



## Cell Size

### ENE-1.B.1

**Surface area-to-volume ratios affect the ability of a biological system to obtain necessary resources, eliminate waste products, acquire or dissipate thermal energy, and otherwise exchange chemicals and energy with the environment.**



## Cell Size

Volume of a Sphere:  $V = \frac{4}{3}\pi r^3$

Volume of a Cube:  $V = s^3$

Volume of a Rectangular Solid:  $V = lwh$

Volume of a Cylinder:  $V = \pi r^2 h$

Surface Area of a Sphere:  $SA = 4\pi r^2$

Surface Area of a Cube:  $SA = 6s^2$

Surface Area of a Rectangular Solid:

$$SA = 2lh + 2lw + 2wh$$

Surface Area of a Cylinder:  $SA = 2\pi rh + 2\pi r^2$

$r$  = radius

$l$  = length

$h$  = height

$w$  = width

$s$  = length of one side of a cube



## Cell Size

### ENE-1.B.2

The surface area of the plasma membrane must be large enough to adequately exchange materials—

- a. These limitations can restrict cell size and shape. Smaller cells typically have a higher surface area-to-volume ratio and more efficient exchange of materials with the environment.
- b. As cells increase in volume, the relative surface area decreases and the demand for internal resources increases.



## Cell Size

### ENE-1.B.2

The surface area of the plasma membrane must be large enough to adequately exchange materials—

- c. More complex cellular structures (e.g., membrane folds) are necessary to adequately exchange materials with the environment.
- d. As organisms increase in size, their surface area-to-volume ratio decreases, affecting properties like rate of heat exchange with the environment.



## Cell Size

### ENE-1.C.1

**Organisms have evolved highly efficient strategies to obtain nutrients and eliminate wastes. Cells and organisms use specialized exchange surfaces to obtain and release molecules from or into the surrounding environment.**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**Which of the following cells is most efficient?**

**Note: SA = surface area V = volume**

- A. SA: 4 V: 1**
- B. SA: 3 V: 2**
- C. SA: 2 V: 3**
- D. SA: 1 V: 4**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3

Which of the following cells is most efficient?

Note: SA = surface area V = volume

A. SA: 4 V: 1



The most efficient cell is the cell with the highest surface area to volume ratio.

A.  $4/1 = 4$

B.  $3/2 = 1.5$

C.  $2/3 = 0.67$

D.  $1/4 = 0.25$



**As surface area is squared,  
volume is...**

- A. Halved**
- B. Doubled**
- C. Squared**
- D. Cubed**



As surface area is squared, volume is...

D. Cubed



Let's take a cube for example.

The side length x side height equals the side squared x 6 sides gives the surface area of the cube.

The side length x side height x side width equals the side cubed gives you the volume of the cube.

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**As the organism grows, how  
does it overcome the SA:V  
requirement?**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3

**As the organism grows,  
how does it overcome the  
SA:V requirement?**



**Increases the number of cells. As the organism is bigger, it has more cells to ensure that each cell still has a large surface area to volume ratio. In addition, the organism builds “compartments” (aka tissues/organs with specific jobs)**



**The small intestines is responsible for nutrient absorption in the digestive system. There are folds called microvilli in this organ. What is the function of the microvilli in the small intestines?**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**The small intestines is responsible for nutrient absorption in the digestive system. There are folds called microvilli in this organ. What is the function of the microvilli in the small intestines?**

**Increases the surface area which provides more space for an increased efficiency absorbing nutrients.**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**What is the surface area of a sphere with a radius of 3?**

- A. 4 pi**
- B. 16 pi**
- C. 36 pi**
- D. 64 pi**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3

What is the surface area of a sphere with a radius of 3?

C. 36 pi



The equation for surface area is  $4\pi(r)^2$ .

$$\begin{aligned}\text{So, } & 4\pi(3)^2 \\ & = 4\pi(9) \\ & = 36\pi\end{aligned}$$



What is the volume of a sphere with a radius of 3?

- A.  $(4/3) \pi$
- B.  $(32/3) \pi$
- C.  $(108/3) \pi$  or  $36 \pi$
- D.  $(256/3) \pi$



# AP BIO INSTA-REVIEW

TOPIC

# 2.3

What is the volume of a sphere with a radius of 3?

c.  $(108/3) \pi$



The equation for volume is  $(4/3)\pi(r)^3$ .

$$\begin{aligned} \text{So, } & (4/3)\pi(3)^3 \\ & = (4/3)\pi(27) \\ & = (108/3)\pi \end{aligned}$$

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**What is the surface area of a cube with a side length of 2?**

- A. 6**
- B. 24**
- C. 54**
- D. 96**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3

What is the surface area of a cube with a side length of 2?

**B. 24**



The equation for surface area is  $6s^2$ .

$$\begin{aligned} \text{So, } & 6(2)^2 \\ & = 6(4) \\ & = 24 \end{aligned}$$

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**What is the volume of a cube with a side length of 2?**

- A. 1**
- B. 8**
- C. 27**
- D. 64**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



What is the volume of a cube with a side length of 2?

B. 8

The equation for surface area is  $s^2$ .

So,  $2^3 = 8$



**Why is the inner membrane of the mitochondria highly folded?**

- A. Increase volume of mitochondria**
- B. Increase in surface area for oxidative phosphorylation**
- C. Decrease volume of mitochondria**
- D. Decrease in surface area for oxidative phosphorylation**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3

**Why is the inner membrane of the mitochondria highly folded?**

**B. Increase in surface area for oxidative phosphorylation**



**The more surface area available in the mitochondria, the more sites of oxidative phosphorylation, and the more ATP can be synthesized for the cell.**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**How does the increase in surface area affect the volume?**



# AP BIO INSTA-REVIEW

TOPIC

# 2.3

**How does the increase in surface area affect the volume?**



**As surface area increases, the volume increases. The surface area increases by factor squared. The volume increased by factor cubed.**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**How do microvilli increase diffusion?**

**How do microvilli increase diffusion?**



**Microvilli are extensions of the plasma membrane. These are traditionally found on cells like those in the small intestines which are responsible for absorption of nutrients. They are able to increase diffusion by increasing the surface area to volume ratios of these cells.**

# AP BIO INSTA-REVIEW

TOPIC

# 2.3



**Which cell is more efficient?**

**A. Sphere**

**B. Cube**

**Note:**

Sphere	Cube
SA: $36\pi$	SA: 24
V: $(108/3)\pi$	V: 8

Which cell is more efficient?

B. Cube



The sphere has a SA/V ratio of 1 and the cube has a SA/V ratio of 3.

The larger SA:V ratio is more efficient