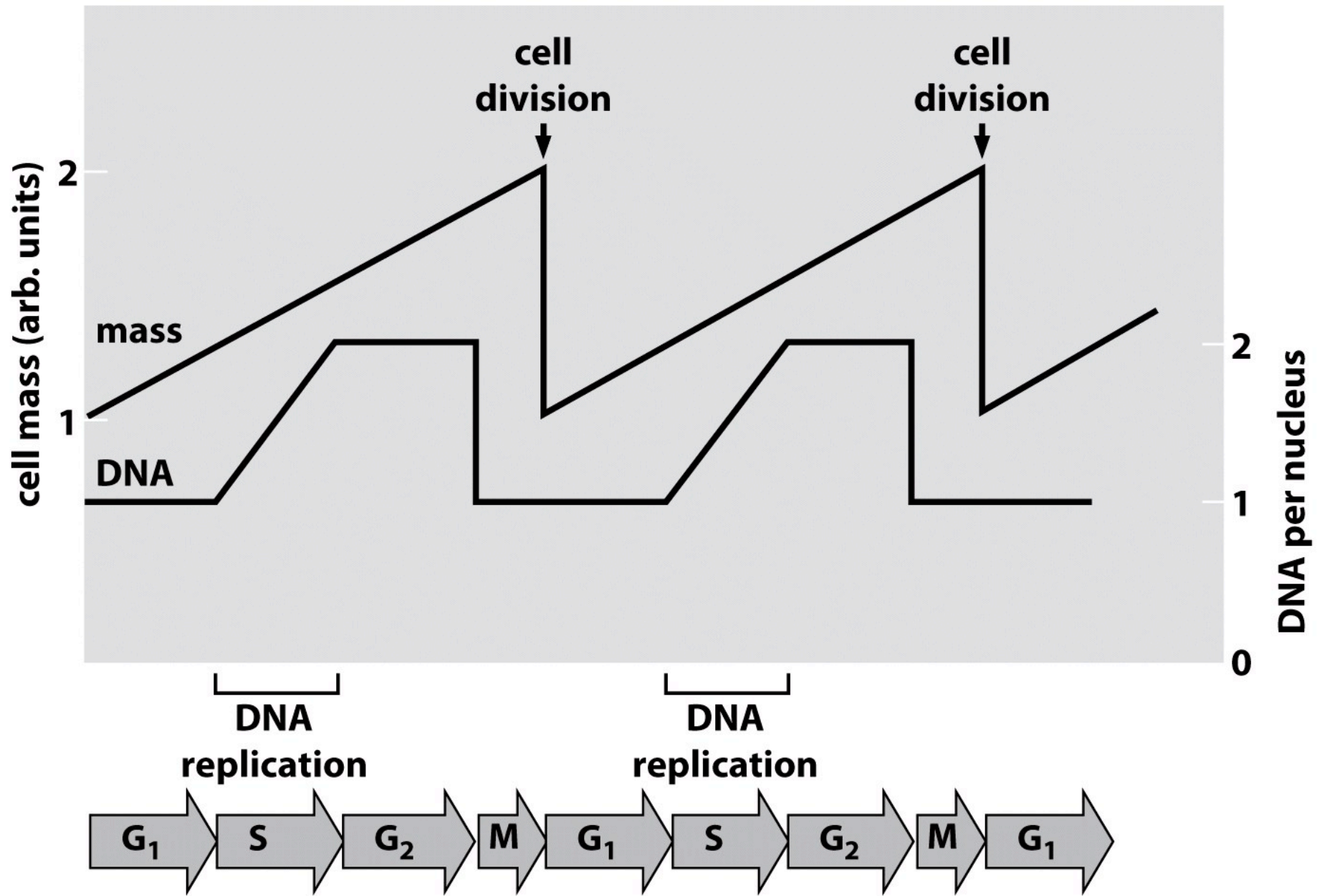


Figure 3.15b Physical Biology of the Cell (© Garland Science 2009)

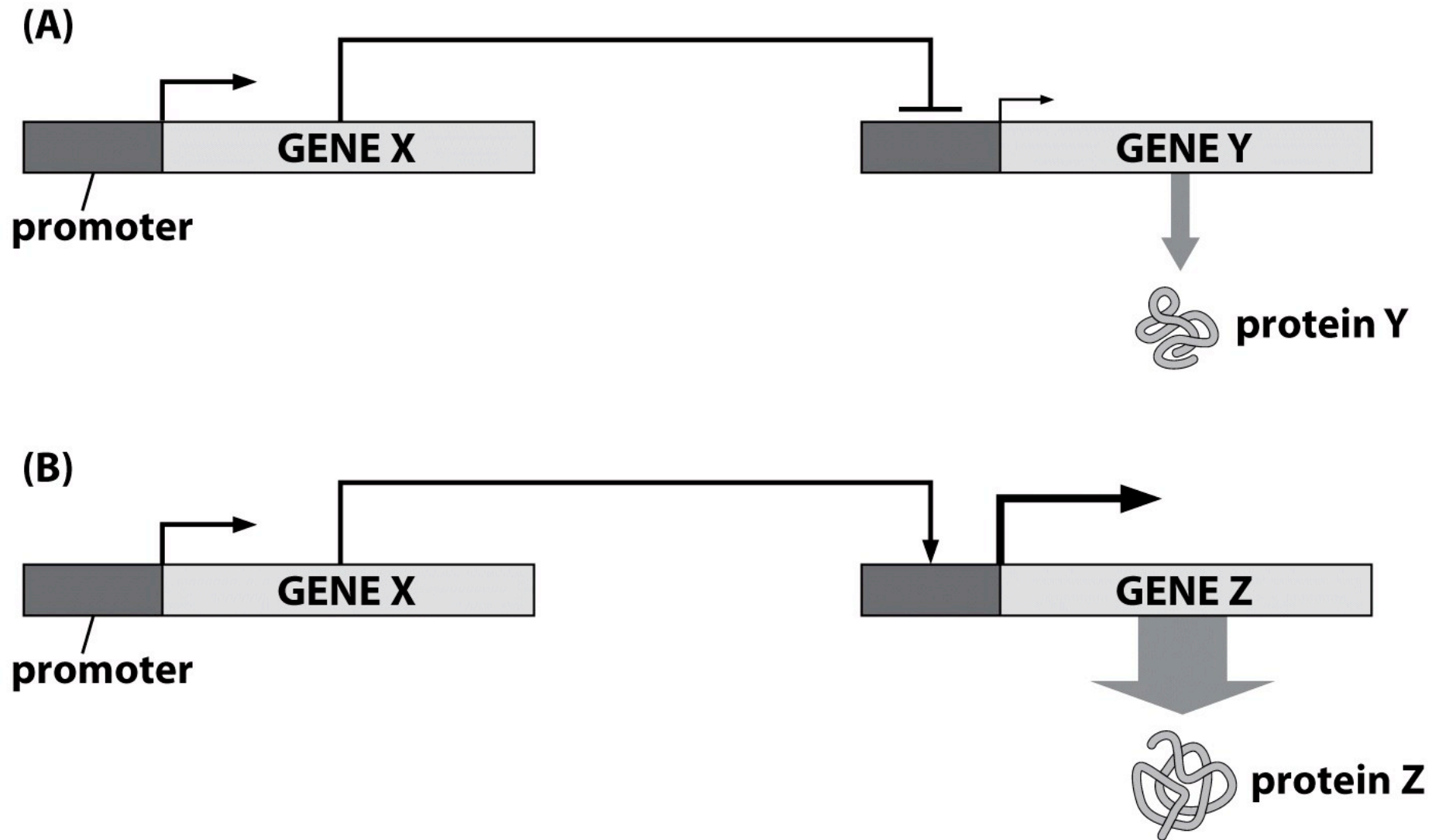


Figure 3.16 Physical Biology of the Cell (© Garland Science 2009)

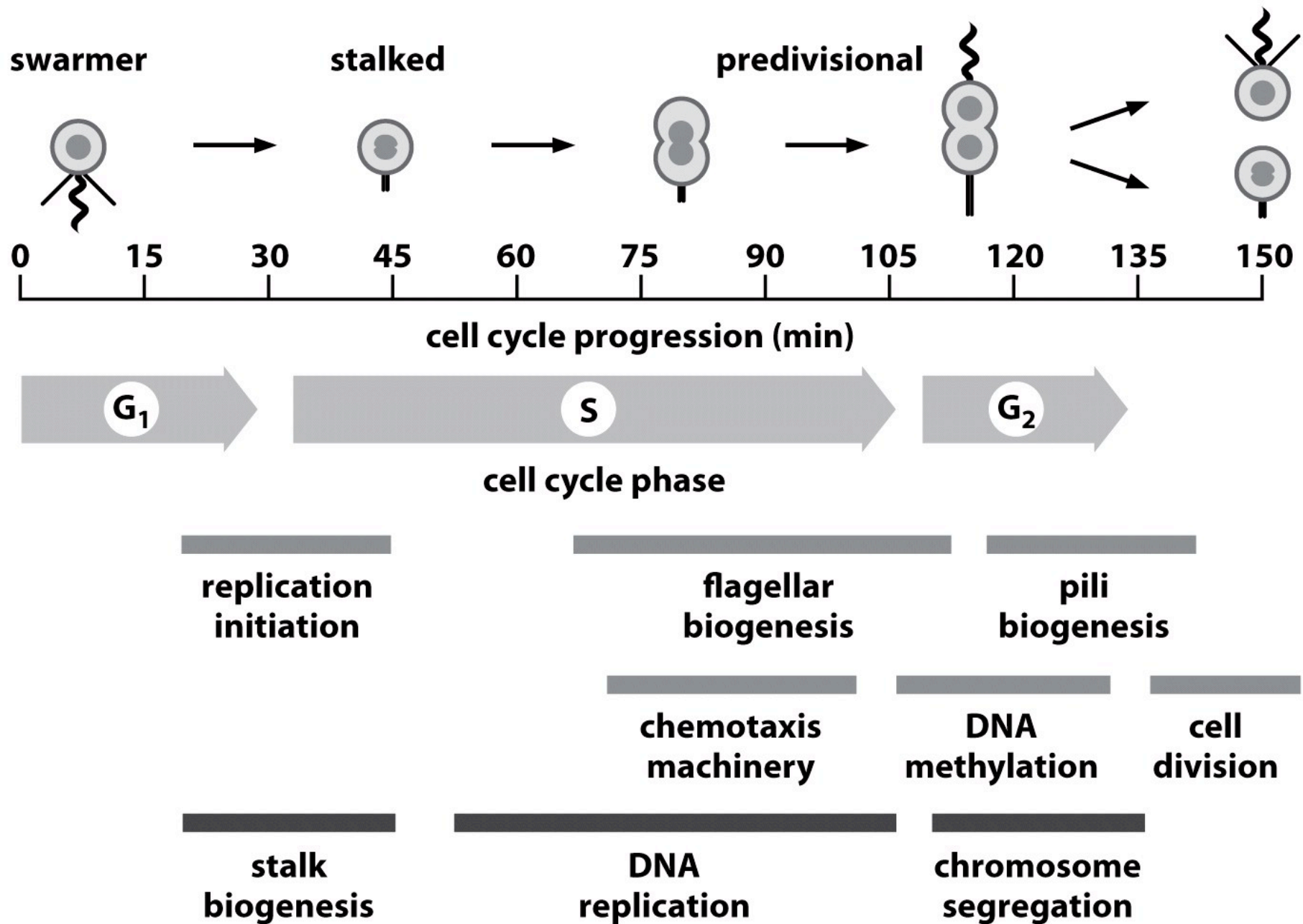


Figure 3.17a Physical Biology of the Cell (© Garland Science 2009)

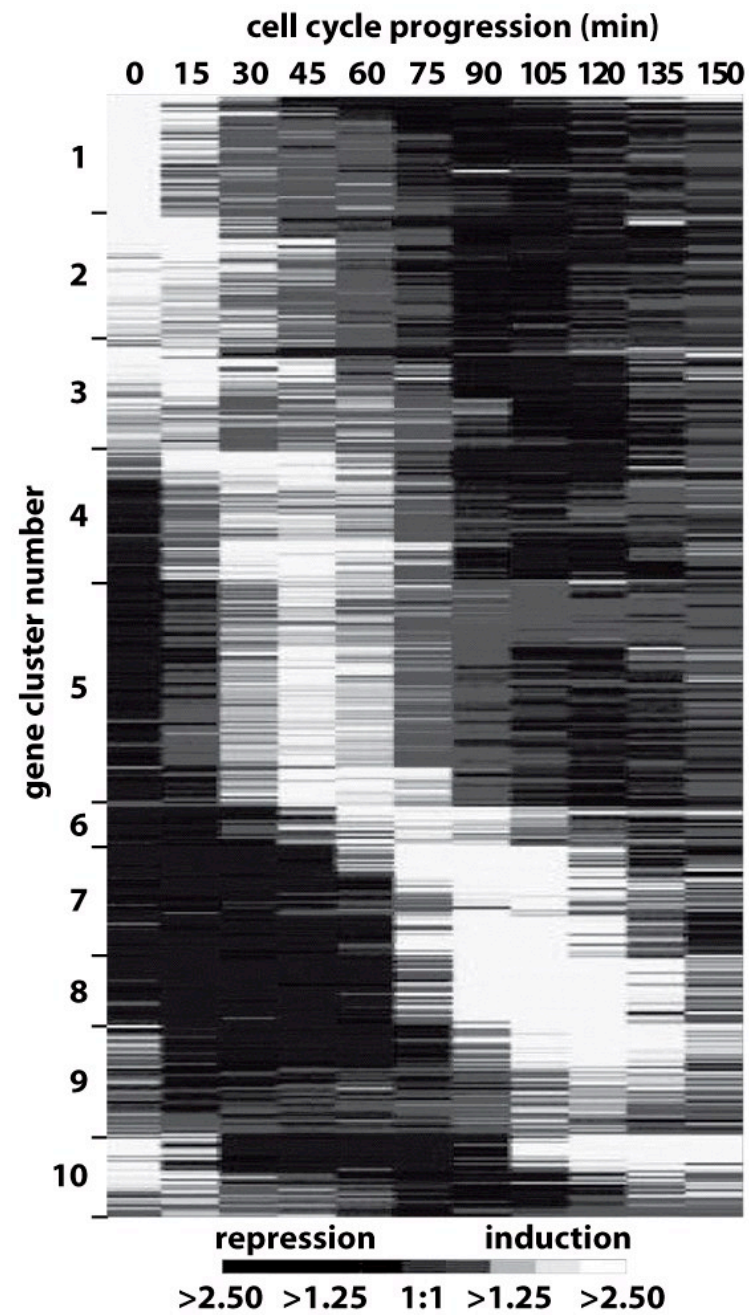


Figure 3.17b Physical Biology of the Cell (© Garland Science 2009)

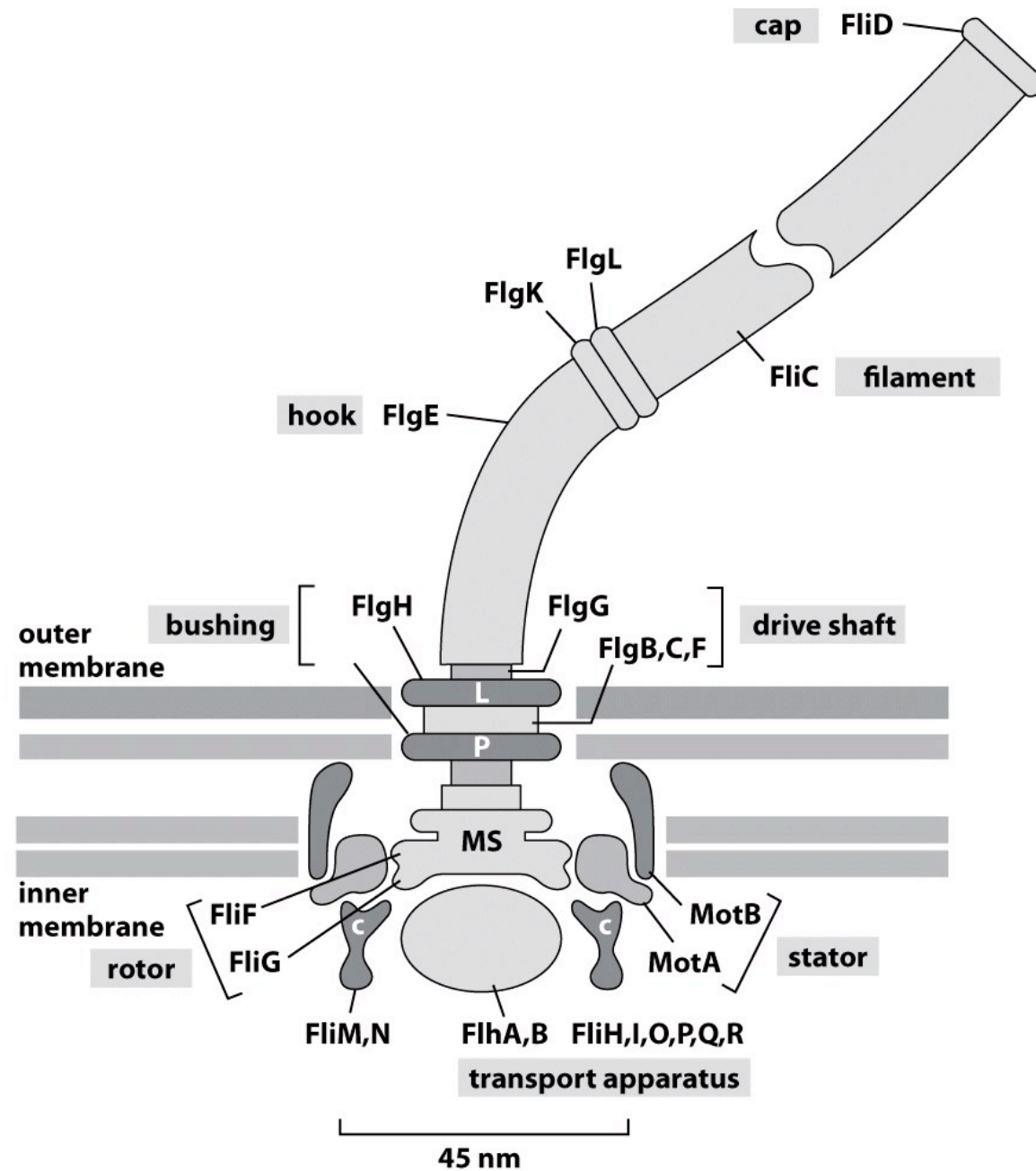


Figure 3.18a Physical Biology of the Cell (© Garland Science 2009)

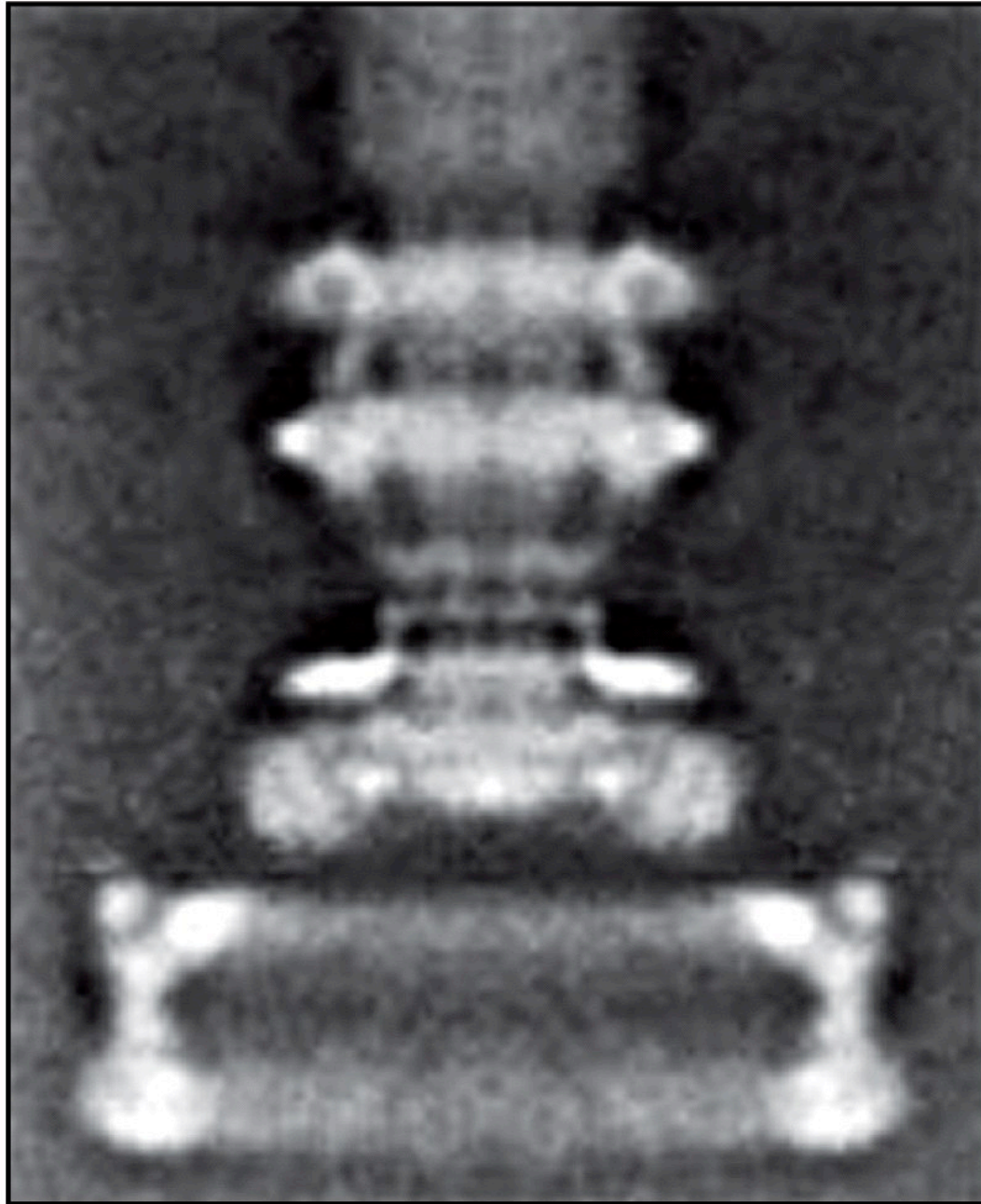


Figure 3.18b Physical Biology of the Cell (© Garland Science 2009)

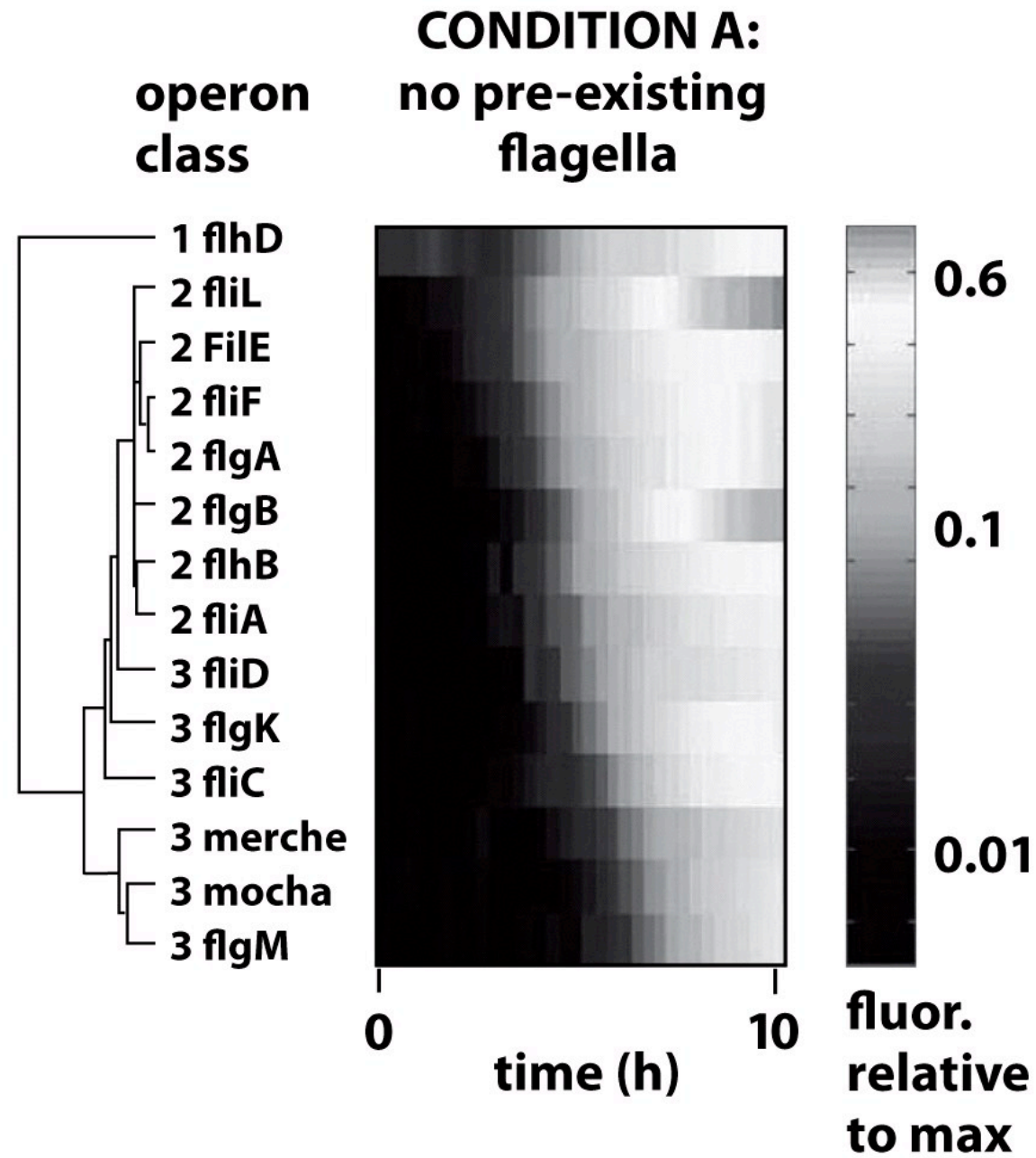


Figure 3.19a Physical Biology of the Cell (© Garland Science 2009)

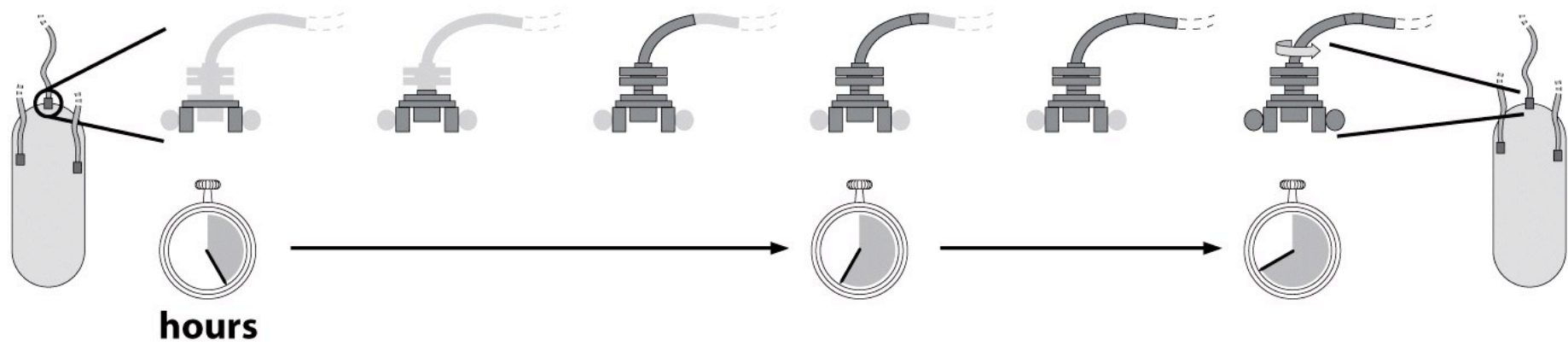


Figure 3.19b Physical Biology of the Cell (© Garland Science 2009)

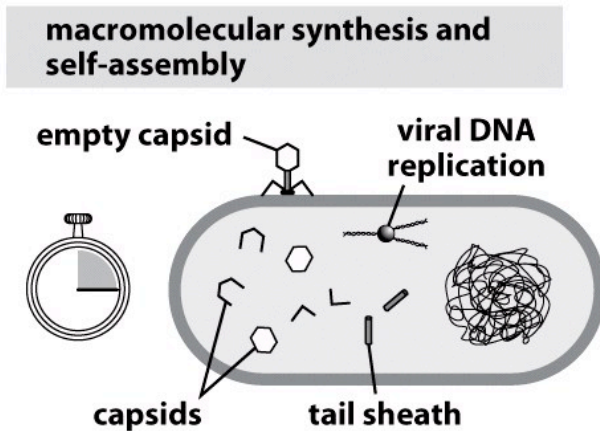
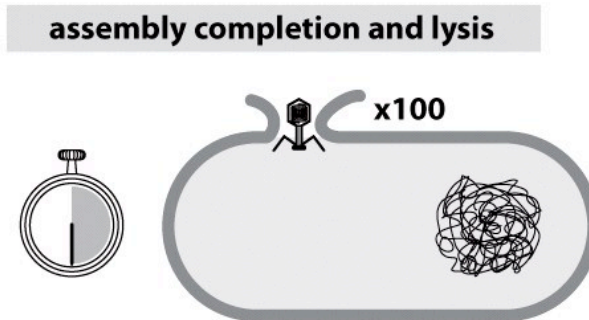
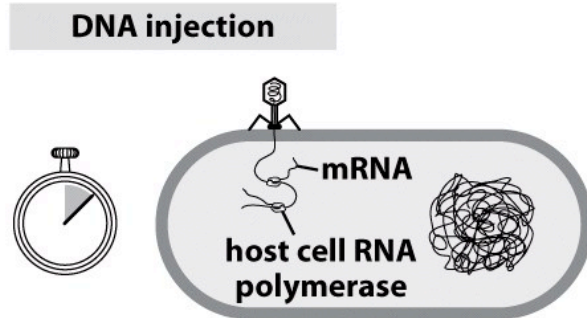
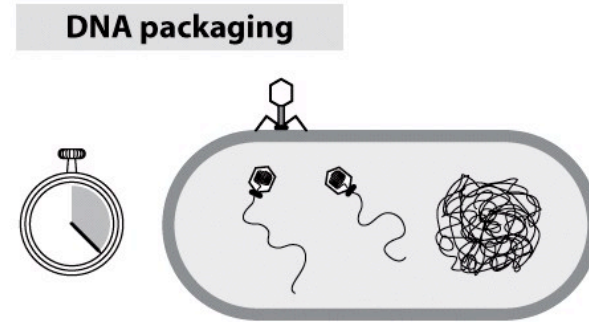
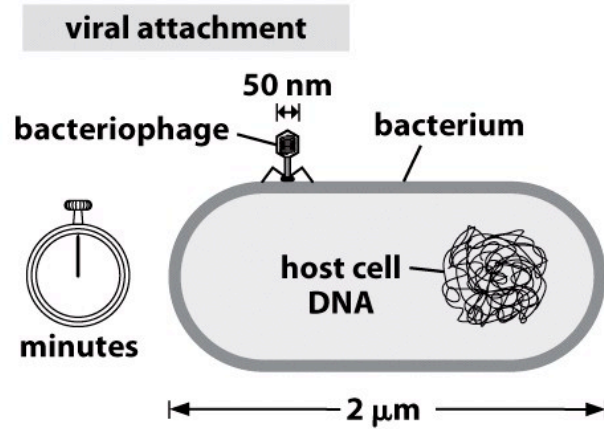


Figure 3.20 Physical Biology of the Cell (© Garland Science 2009)

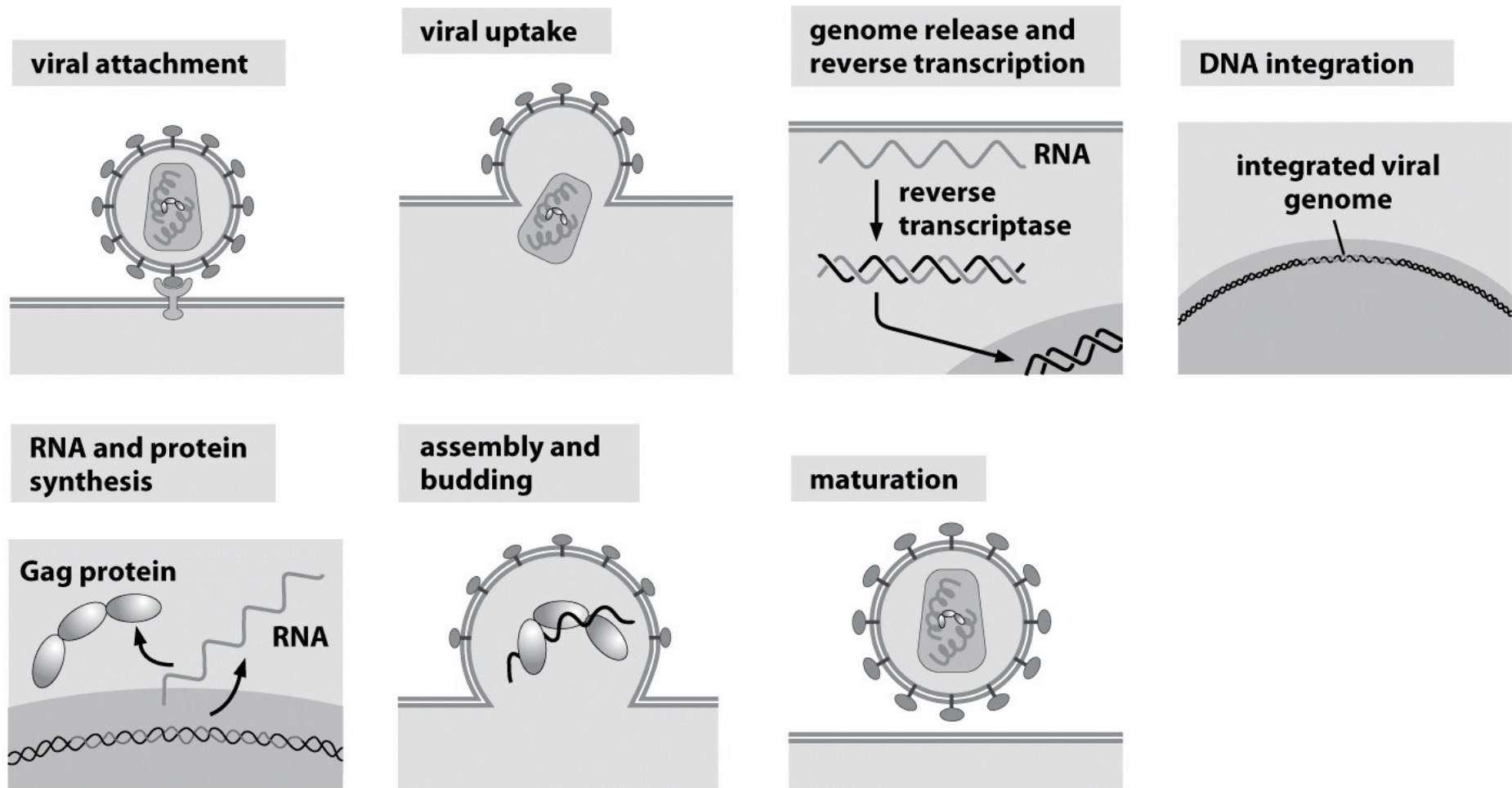


Figure 3.21 Physical Biology of the Cell (© Garland Science 2009)

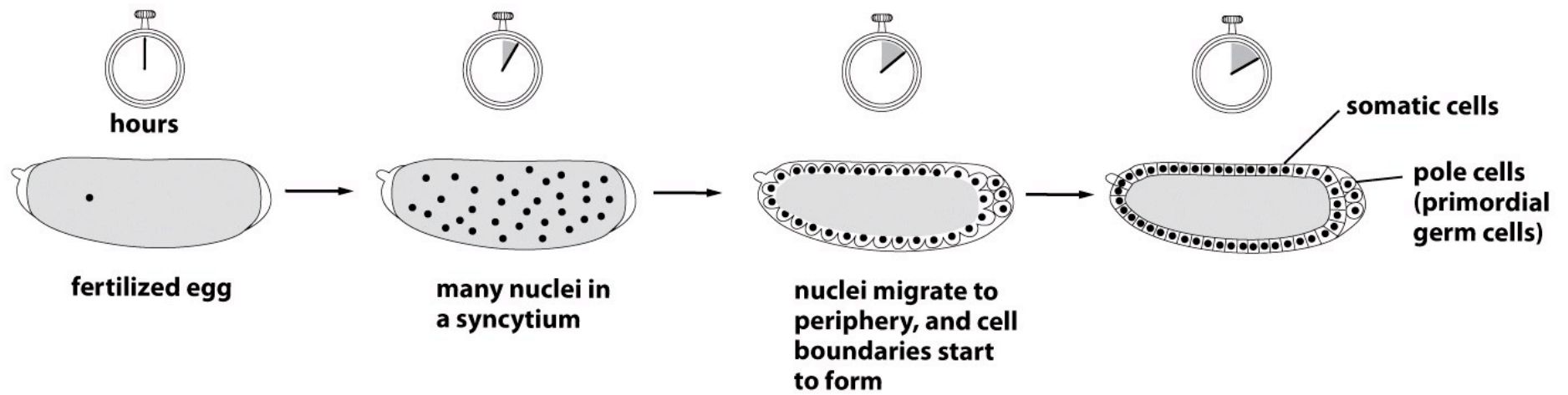
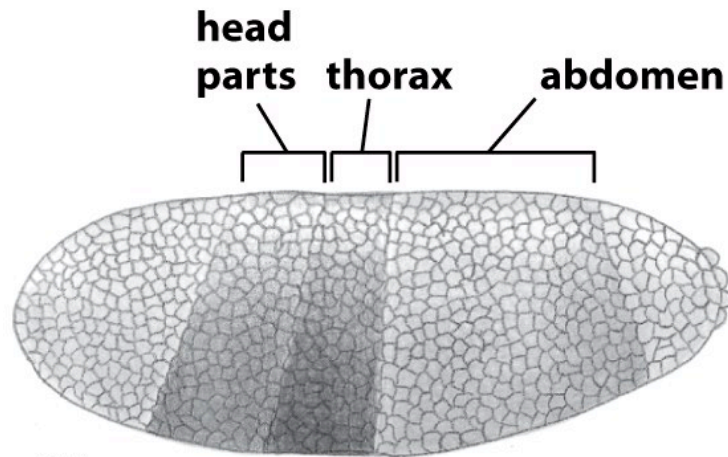
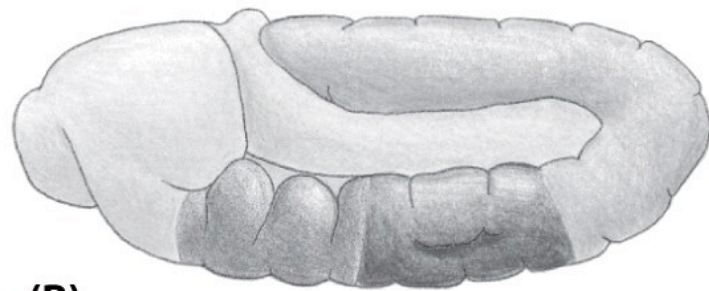


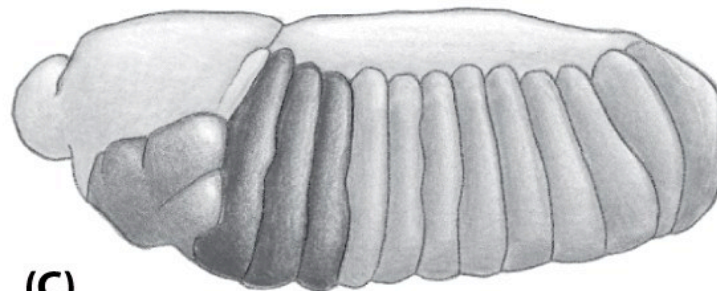
Figure 3.22 Physical Biology of the Cell (© Garland Science 2009)



(A)



(B)



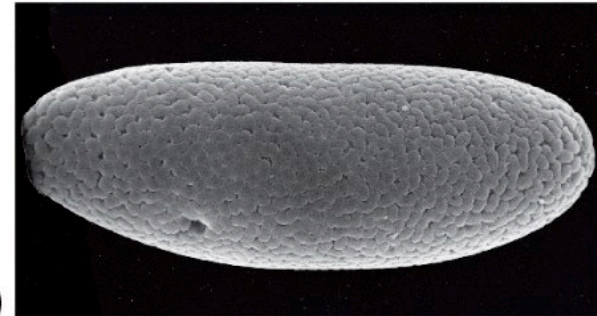
(C)

0.5 mm



hours

(D)



(E)



(F)



Figure 3.23 Physical Biology of the Cell (© Garland Science 2009)

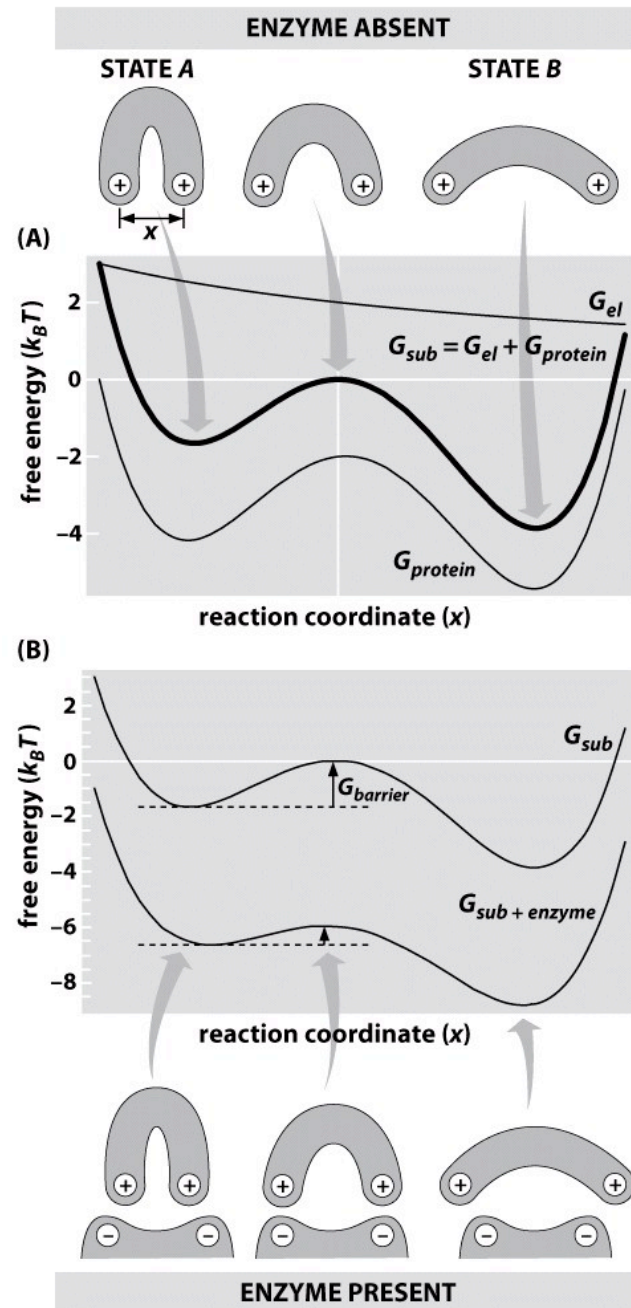


Figure 3.24 Physical Biology of the Cell (© Garland Science 2009)

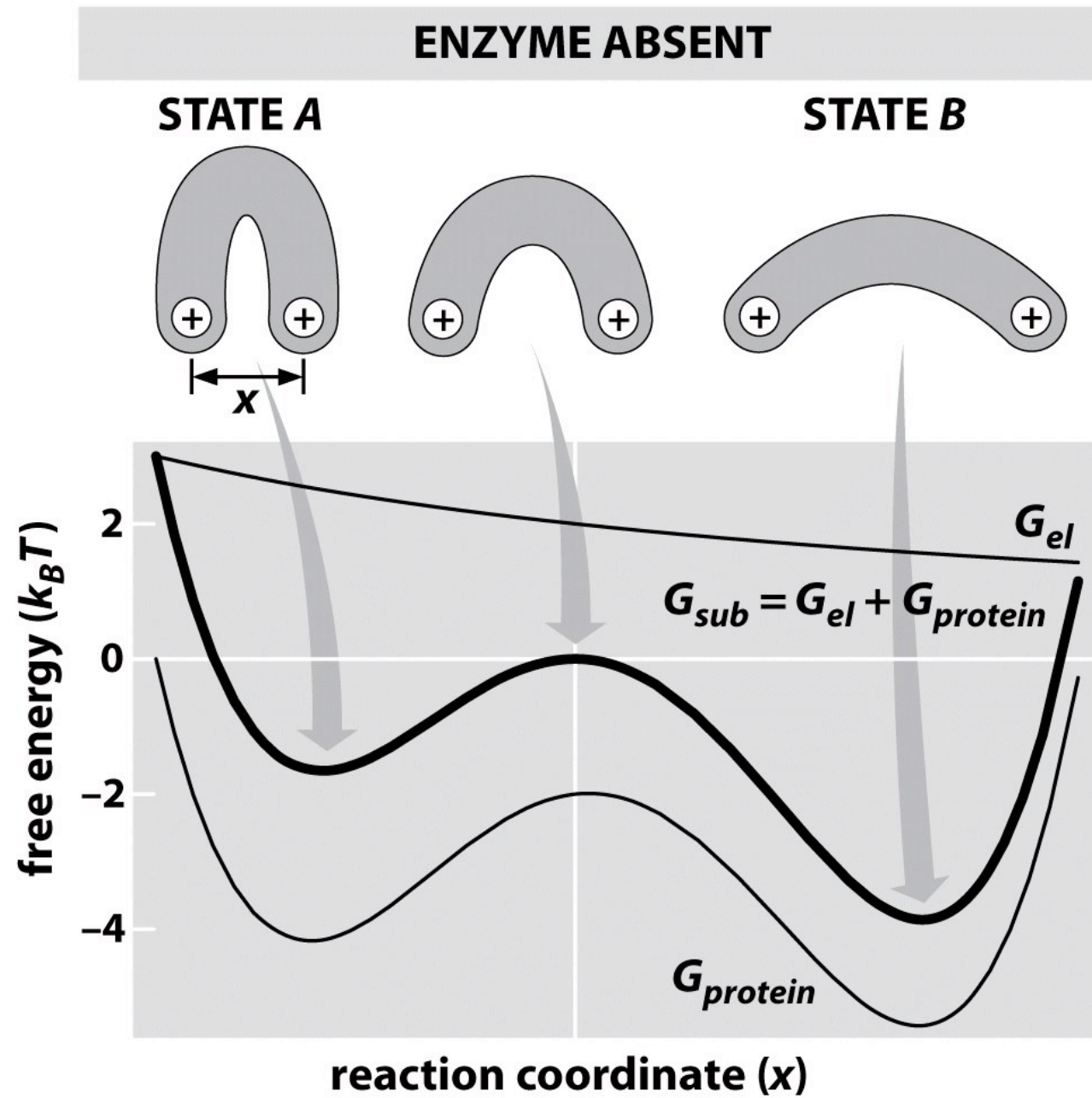


Figure 3.24a Physical Biology of the Cell (© Garland Science 2009)

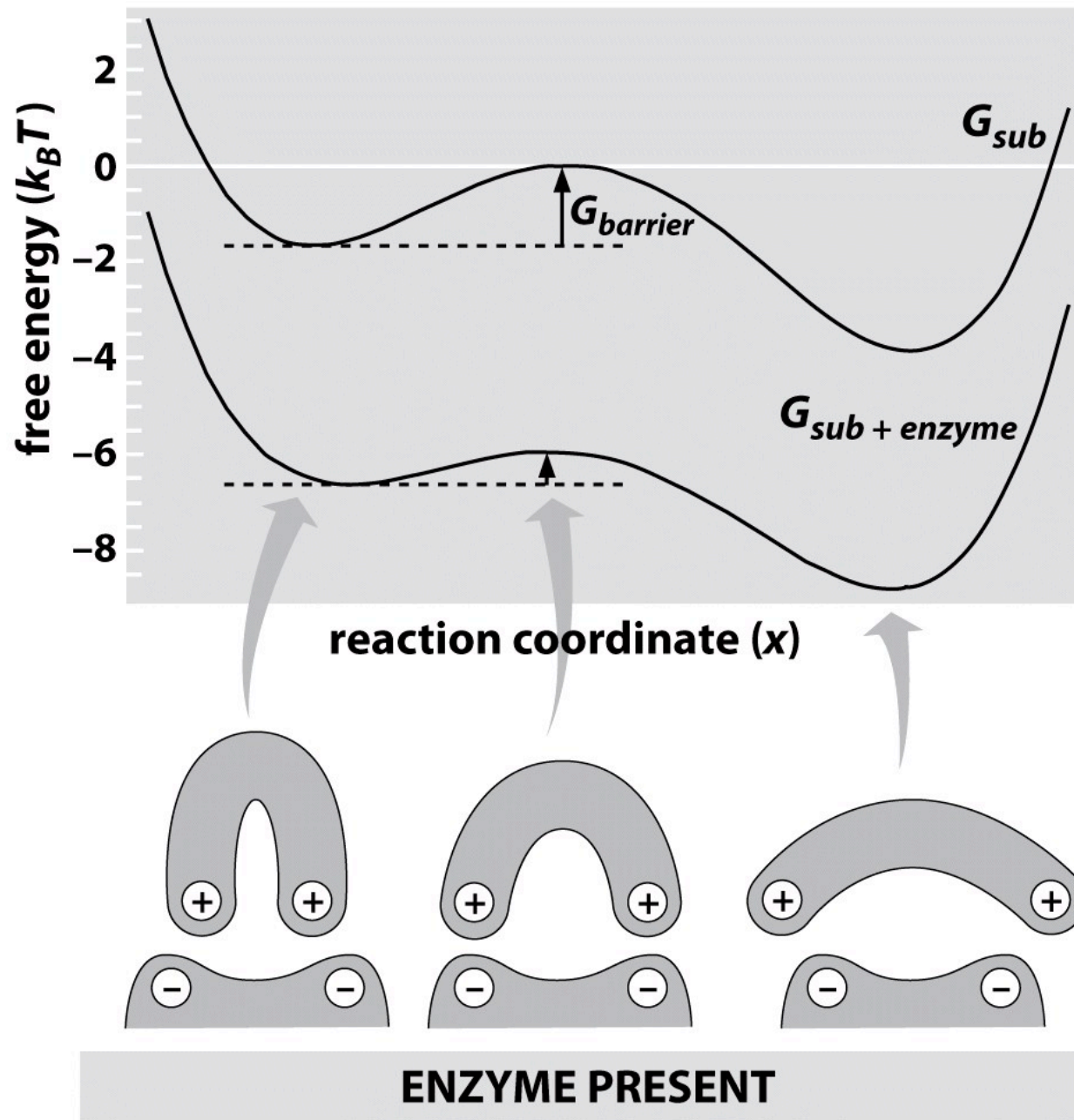


Figure 3.24b Physical Biology of the Cell (© Garland Science 2009)

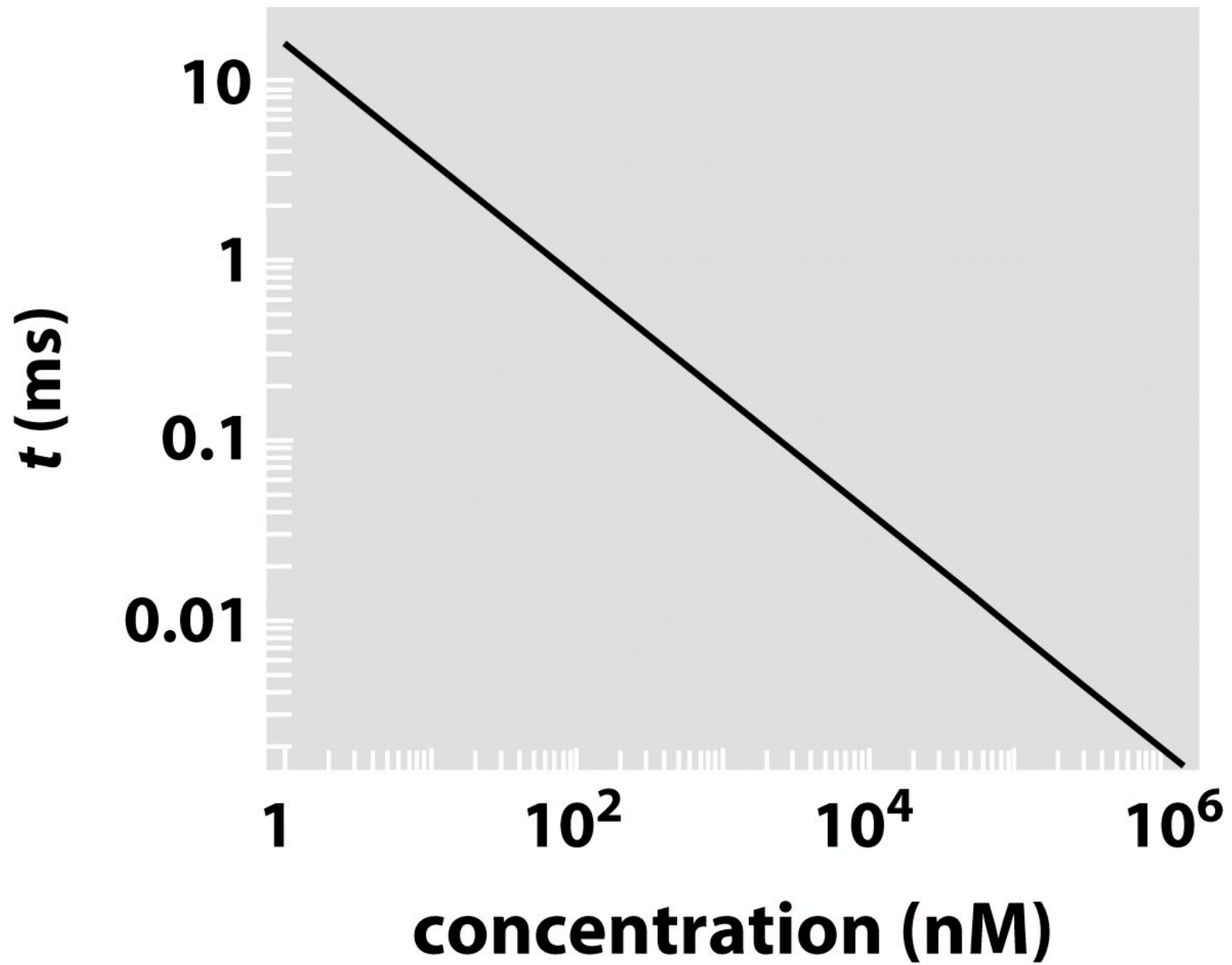


Figure 3.25 Physical Biology of the Cell (© Garland Science 2009)

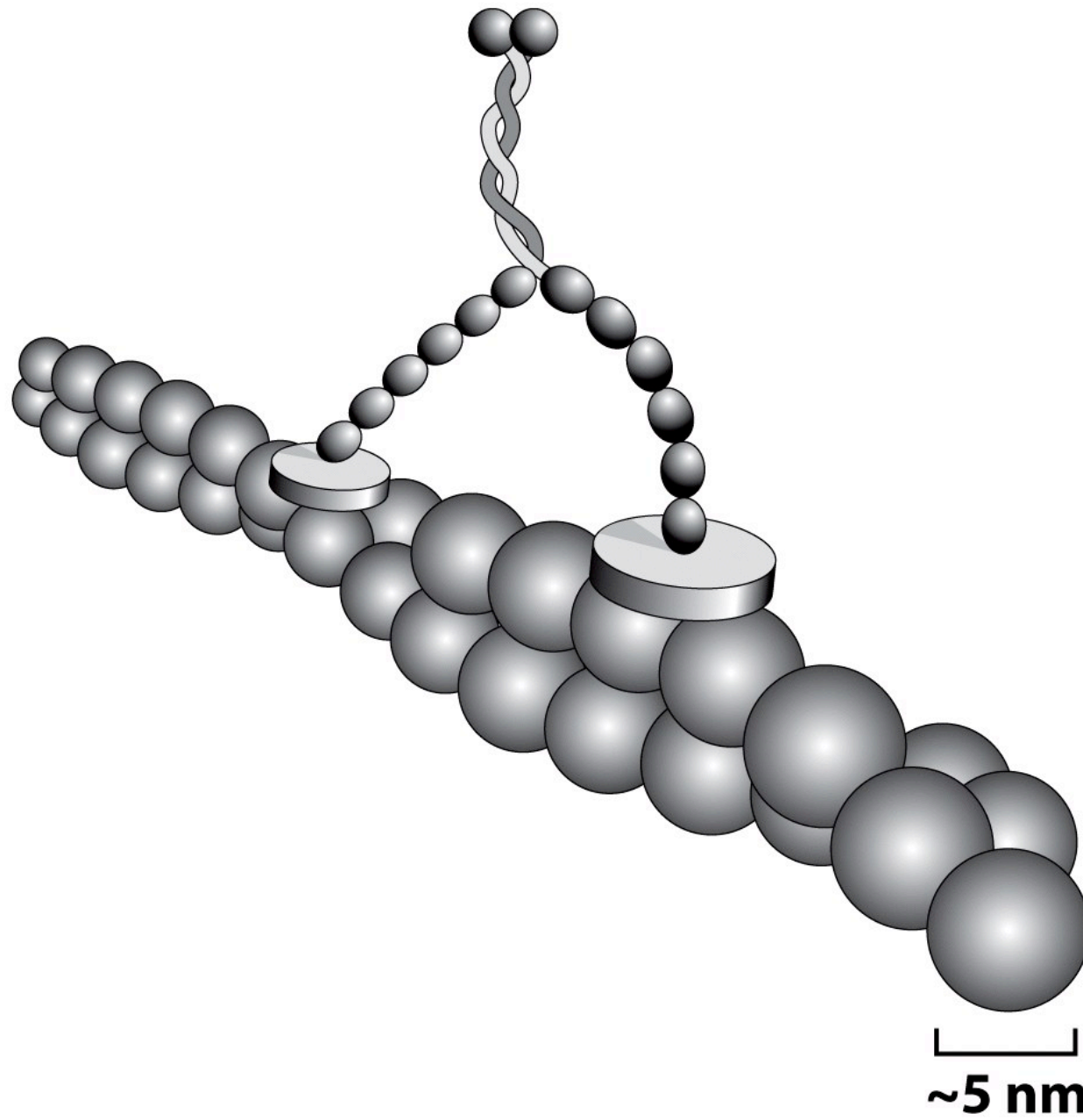


Figure 3.26a Physical Biology of the Cell (© Garland Science 2009)

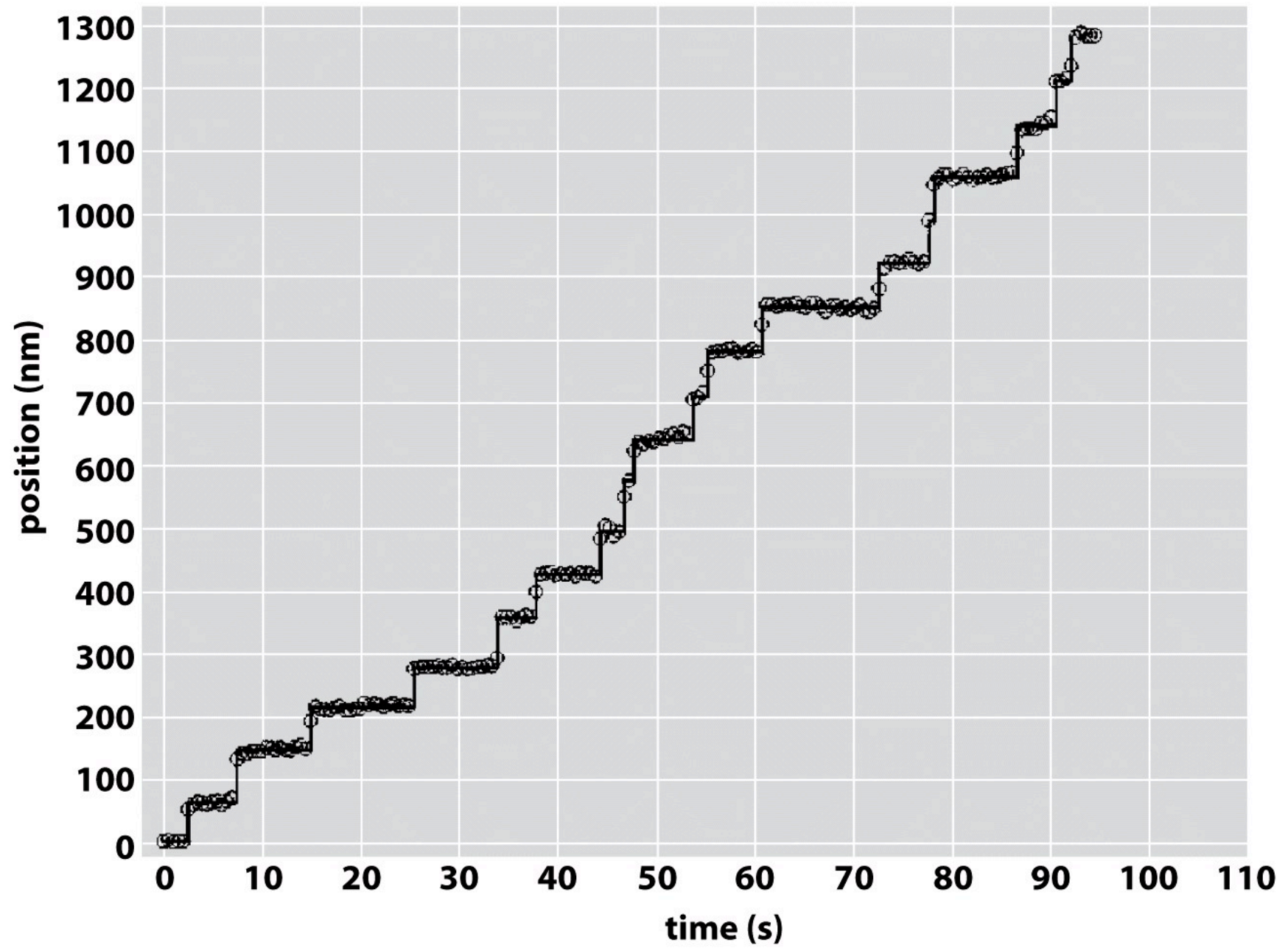


Figure 3.26b Physical Biology of the Cell (© Garland Science 2009)

