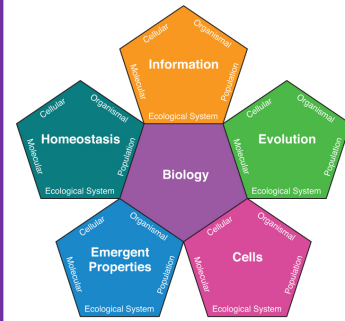


Integrating Concepts in Biology



PowerPoint Slides for Chapter 4: **Evolution and Origin of Cells**

4.3 Can non-living objects compete and grow?

by A. Malcolm Campbell, Laurie J. Heyer, &
Christopher Paradise

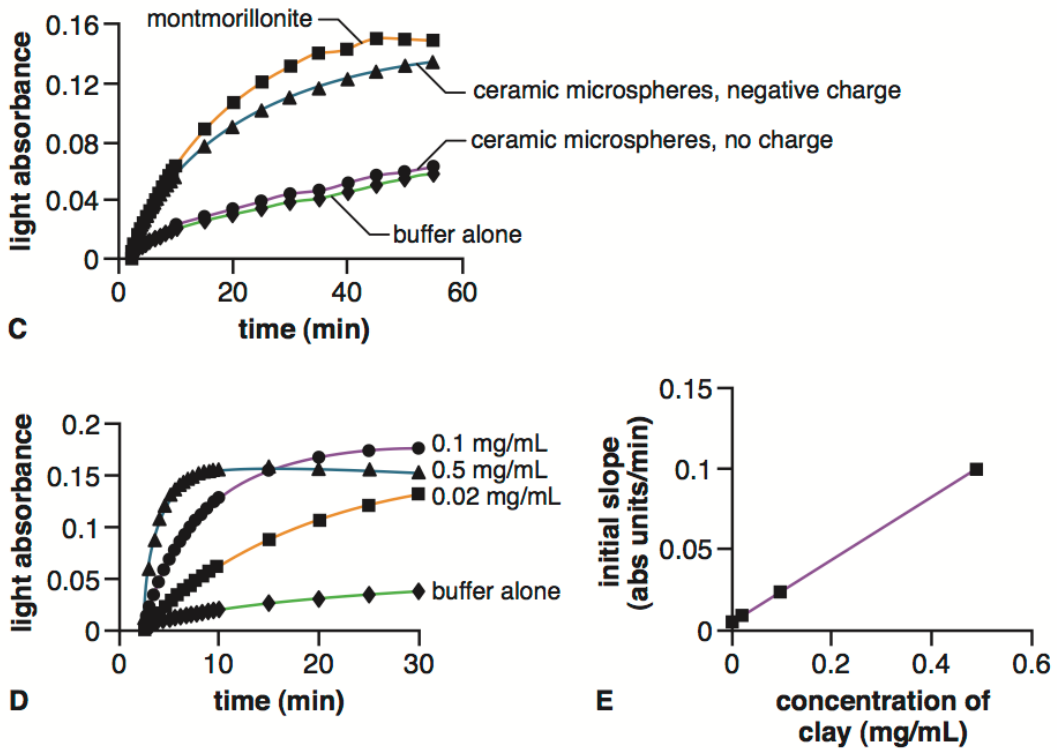
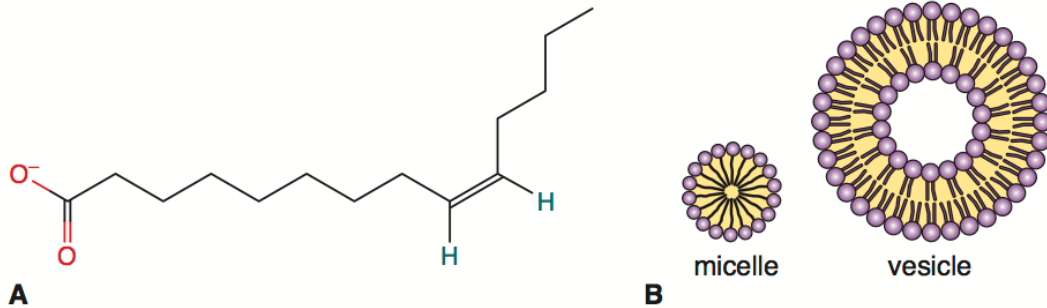
Biology Learning Objectives

- Illustrate how natural selection works by giving a real example.
- Discuss how vesicles can grow and compete.
- Illustrate how abiotic structures exhibit dynamic and competitive behaviors.

Bio-Math Learning Objectives

- Determine the rate of change in a biological measurement

Abiotic Vesicle Formation



C, D, E. modified from Hanczyc *et al.*, 2003.

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Fig. 4.11

Naturally Occurring Lipid

myristoleate fatty acid

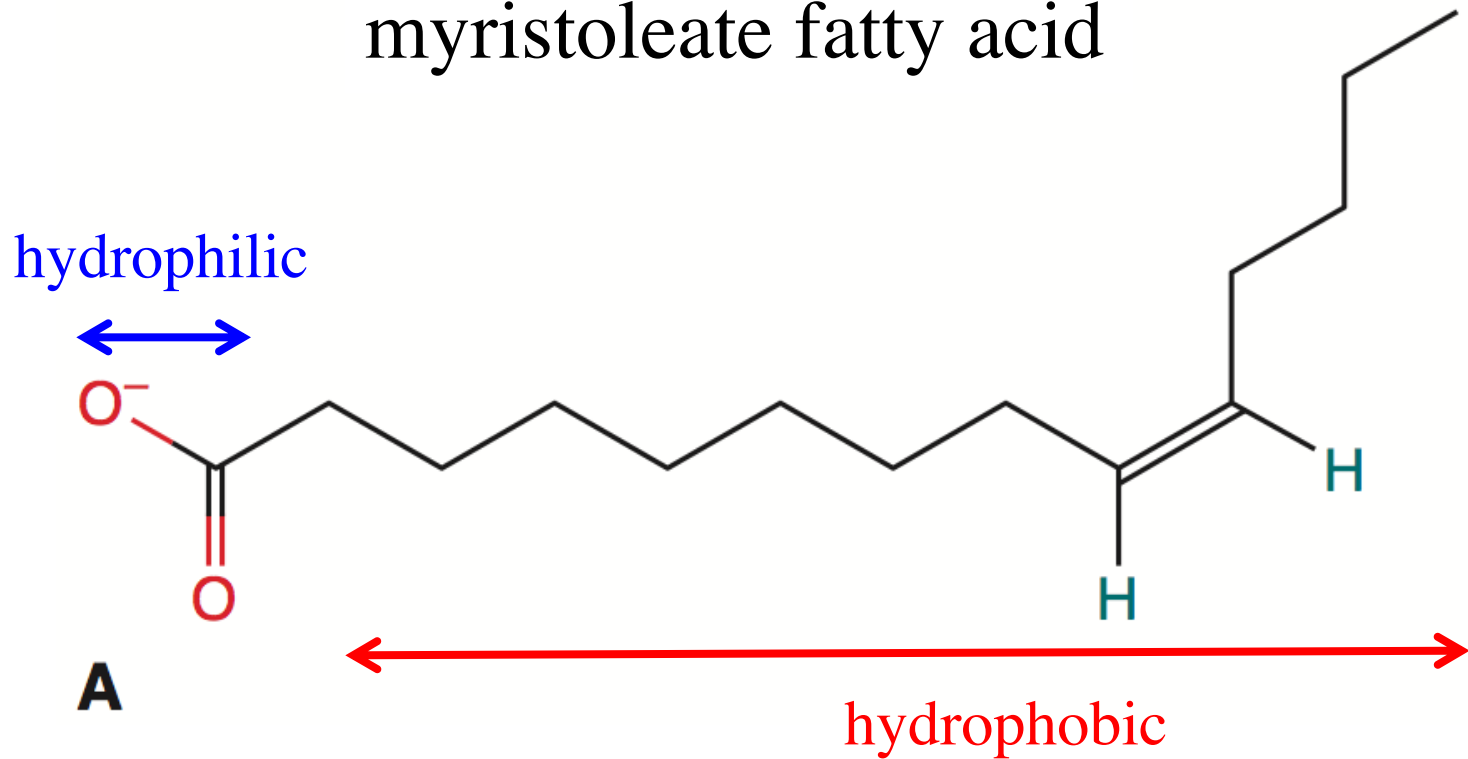
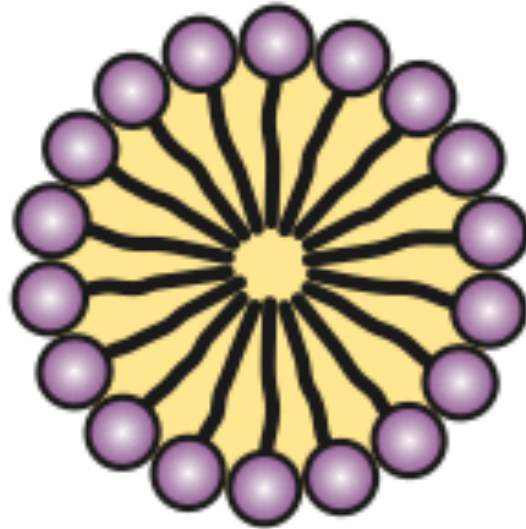


Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Single Layer Sphere of Lipids



micelle

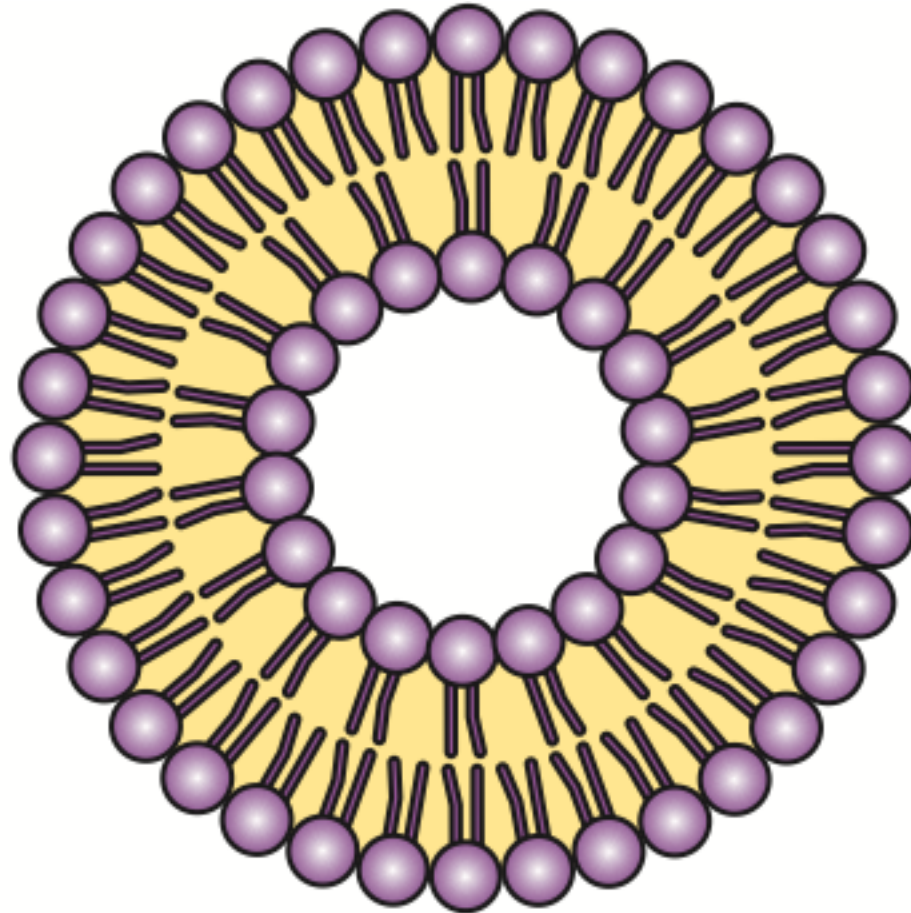
B

Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Lipid Bilayer Hollow Vesicle



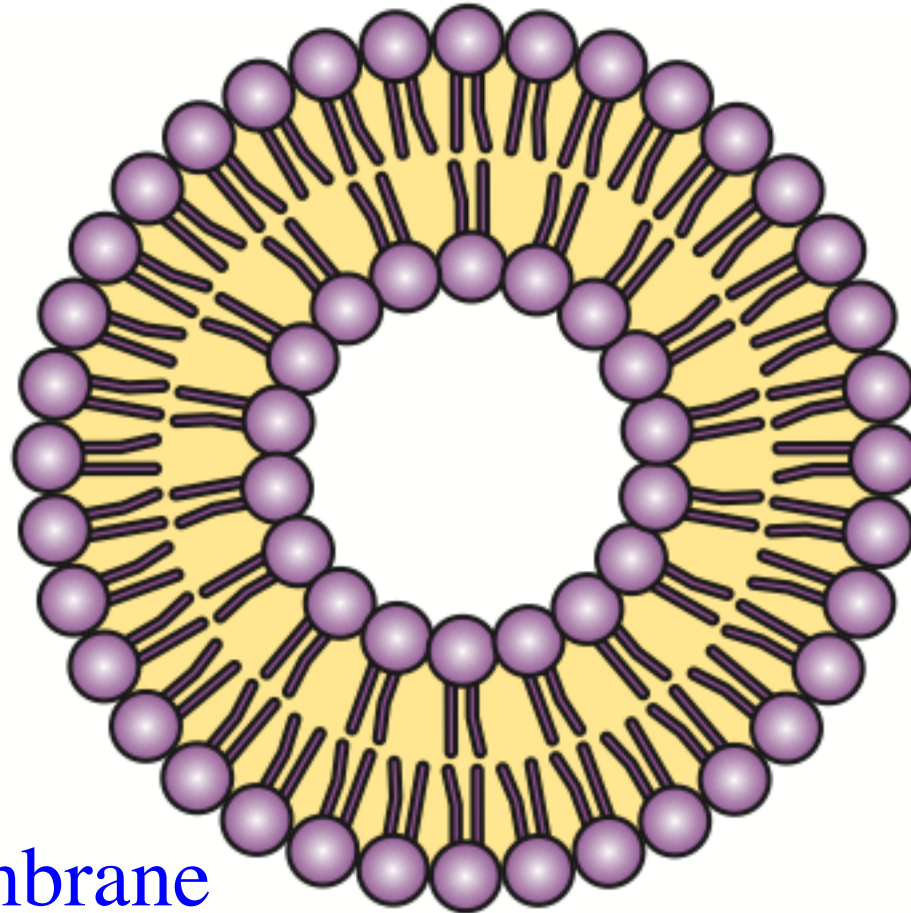
vesicle

Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Lipid Bilayer Hollow Vesicle



view

Jsmol membrane

vesicle

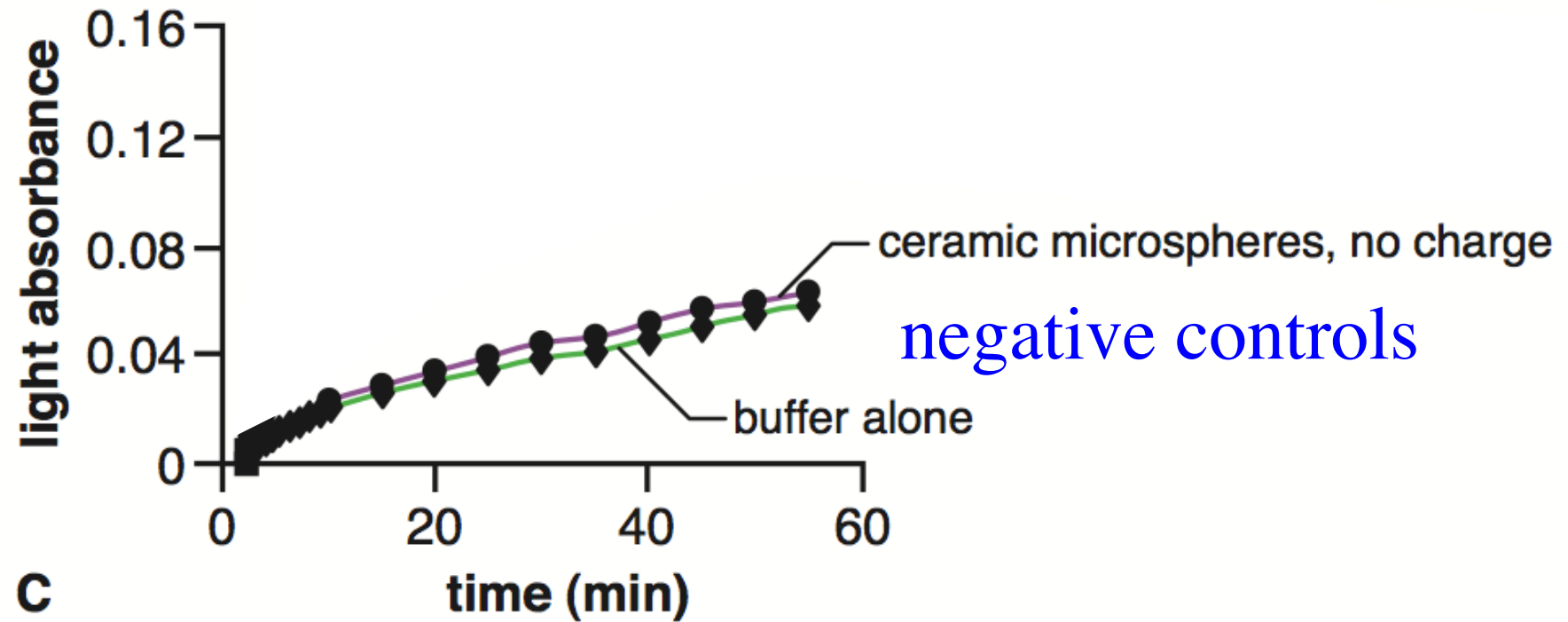
Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Unable to form Vesicles Quickly

measure of
vesicle formation



C

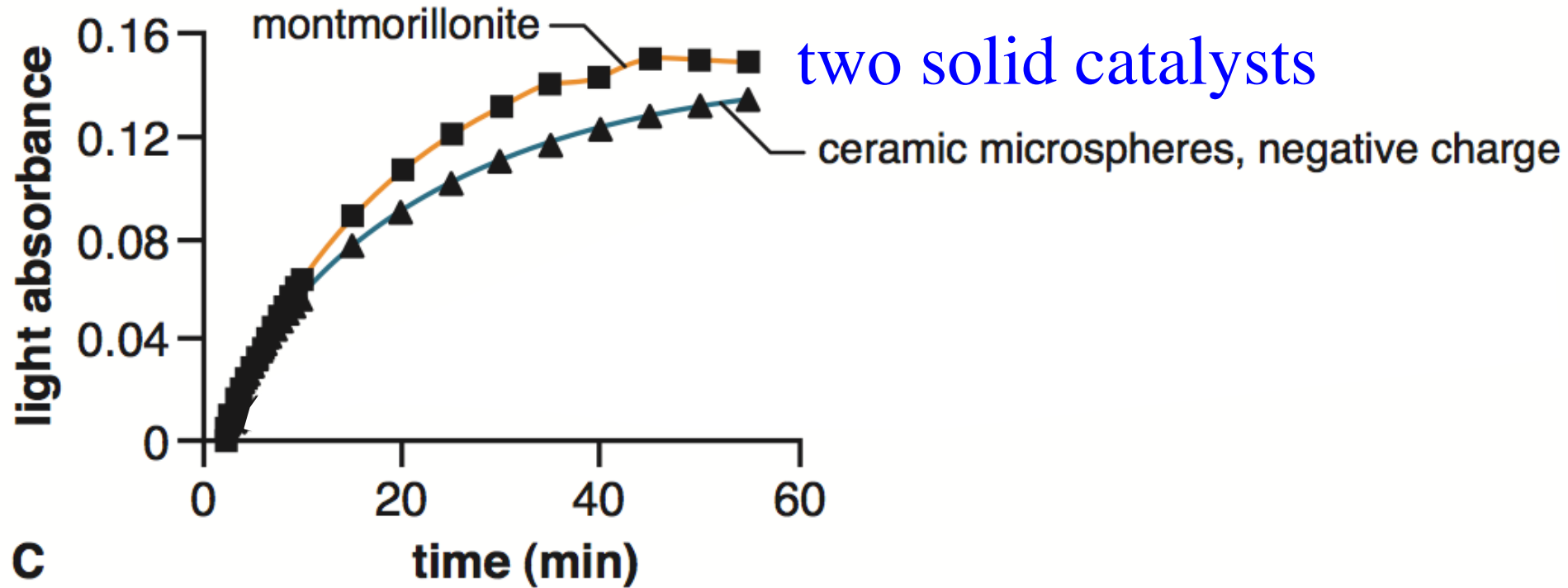
Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Catalytic Charged Surfaces

measure of
vesicle formation



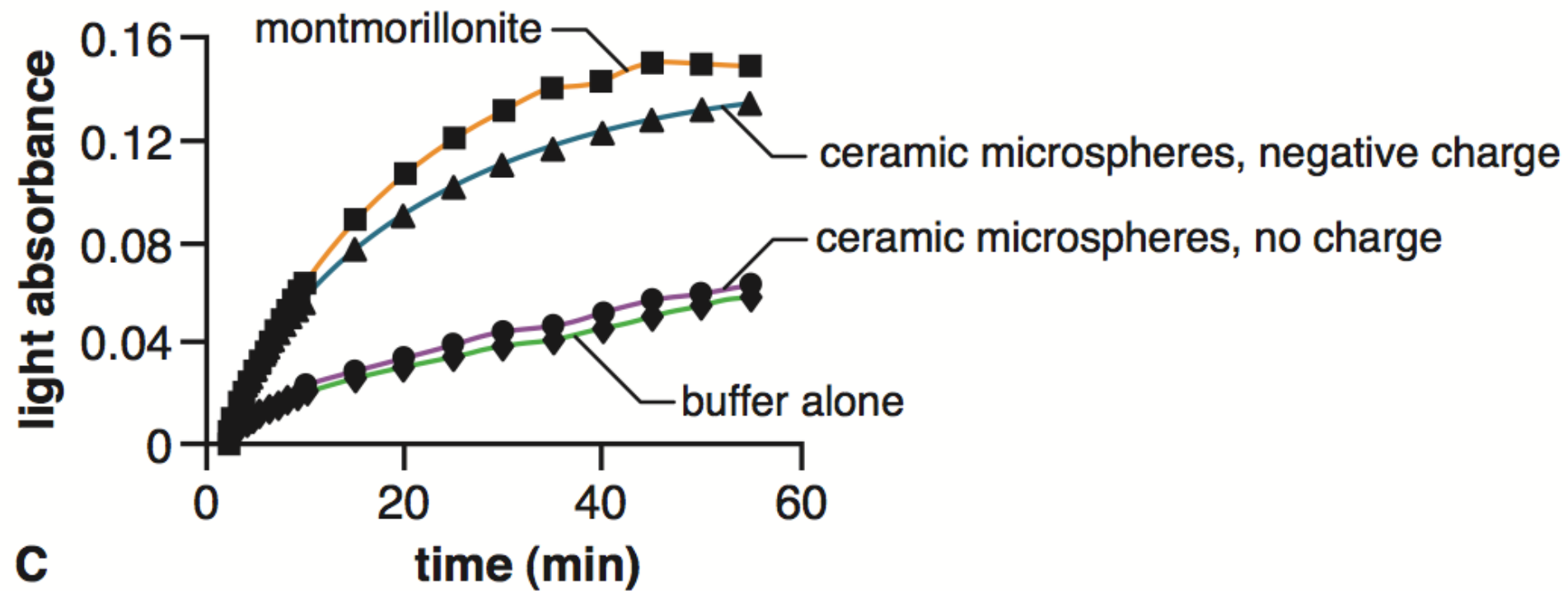
C

Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Catalytic Charged Surfaces



C

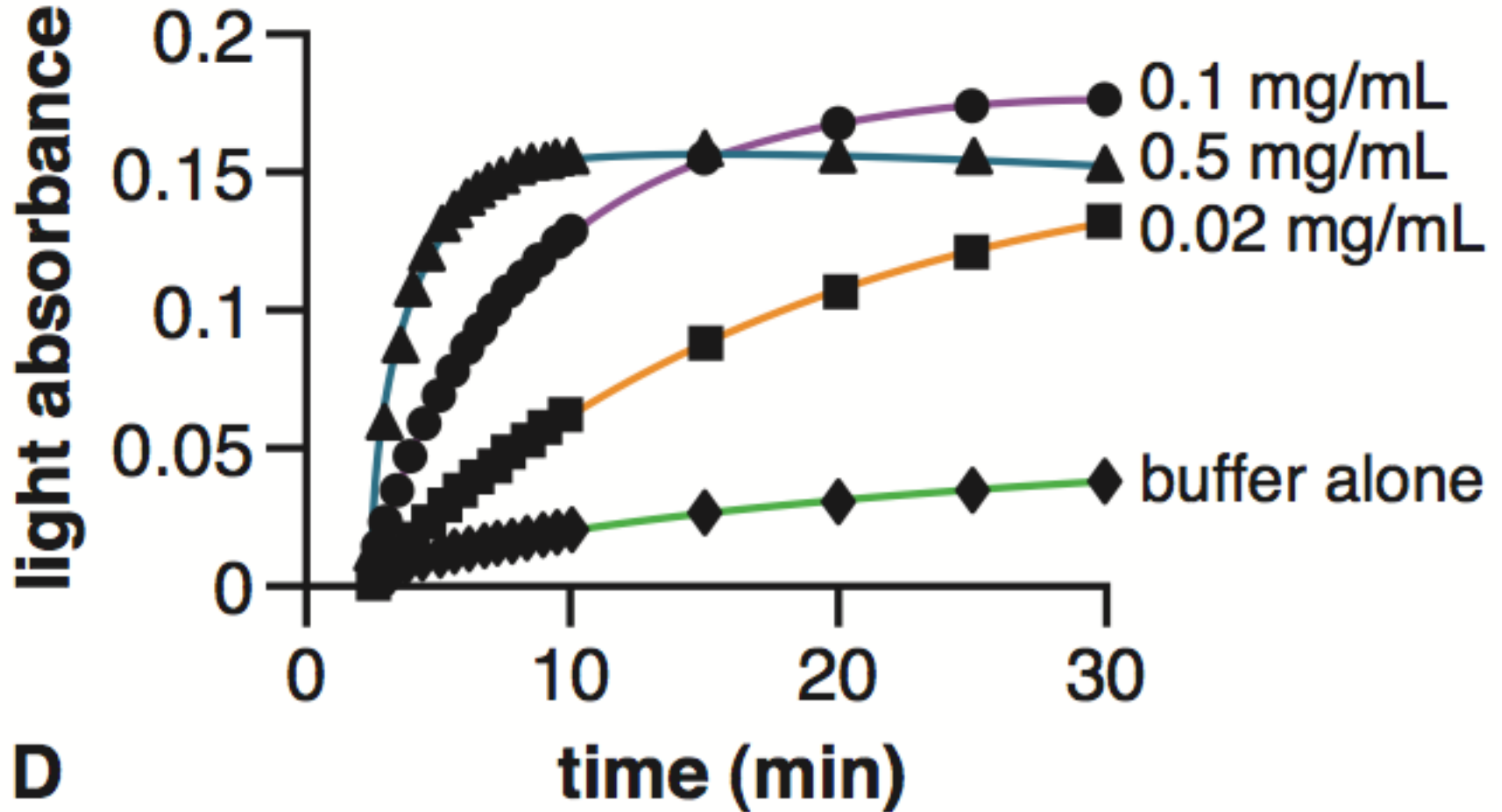
Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Clay Concentration Effects

measure of
vesicle formation



D

Fig. 4.11

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Clay Concentration Effects

measure of
vesicle formation

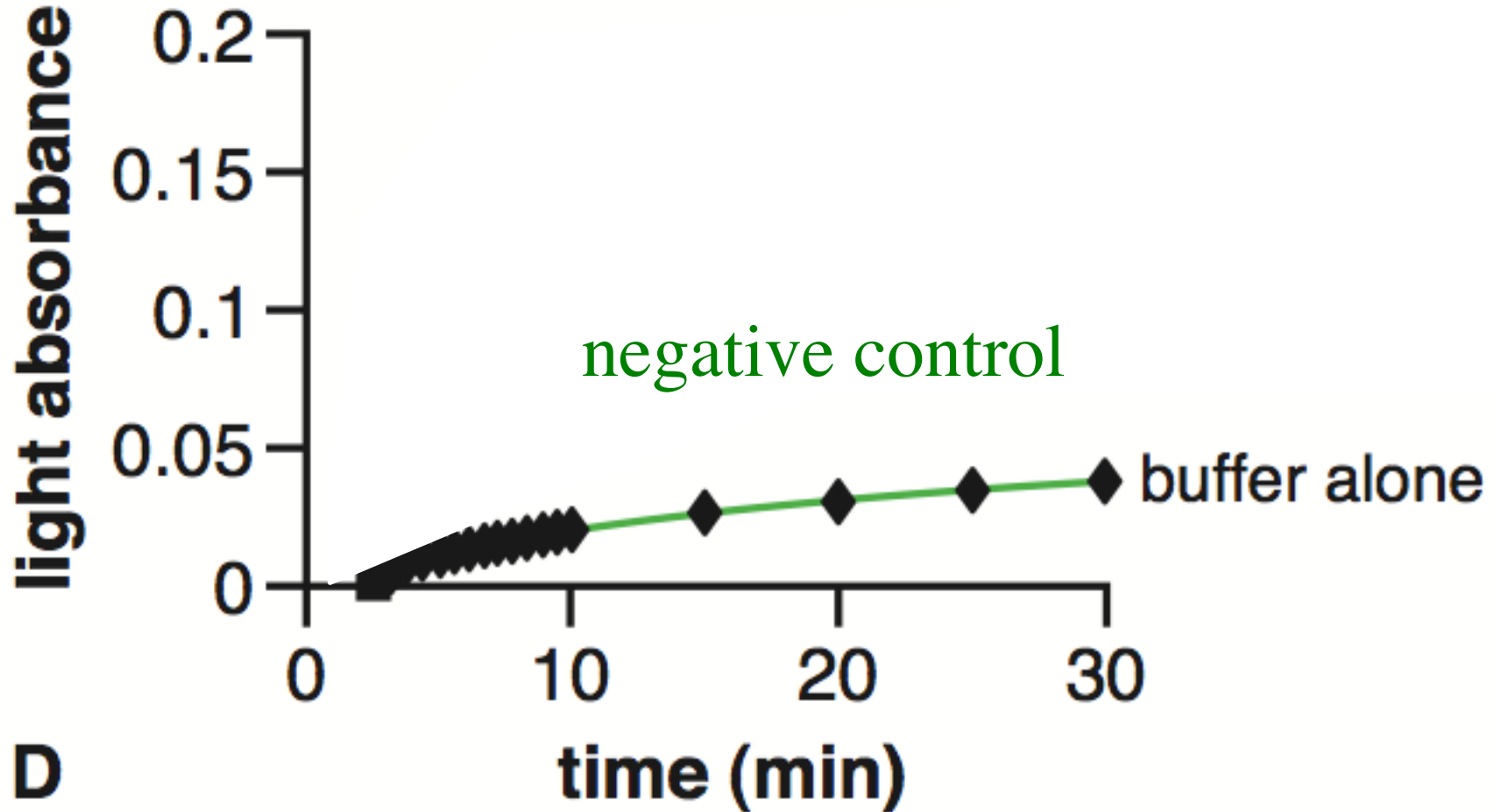


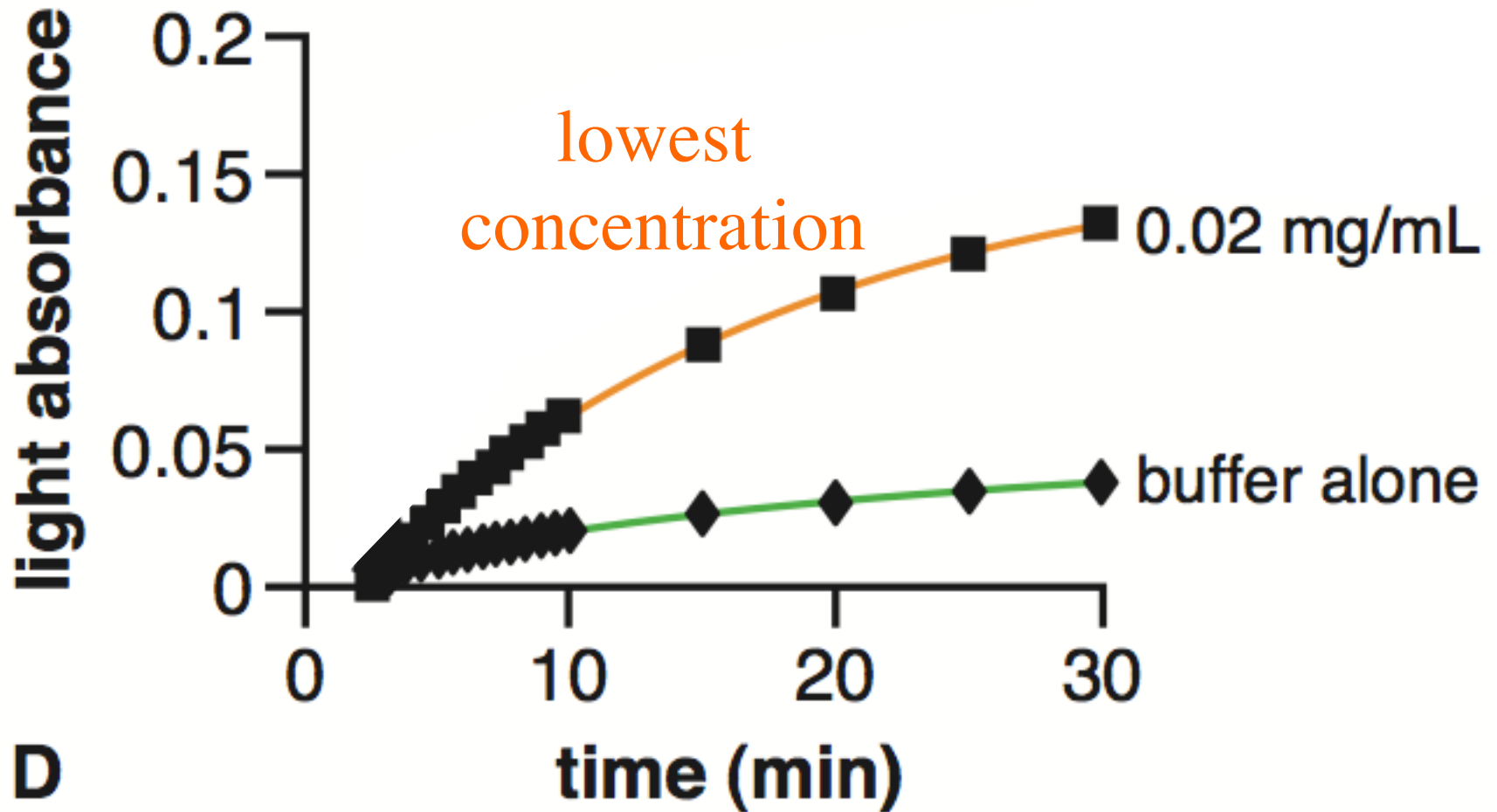
Fig. 4.11

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Clay Concentration Effects

measure of
vesicle formation



D

Fig. 4.11

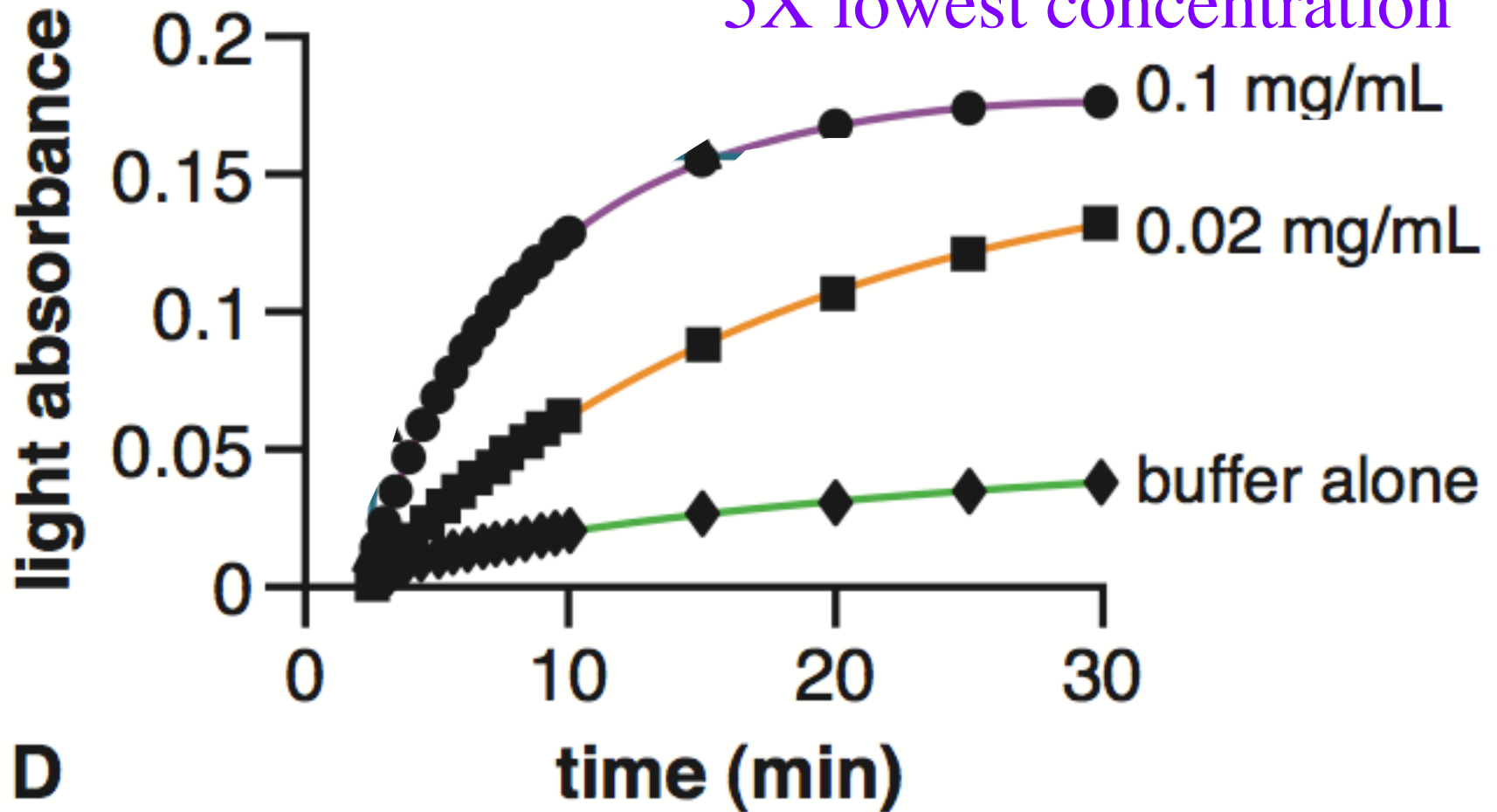
C, D, E. modified from Hanczyc *et al.*, 2003.

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Clay Concentration Effects

measure of
vesicle formation

5X lowest concentration



D

Fig. 4.11

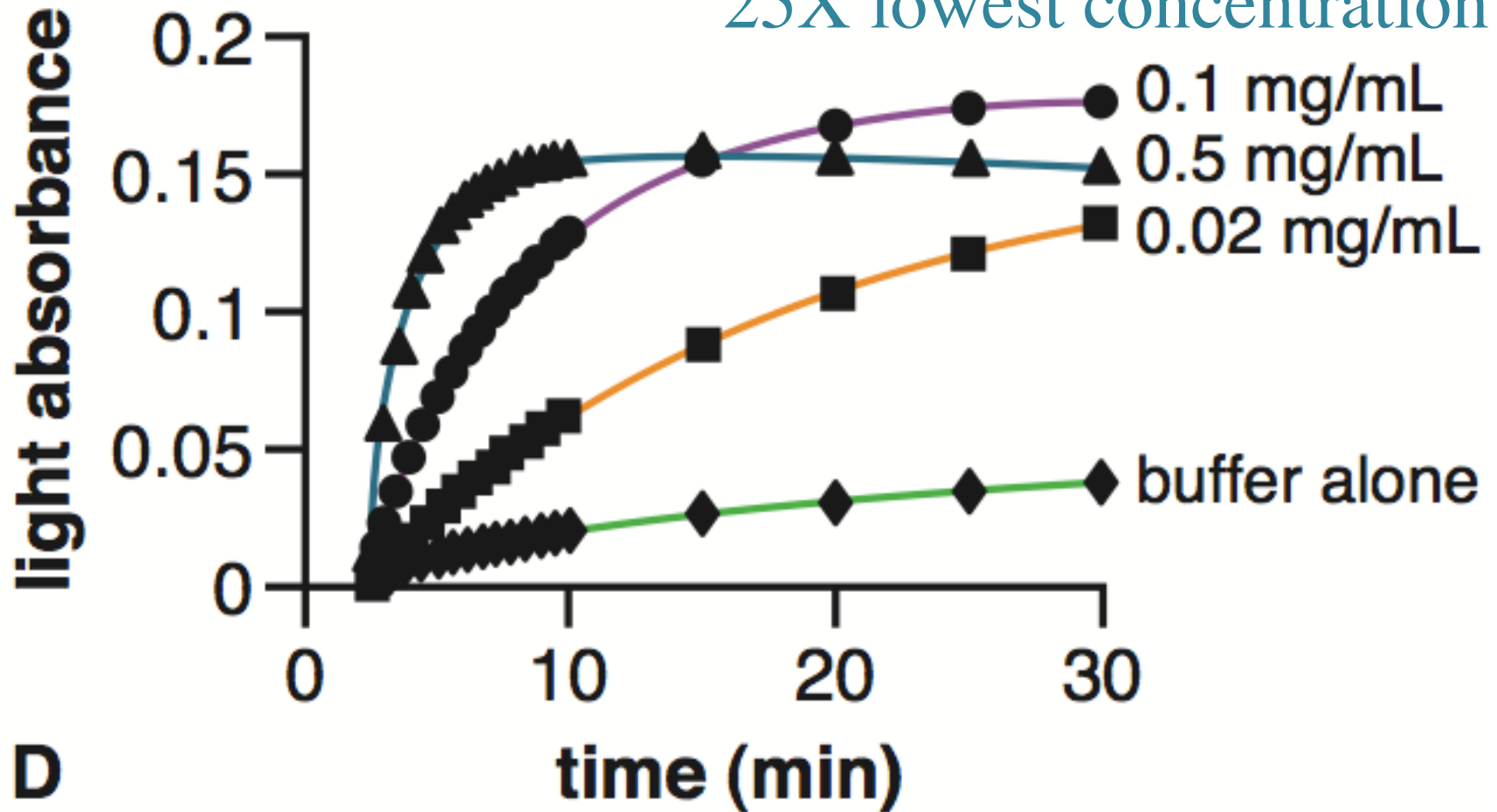
C, D, E. modified from Hanczyc *et al.*, 2003.

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Clay Concentration Effects

measure of
vesicle formation

25X lowest concentration



D

Fig. 4.11

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Clay Concentration Effects

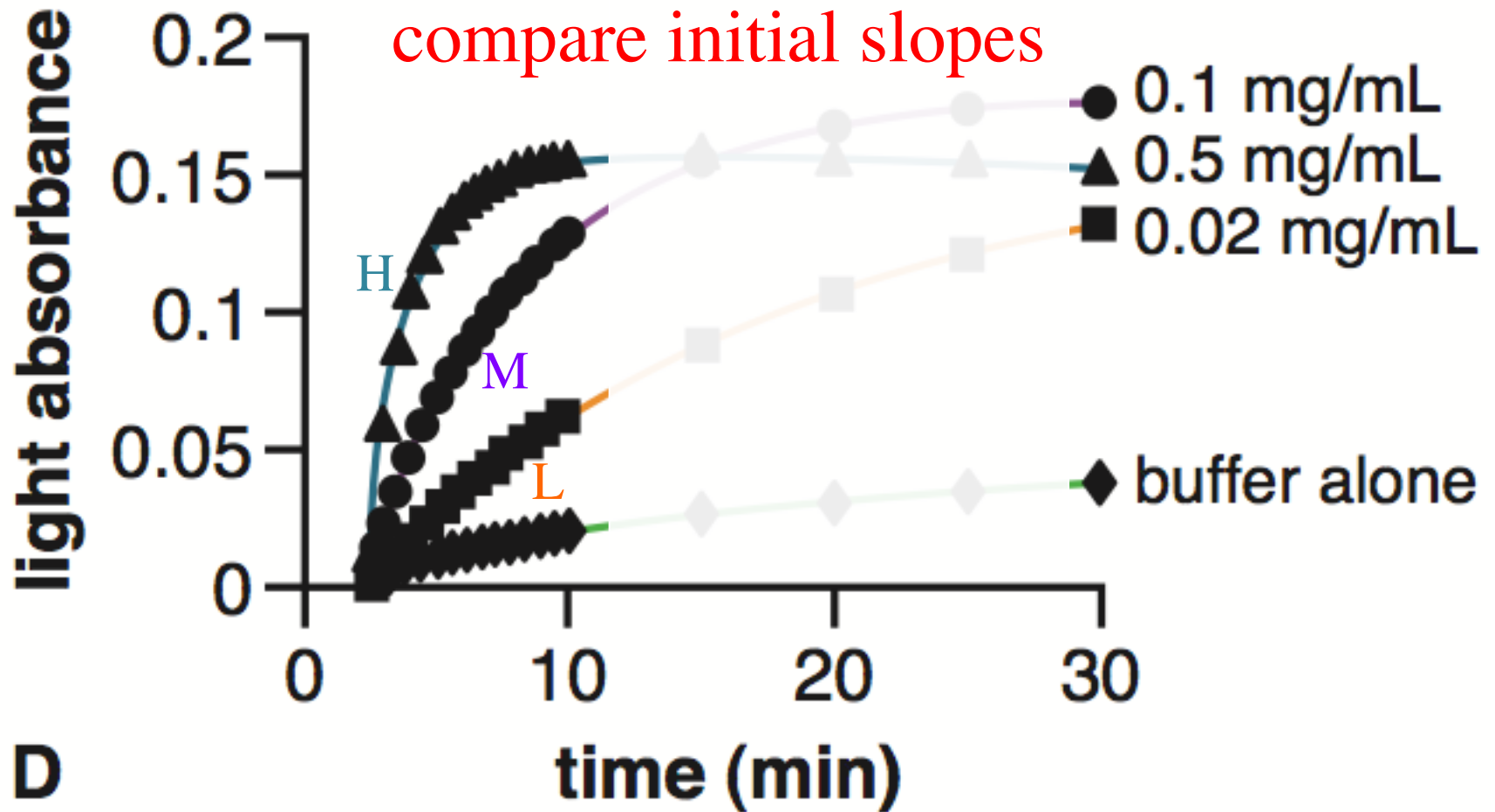


Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Clay Concentration Effects

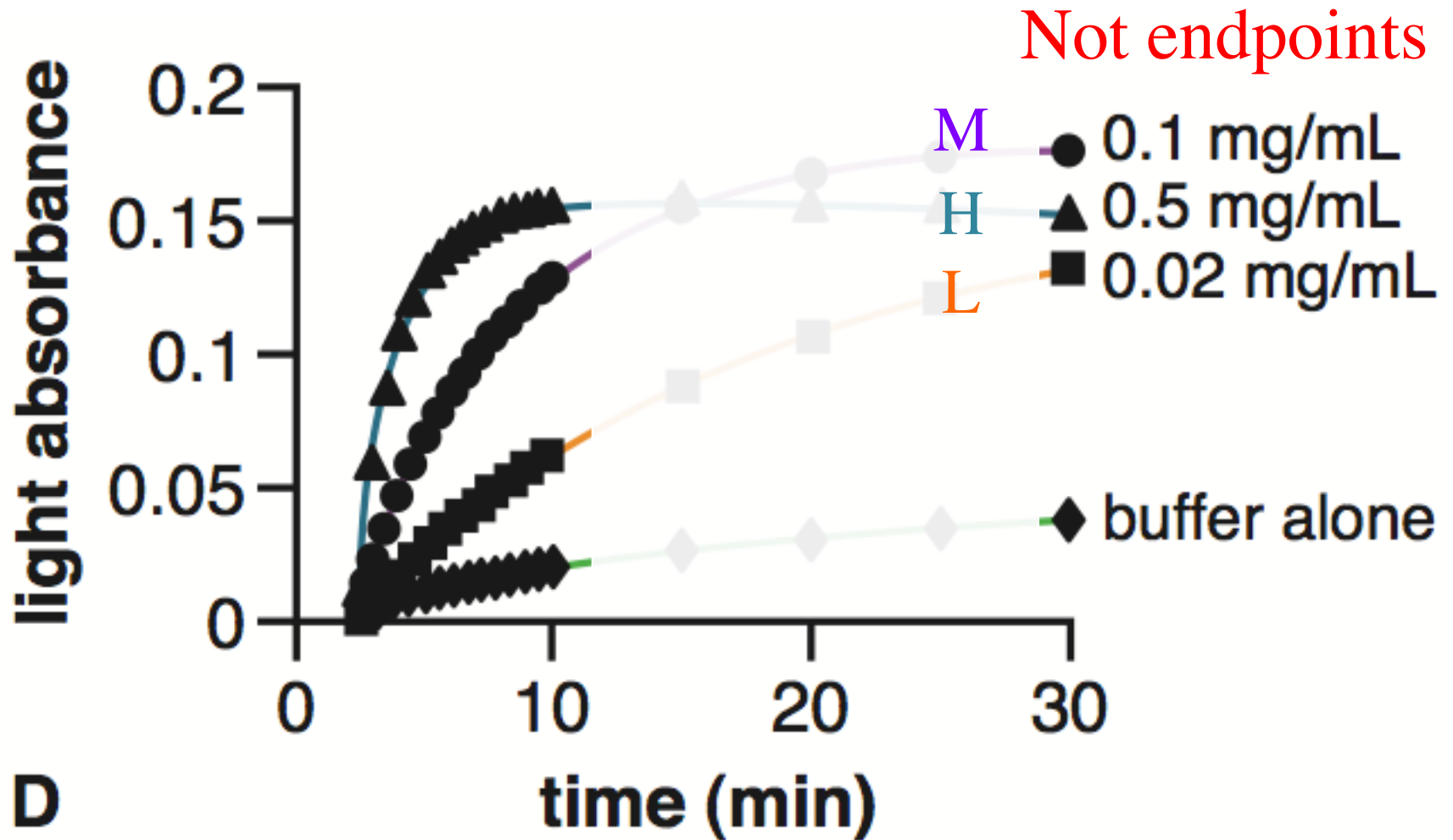


Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Clay Concentration Effects

most clay yields
vesicles fastest

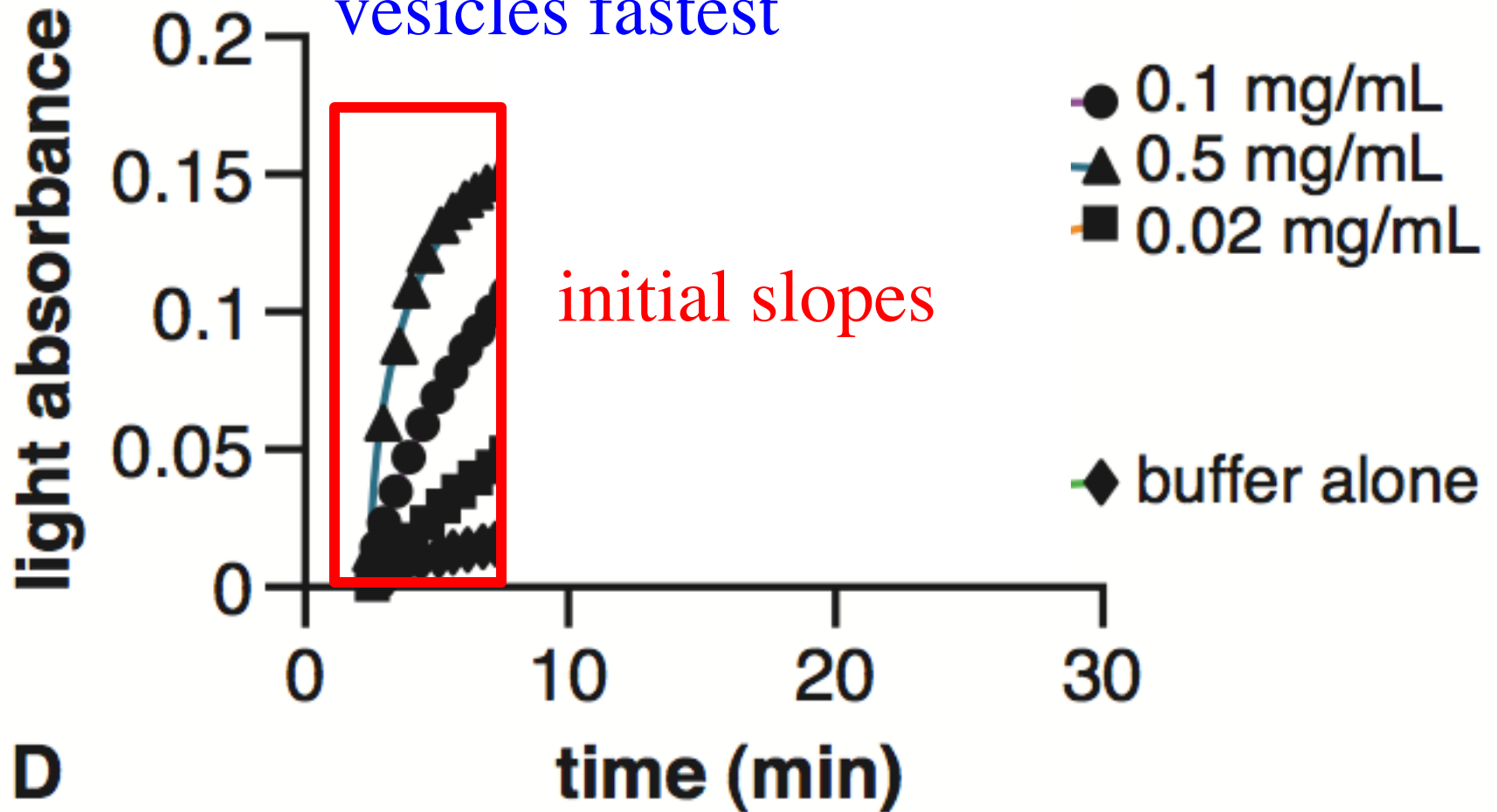
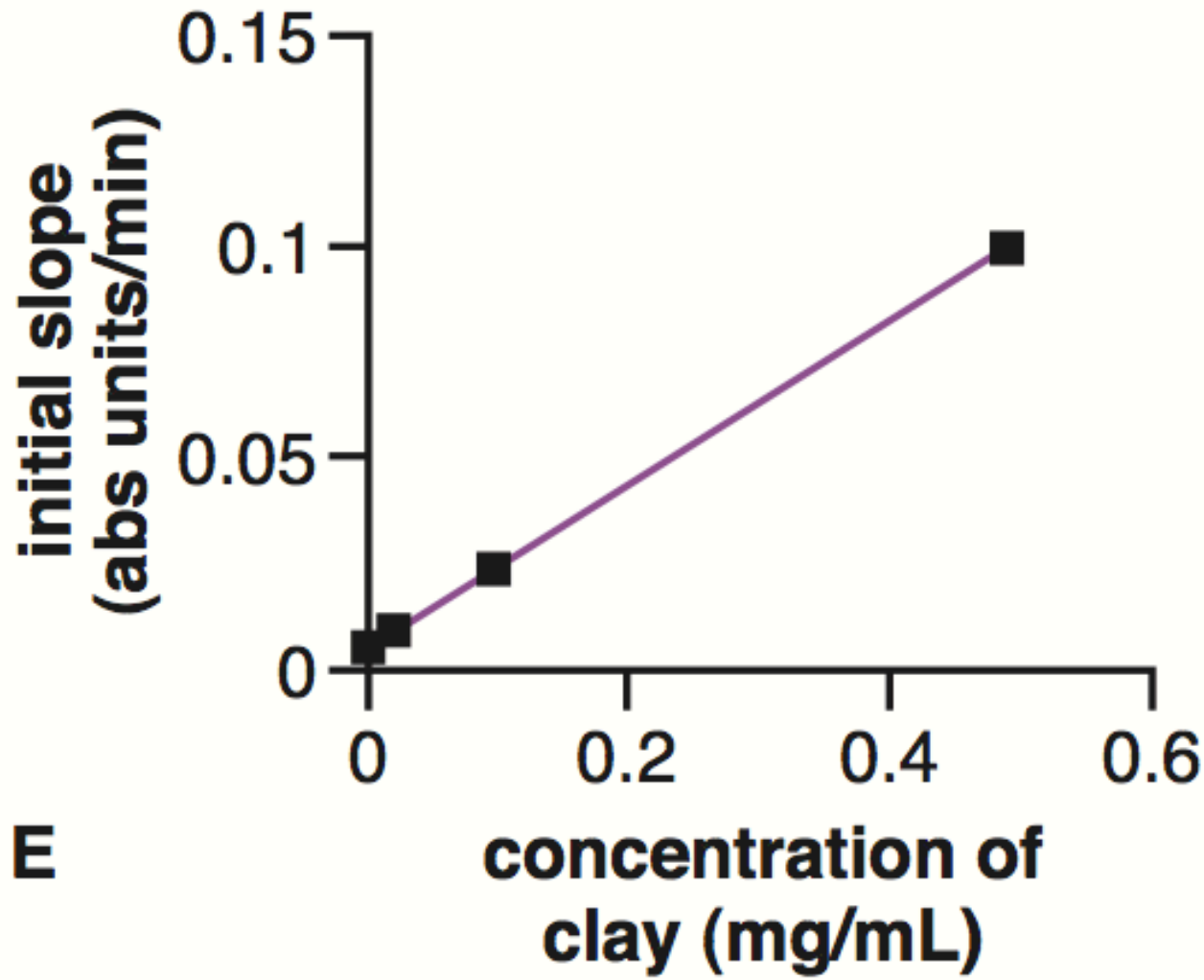


Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Clay Concentration Effects



E

Fig. 4.11

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Clay Concentration Effects

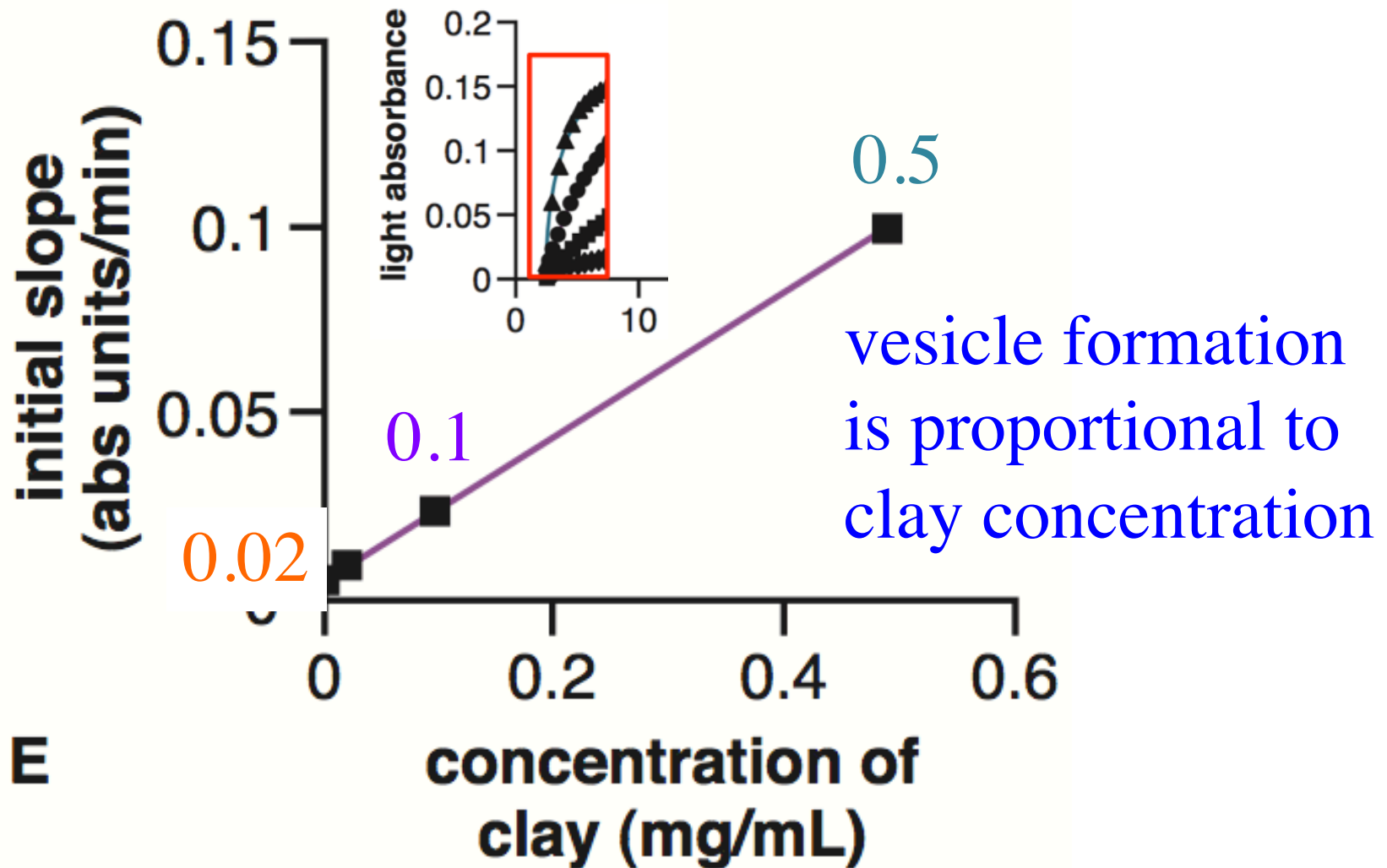
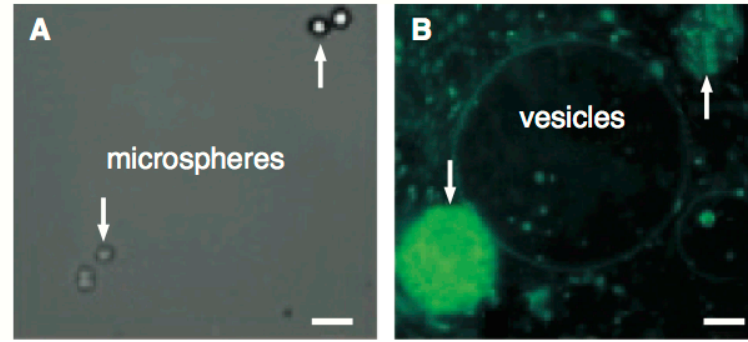


Fig. 4.11

C, D, E. modified from Hanczyc *et al.*, 2003.

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Microspheres Inside Vesicles

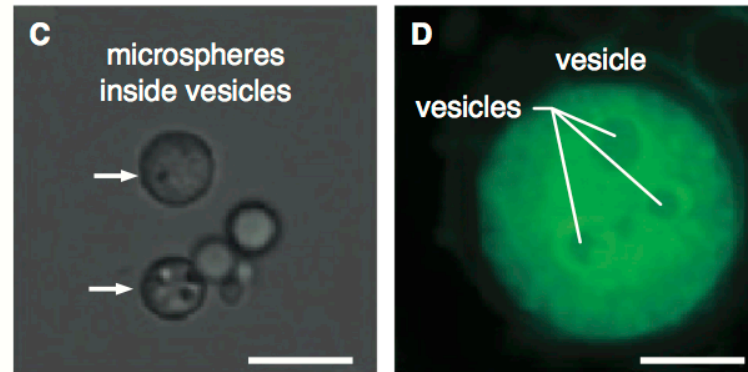


beads visualized

lipids visualized

Abiotic Vesicles Capture Cargo

beads inside
vesicles



vesicles inside
vesicles

Fig. 4.12

RNA Cargo in Vesicles

RNA inside vesicles

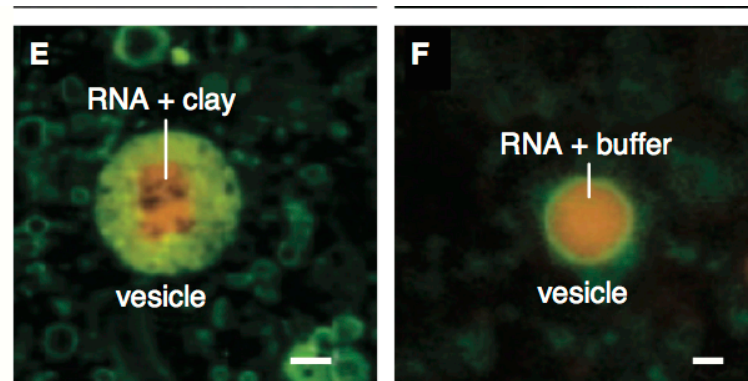


Fig. 4.12

A – D: modified from Hanczyc *et al.*, 2003; E, F: modified from Hanczyc, *et al.*, 2003
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RNA Cargo in Vesicles

What chemical property of RNA could enhance its capacity to catalyze the formation of lipid vesicles?

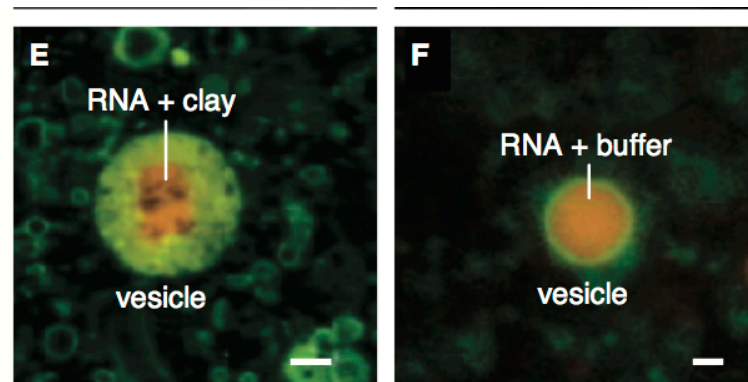


Fig. 4.12

A – D: modified from Hanczyc *et al.*, 2003; E, F: modified from Hanczyc, *et al.*, 2003
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RNA Cargo in Vesicles

What chemical property of RNA could enhance its capacity to catalyze the formation of lipid vesicles?

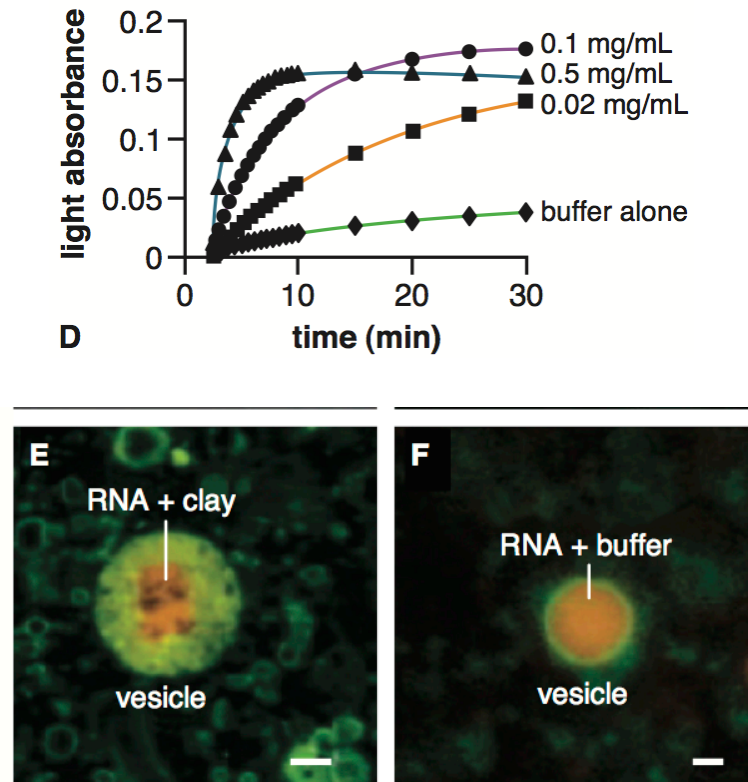


Fig. 4.12

A – D: modified from Hanczyc *et al.*, 2003; E, F: modified from Hanczyc, *et al.*, 2003
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RNA Cargo in Vesicles

RNA can function as enzymes
inside lipid bilayer

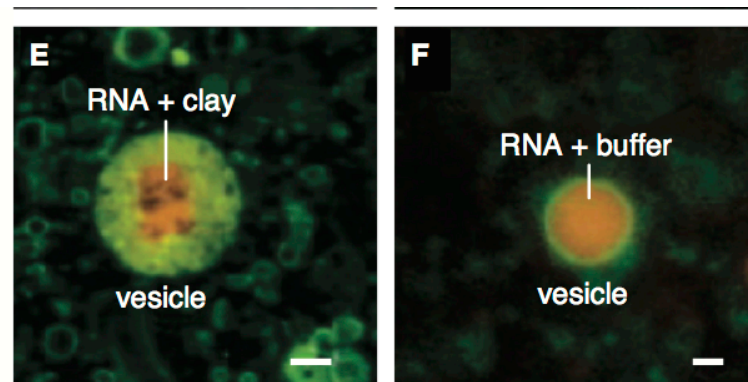


Fig. 4.12

A – D: modified from Hanczyc *et al.*, 2003; E, F: modified from Hanczyc, *et al.*, 2003
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Are Abiotic Vesicles Empty?

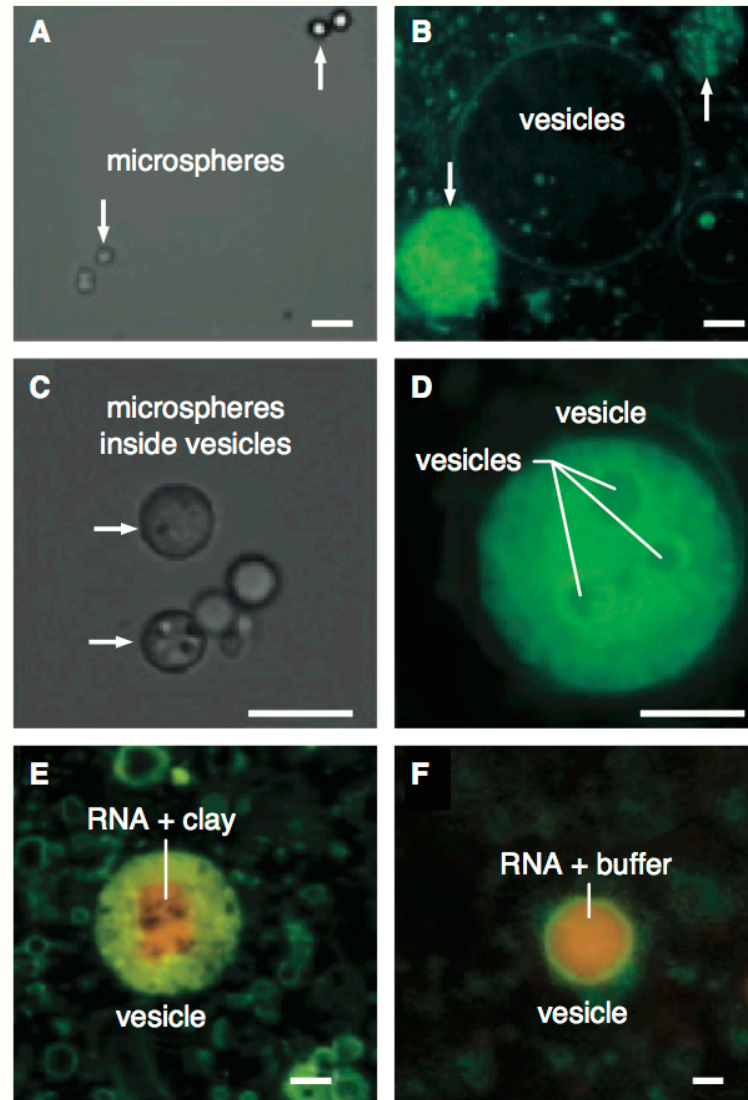
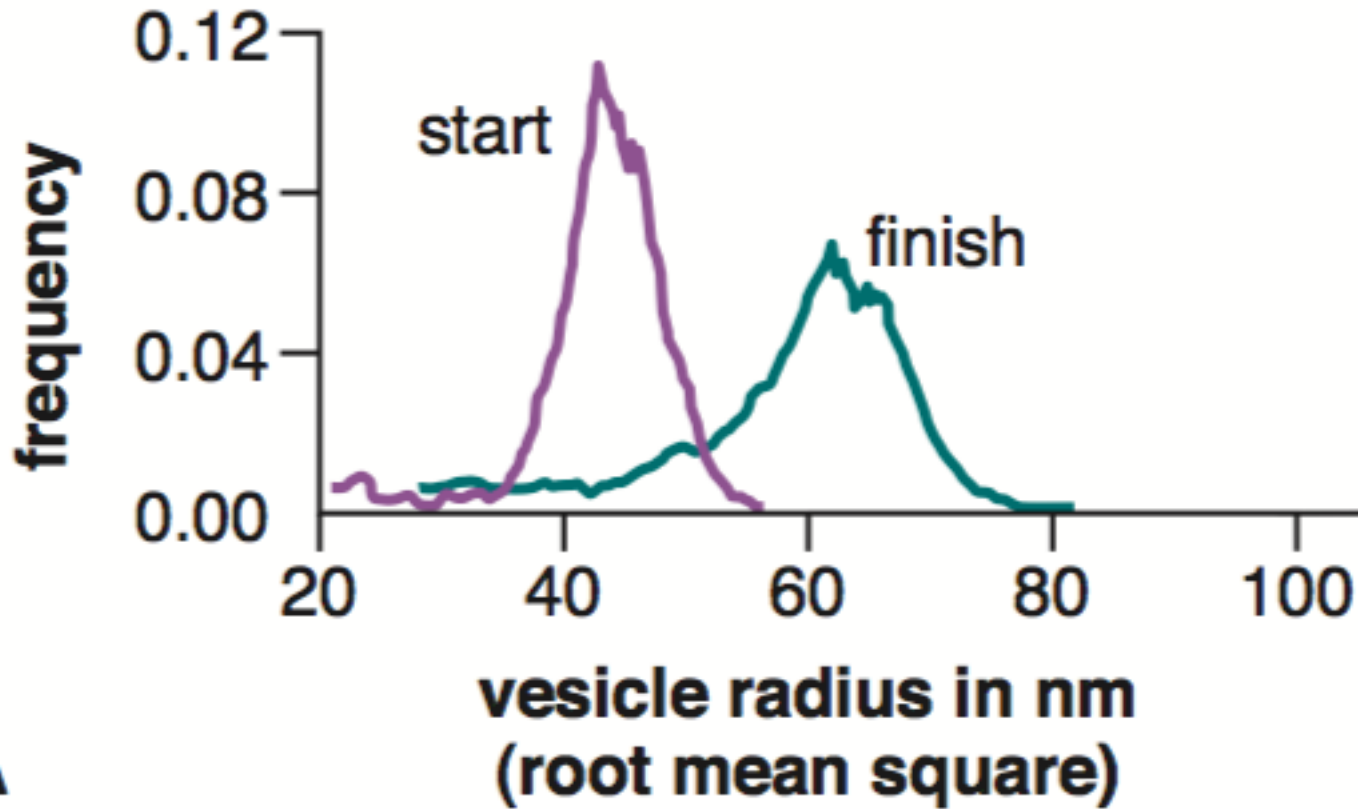


Fig. 4.12

A – D: modified from Hanczyc *et al.*, 2003; E, F: modified from Hanczyc, *et al.*, 2003
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Dynamic Vesicle Sizes



A

Fig. 4.13

Dynamic Vesicle Sizes

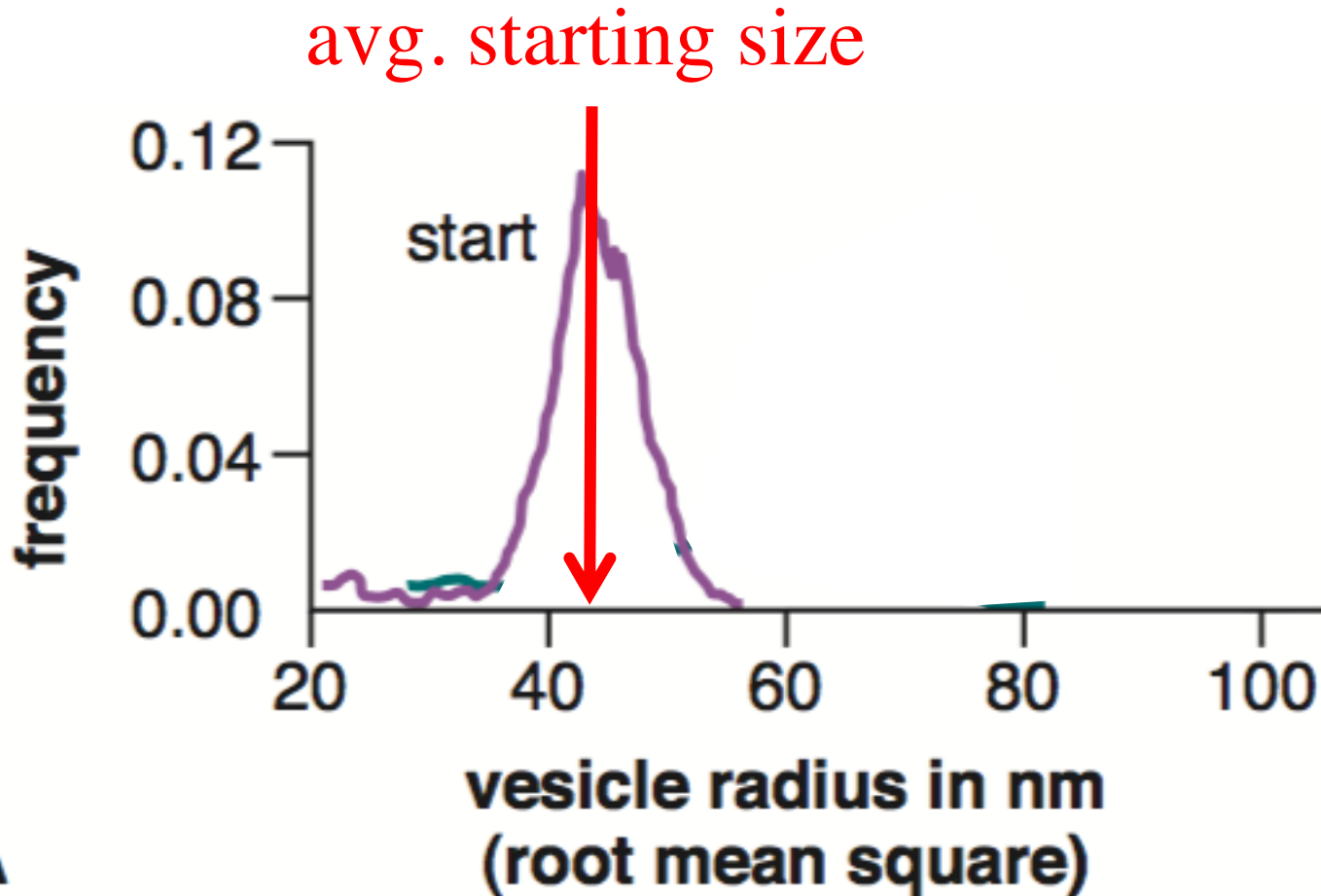


Fig. 4.13

Dynamic Vesicle Sizes

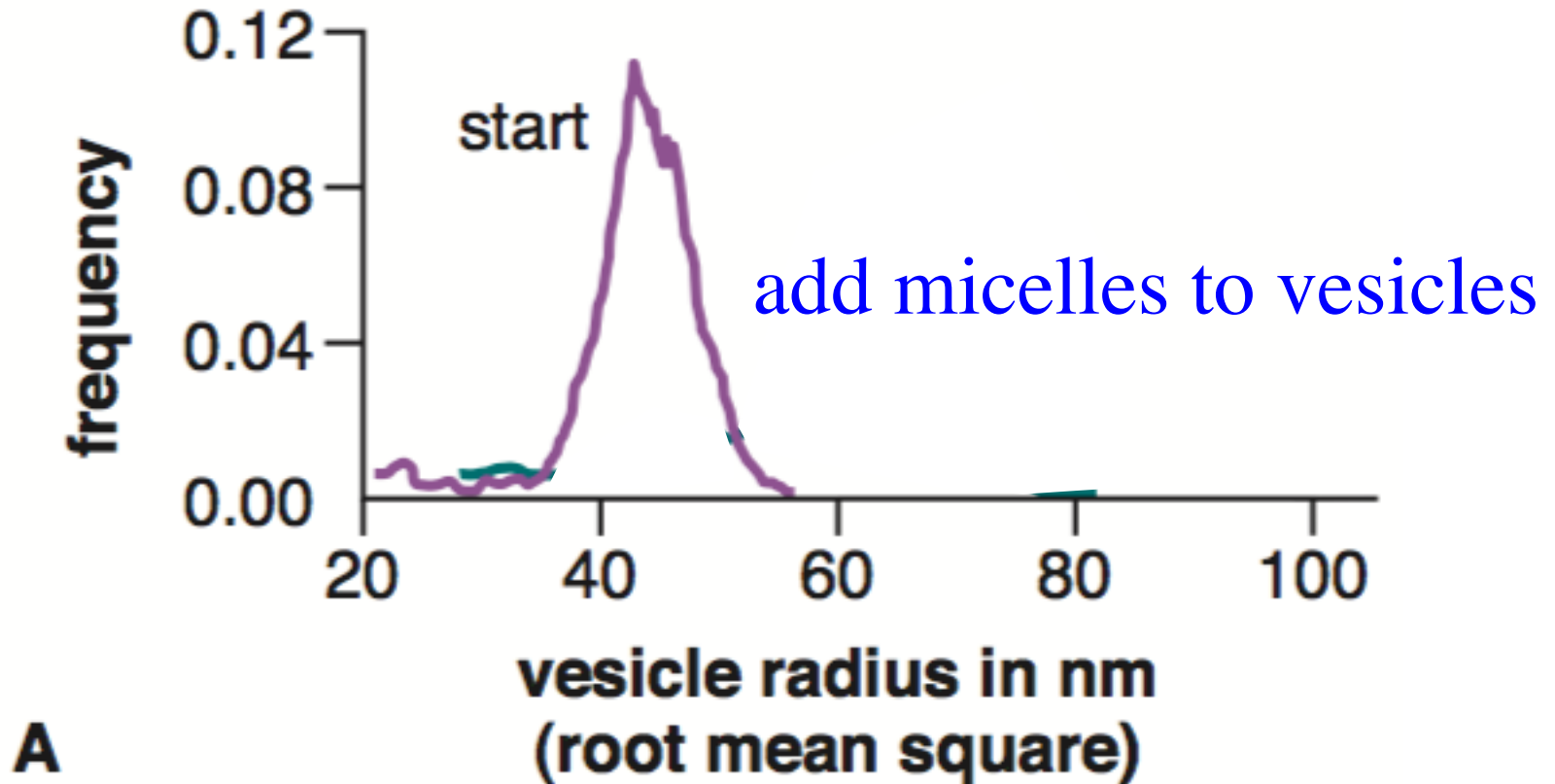


Fig. 4.13

Dynamic Vesicle Sizes

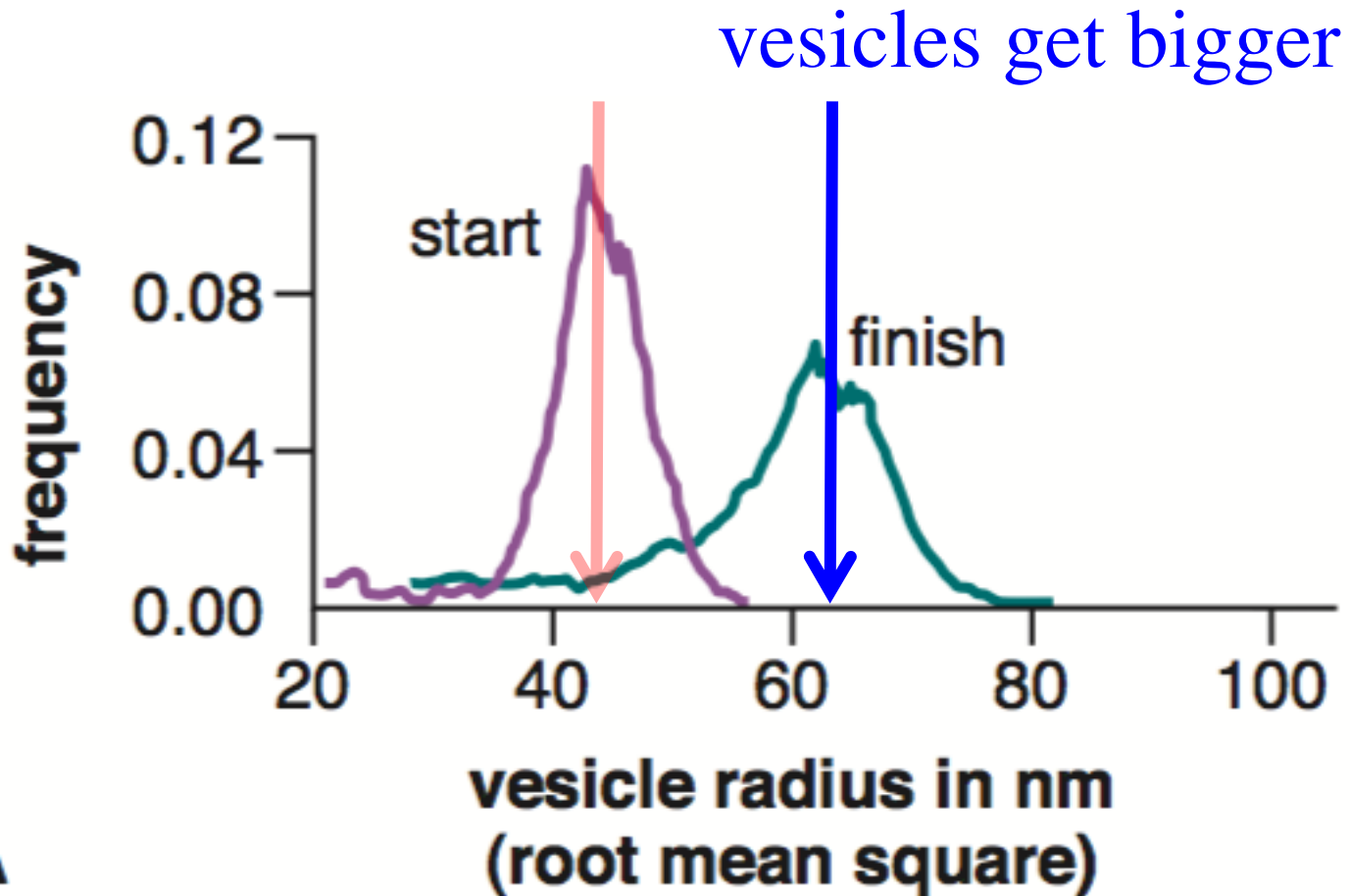


Fig. 4.13

Dynamic Vesicle Sizes

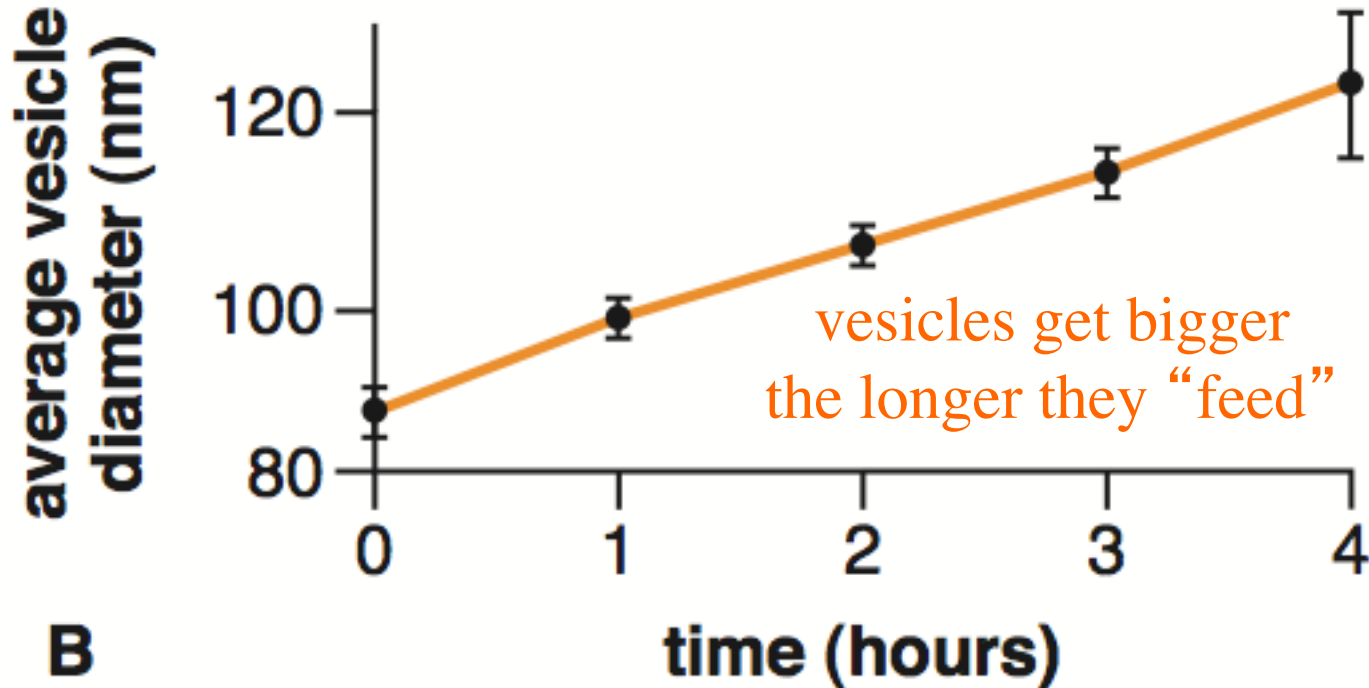
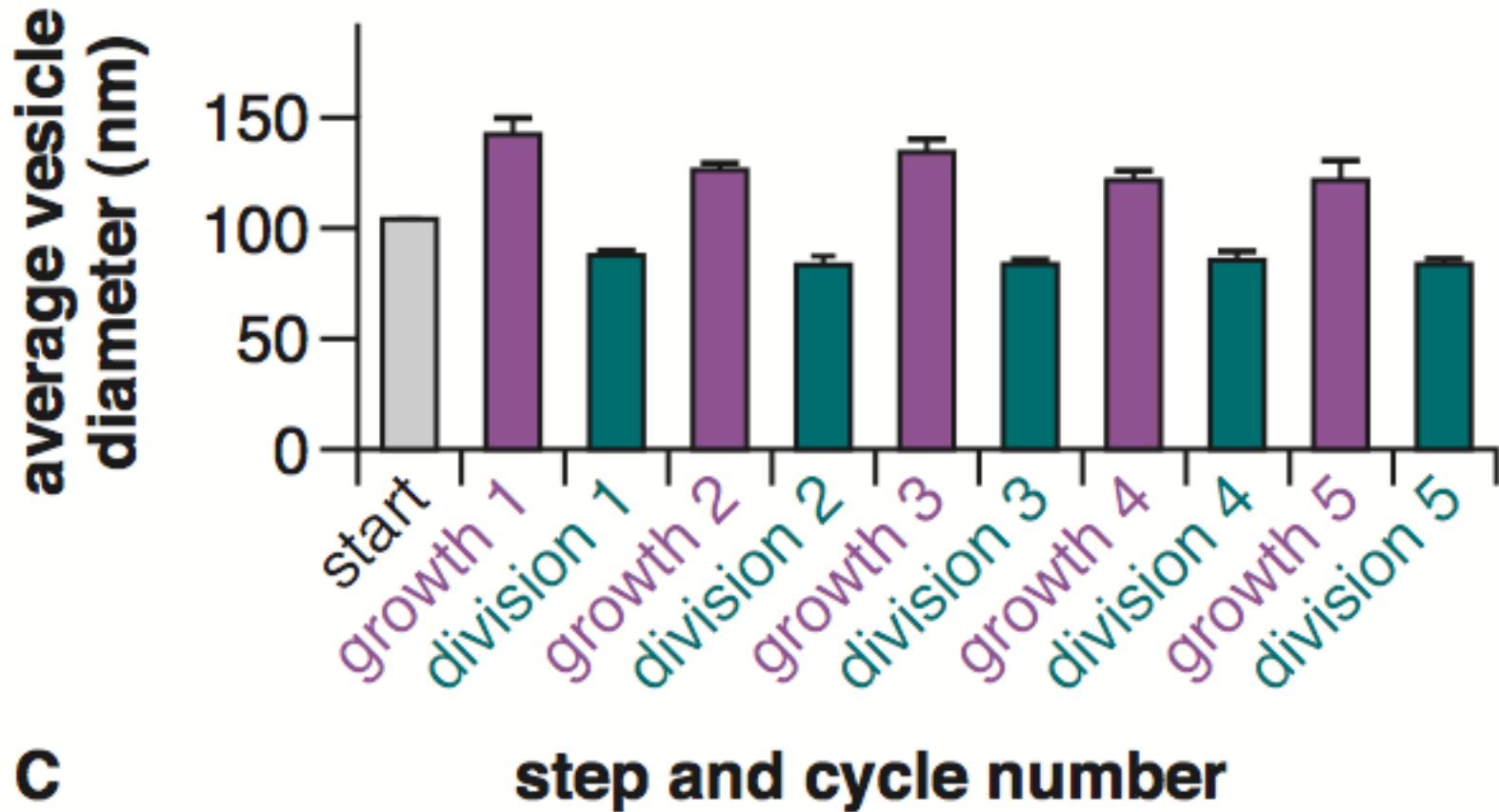


Fig. 4.13

Dynamic Vesicle Sizes

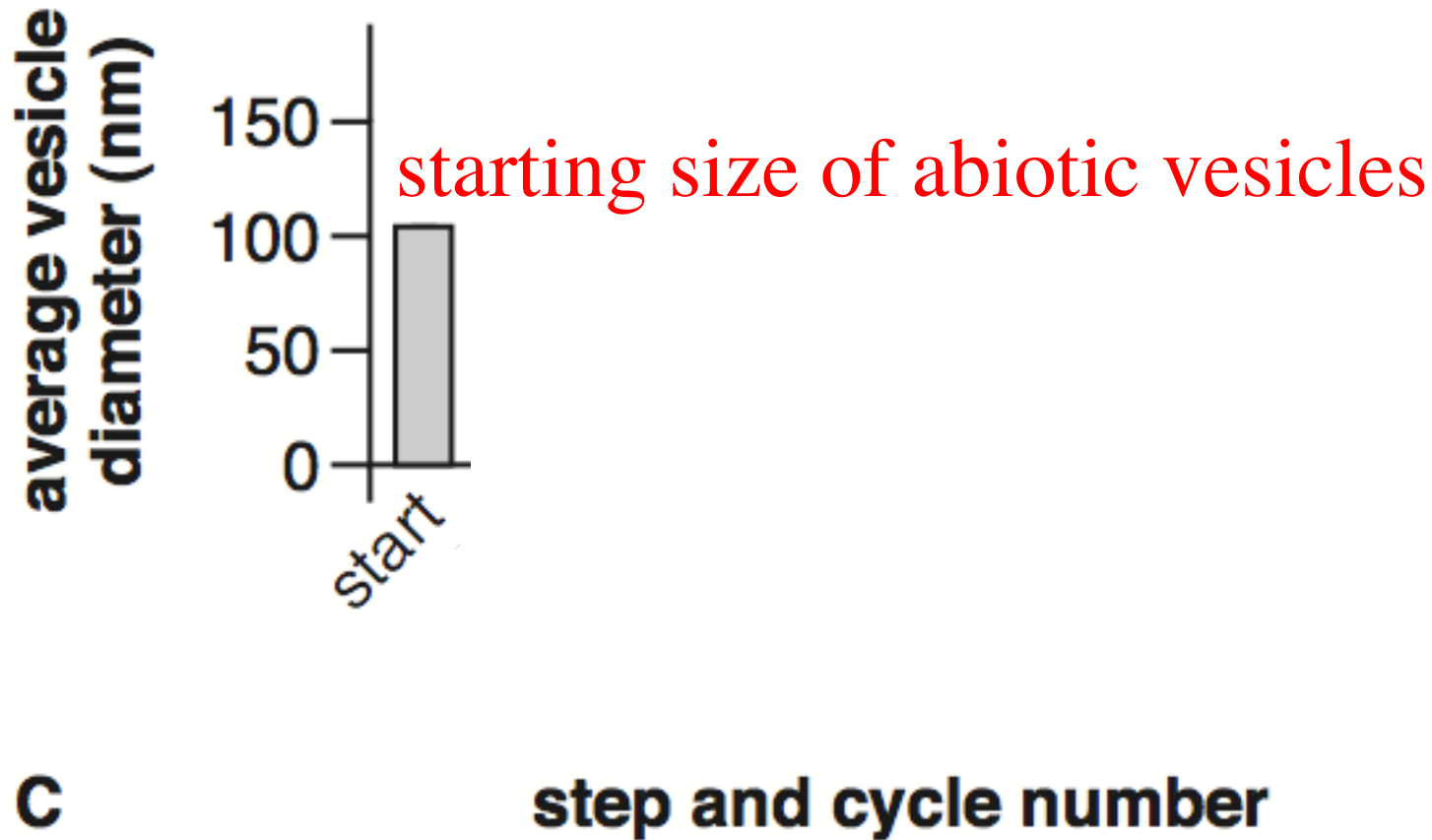


C

step and cycle number

Fig. 4.13

Dynamic Vesicle Sizes



C

step and cycle number

Fig. 4.13

Dynamic Vesicle Sizes

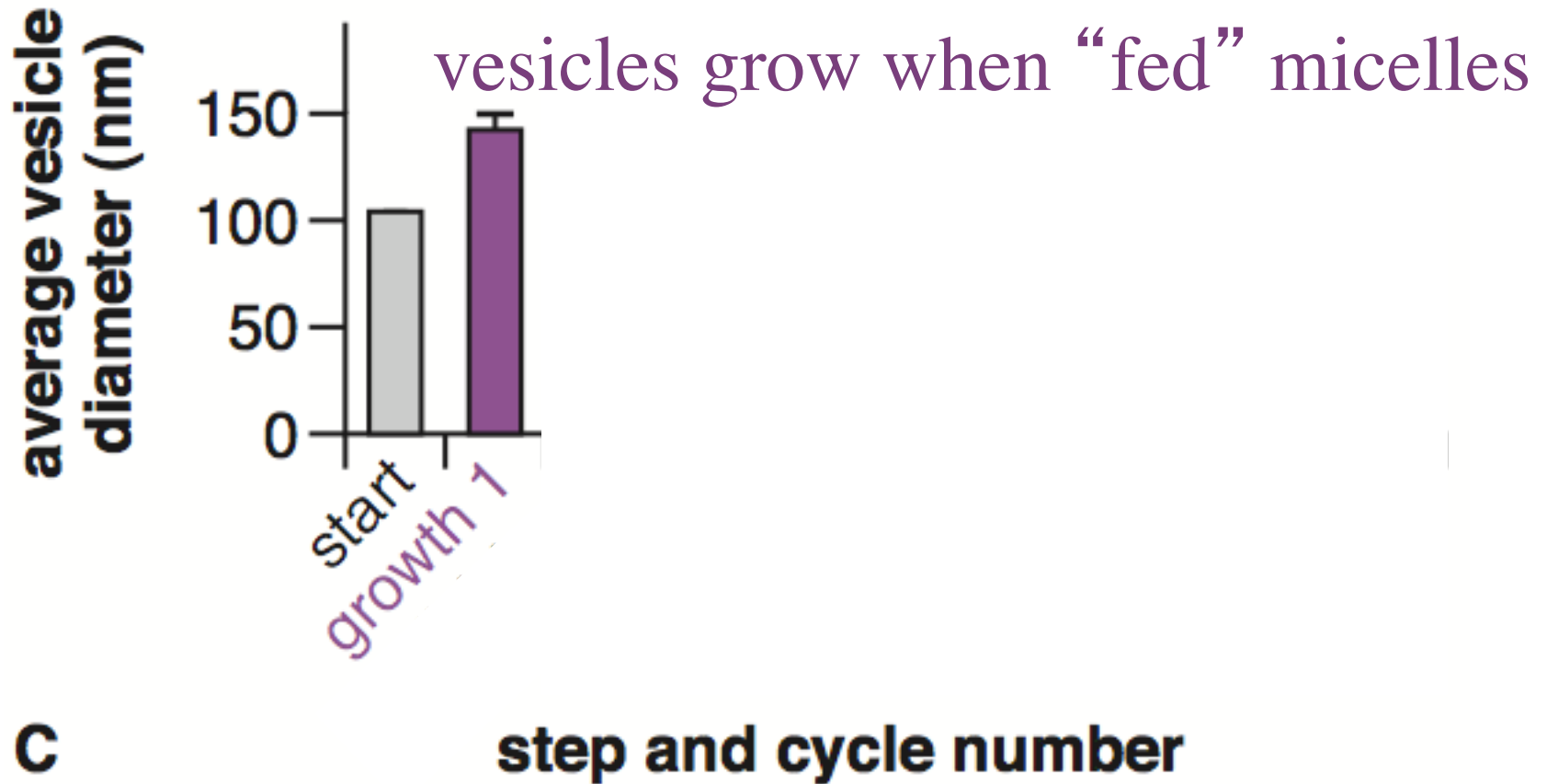


Fig. 4.13

Dynamic Vesicle Sizes

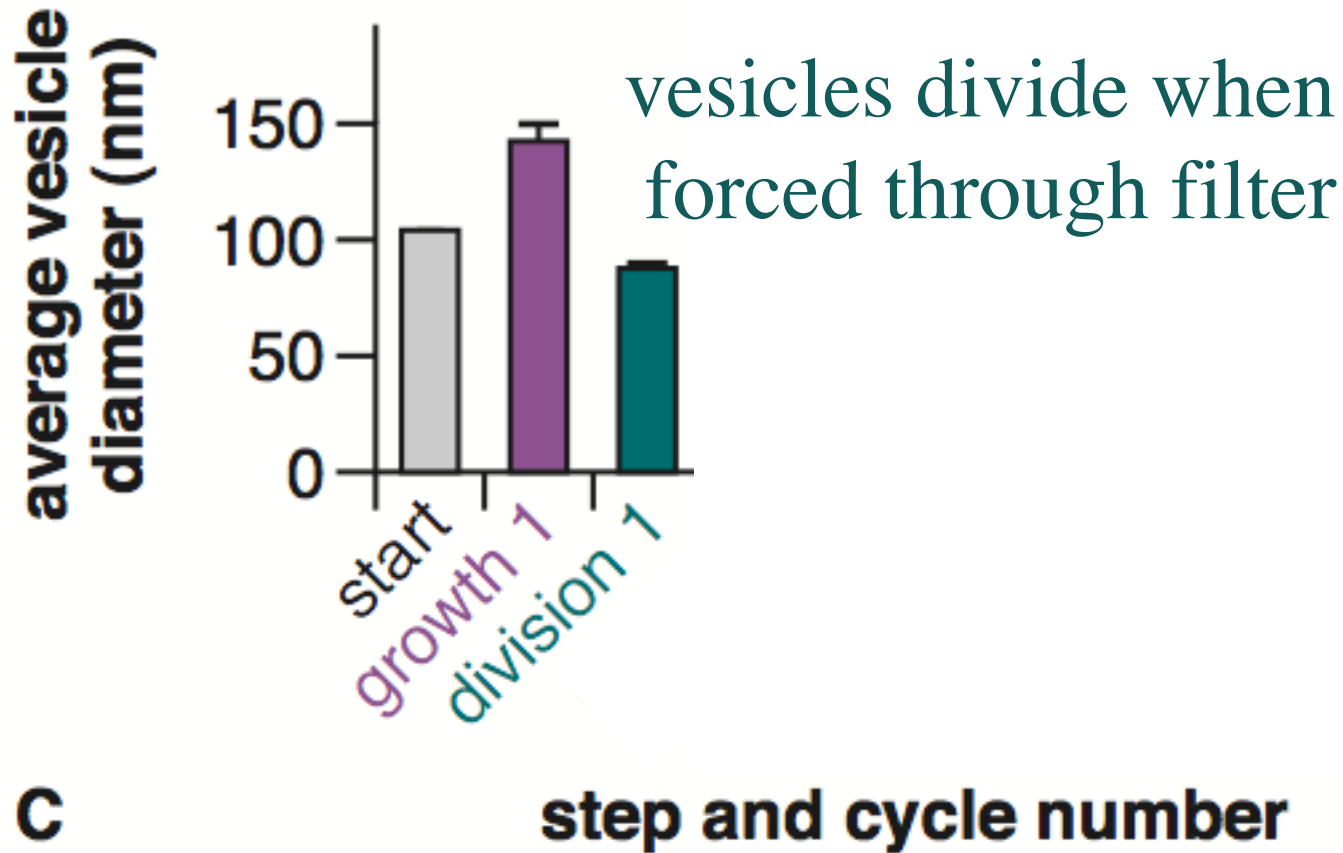


Fig. 4.13

Dynamic Vesicle Sizes

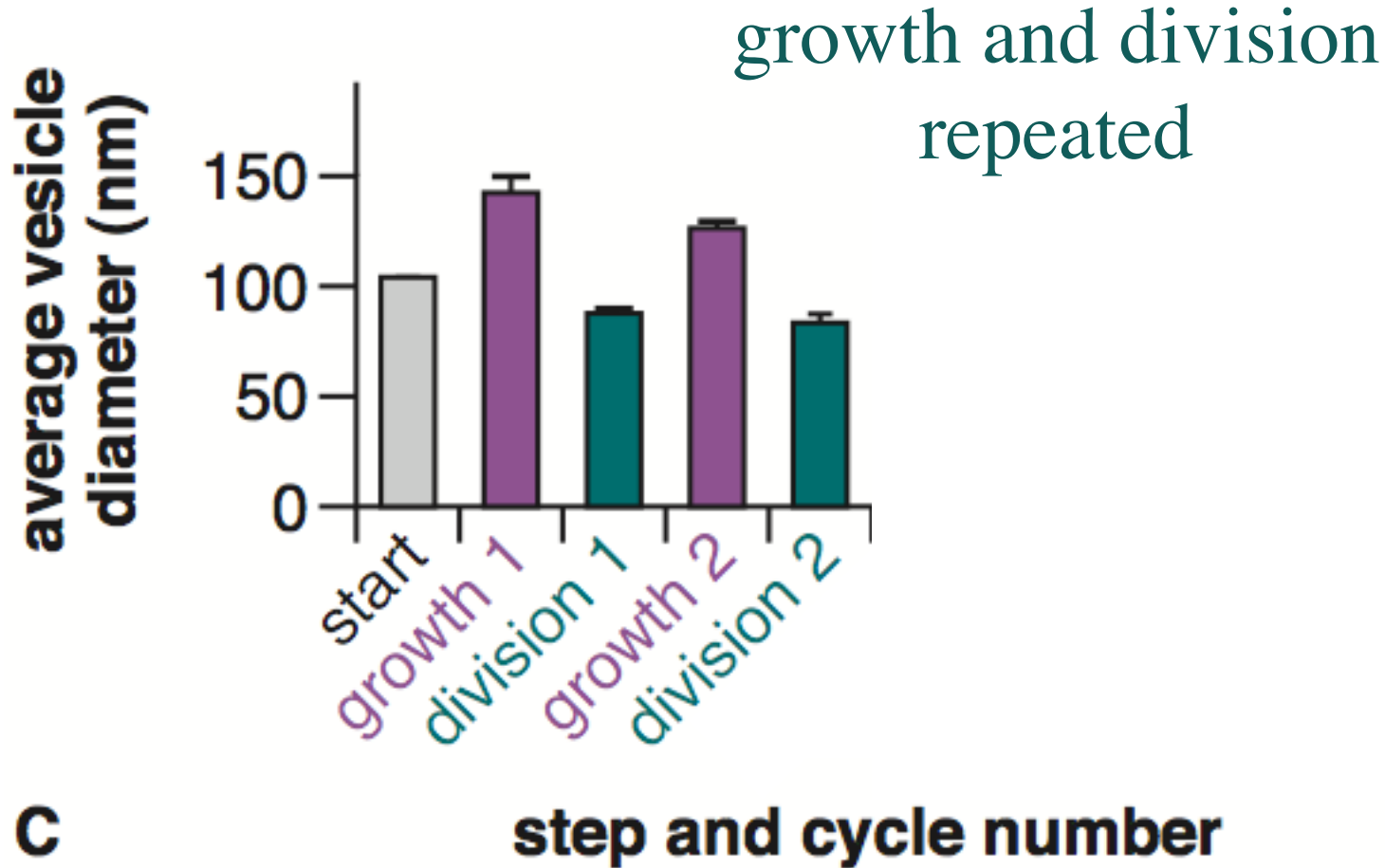
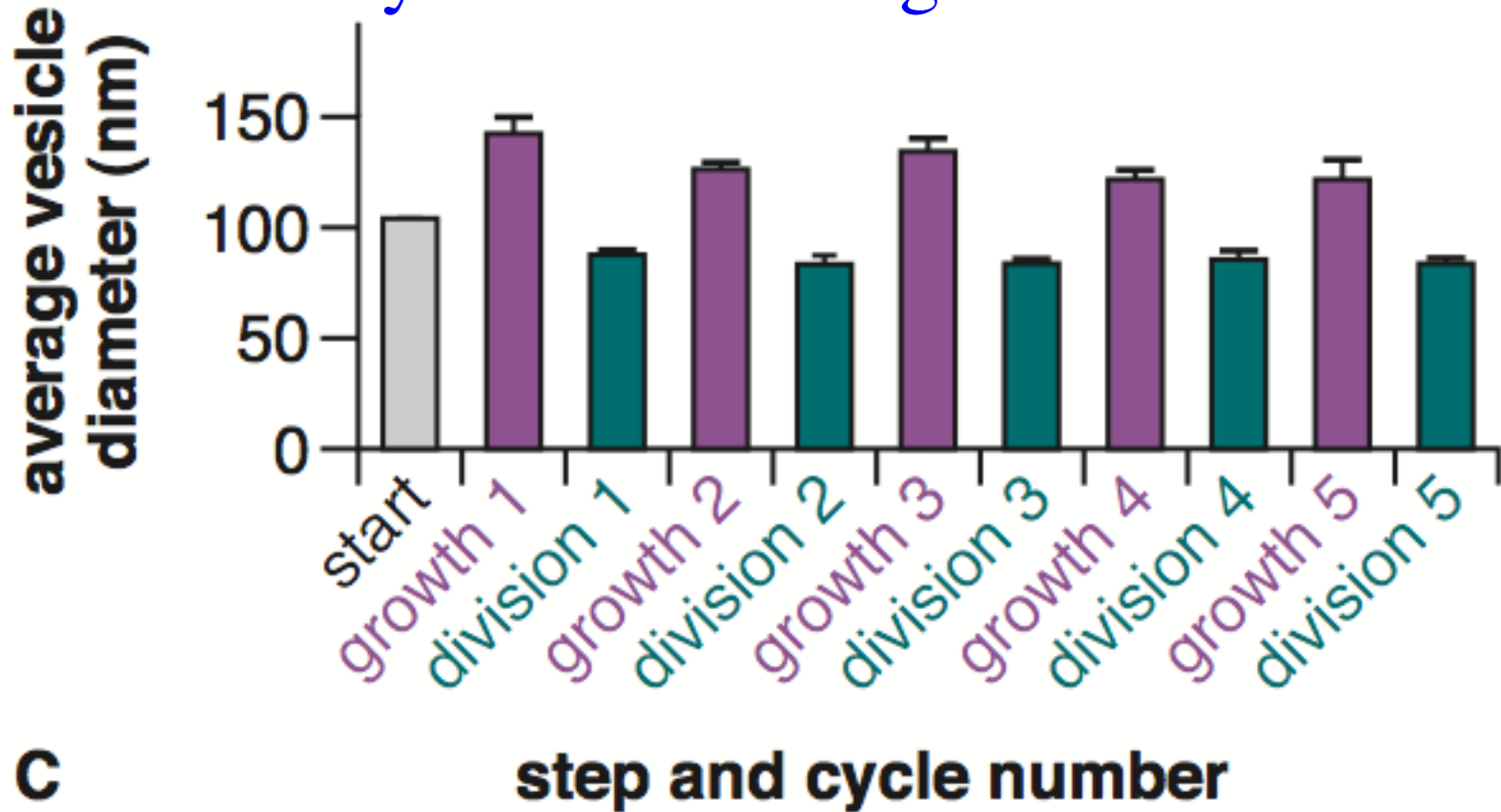


Fig. 4.13

Dynamic Vesicle Sizes

five cycles of abiotic growth and division



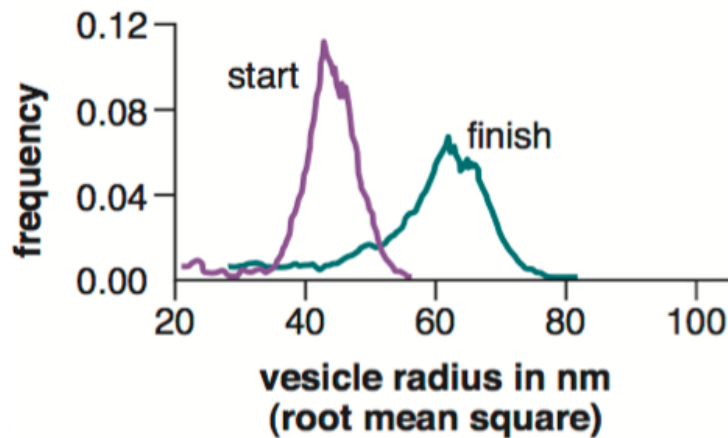
C

step and cycle number

Fig. 4.13

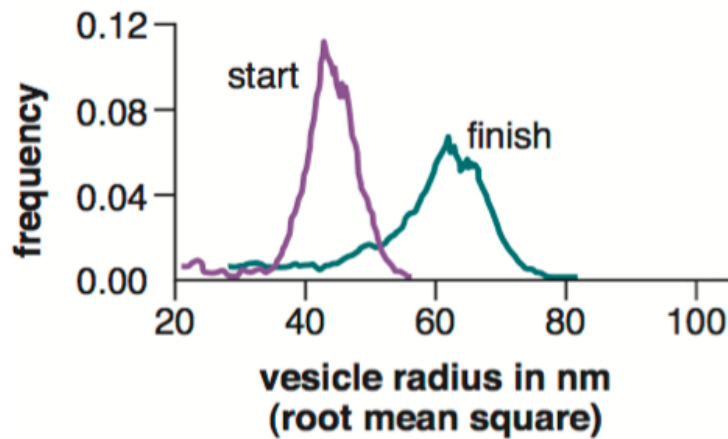
Dynamic Vesicle Sizes

Vesicle Type	Radius (nm)	Surface Area (nm ²)	Volume (nm ³)	Ratio (area/volume)
Small vesicle				
Large vesicle				
Percent Change				



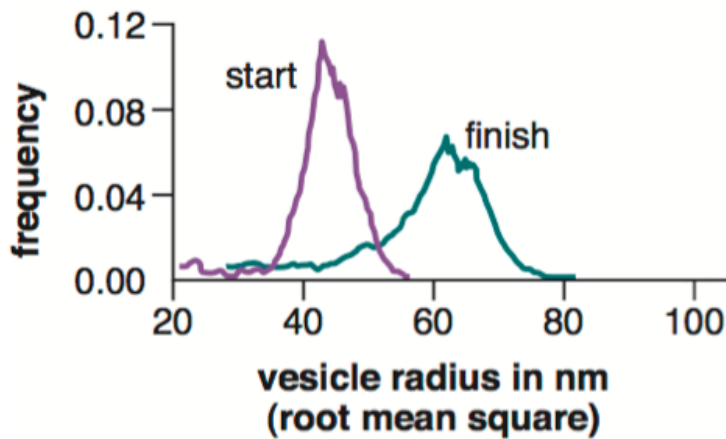
Width Increases

Vesicle Type	Radius (nm)	Surface Area (nm ²)	Volume (nm ³)	Ratio (area/volume)
Small vesicle	45			
Large vesicle	62			
Percent Change	38%			



Surface Area Doubles

Vesicle Type	Radius (nm)	Surface Area (nm ²)	Volume (nm ³)	Ratio (area/volume)
Small vesicle	45	25,400		
Large vesicle	62	48,300		
Percent Change	+38%	+90%		



Volume More Than Doubles

Vesicle Type	Radius (nm)	Surface Area (nm ²)	Volume (nm ³)	Ratio (area/volume)
Small vesicle	45	25,400	381,500	
Large vesicle	62	48,300	997,800	
Percent Change	+38%	+90%	+262%	

