Welcome to
Math 102 Section 107

Krishanu Sankar

MWF 8:00 - 8:50 AM, LSK 200

Math 102: Announcements

- Instructor: Krishanu Sankar
- Email: ksankar@math.ubc.ca
- Course website: https://wiki.math.ubc.ca
- Today:
  - Course information
  - Cell size and power functions

Assignments and Grading

- Homework
  - WeBWorK (online, 3x/week) - 10% (5% points dropped)
  - Old-School Homework (written, 6 total) - 10%

Assignments and Grading

- Homework
  - WeBWorK (online, 3x/week) - 10% (5% points dropped)
  - Old-School Homework (written, 6 total) - 10%
- Quizzes (3 total) - 15%

Assignments and Grading

- Homework
  - WeBWorK (online, 3x/week) - 10% (5% points dropped)
  - Old-School Homework (written, 6 total) - 10%
- Quizzes (3 total) - 15%
- Midterm (October 26) - 15%

Assignments and Grading

- Homework
  - WeBWorK (online, 3x/week) - 10% (5% points dropped)
  - Old-School Homework (written, 6 total) - 10%
- Quizzes (3 total) - 15%
- Midterm (October 26) - 15%
- Final exam (Date TBD) - 50% (44% rule)

Typical Math 102 Week

- Monday:
  - 7 am: Pre-lecture WeBWorK due
  - 8-8:50 am: Lecture

Typical Math 102 Week

- Monday:
  - 7 am: Pre-lecture WeBWorK due
  - 8-8:50 am: Lecture
- Wednesday:
  - 7 am: Pre-lecture WeBWorK due
  - 8-8:50 am: Lecture

Typical Math 102 Week

- Monday:
  - 7 am: Pre-lecture WeBWorK due
  - 8-8:50 am: Lecture
- Wednesday:
  - 7 am: Pre-lecture WeBWorK due
  - 8-8:50 am: Lecture
- Thursday:
  - 7 am: WeBWorK due

Typical Math 102 Week

- Monday:
  - 7 am: Pre-lecture WeBWorK due
  - 8-8:50 am: Lecture
- Wednesday:
  - 7 am: Pre-lecture WeBWorK due
  - 8-8:50 am: Lecture
- Thursday:
  - 7 am: WeBWorK due
- Friday:
  - 8-8:50 am: Lecture & OSH or Quiz

What resources are available?

- Fellow students - study groups

What resources are available?

- Fellow students - study groups
- Me - questions after class
- My office hours: Fill Doodle Poll on section website! (Provisionally MF9-10 and Th1-2, in LSK300B, starting this Friday)

What resources are available?

- Fellow students - study groups
- Me - questions after class
- My office hours: Fill Doodle Poll on section website! (Provisionally MF9-10 and Th1-2, in LSK300B, starting this Friday)
- Math Learning Centre (LSK 301 & 302)
- Piazza

What resources are available?

- Fellow students - study groups
- Me - questions after class
- My office hours: Fill Doodle Poll on section website! (Provisionally MF9-10 and Th1-2, in LSK300B, starting this Friday)
- Math Learning Centre (LSK 301 & 302)
- Piazza
- Free course notes (pdf) and supplemental videos

What resources are available?

- Fellow students - study groups
- Me - questions after class
- My office hours: Fill Doodle Poll on section website! (Provisionally MF9-10 and Th1-2, in LSK300B, starting this Friday)
- Math Learning Centre (LSK 301 & 302)
- Piazza
- Free course notes (pdf) and supplemental videos
- Lecture slides/scans posted after class

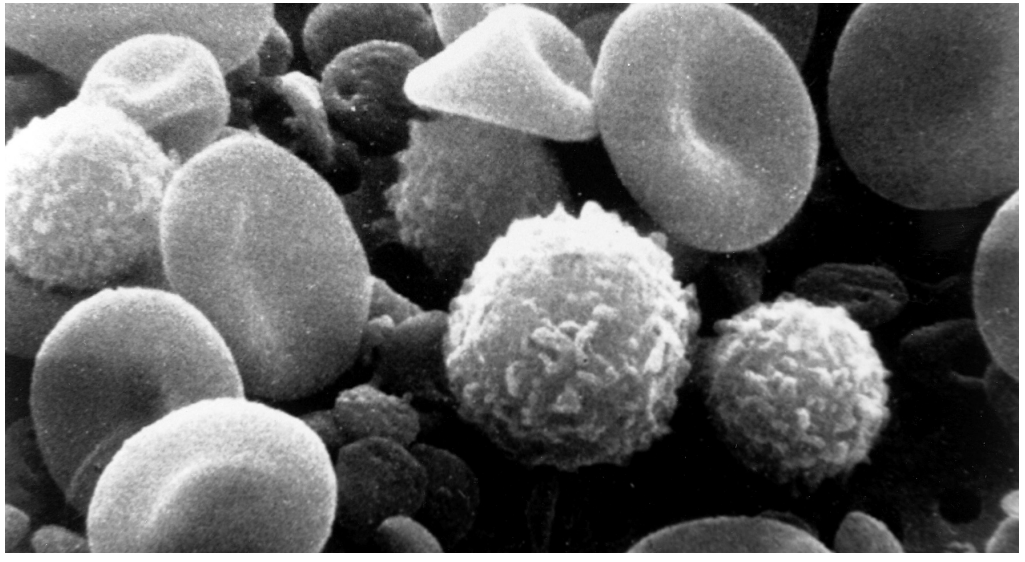
Other Admin

- All questions regarding registration or sectioning should be directed to Mark MacLean or Margaret Ness.

Other Admin

- All questions regarding registration or sectioning should be directed to Mark MacLean or Margaret Ness.
- Lectures will be interactive with prompts and clicker questions. (register your iClicker on Connect)
- I'd like to thank Eric Cytrynbaum, Leah Edelstein-Keshet, and Cole Zmurchok, whose slides were the basis for these lectures.

Why are cells so small?



https://en.wikipedia.org/wiki/White_blood_cell/media/File:SEM_blood_cells.jpg

- WBCs are 12-15 microns in diameter.

- Cells absorb nutrients through their surface, and use the nutrients in their interior. Must have nutrient absorption rate $\geq$ consumption rate, or the cell dies!

- Cells absorb nutrients through their surface, and use the nutrients in their interior. Must have nutrient absorption rate $\geq$ consumption rate, or the cell dies!

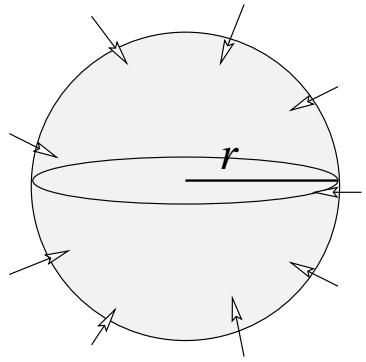
- Mathematical model: assume the cell is *spherical*, and

- Cells absorb nutrients through their surface, and use the nutrients in their interior. Must have nutrient absorption rate $\geq$ consumption rate, or the cell dies!

- Mathematical model: assume the cell is *spherical*, and

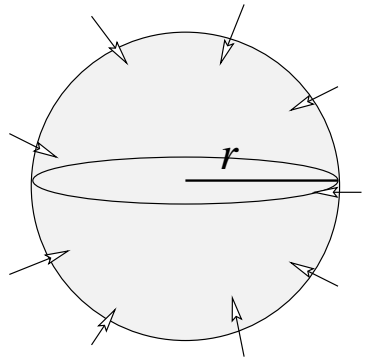
    1. Absorption rate is proportional to surface area.
    2. Consumption rate is proportional to volume.

A mathematical model



1. Nutrient absorption rate is proportional to surface area

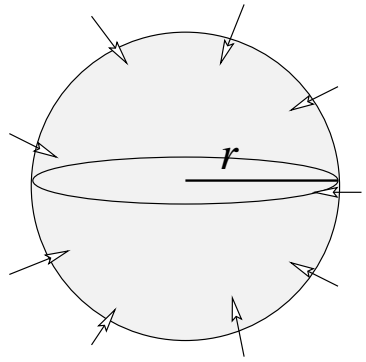
A mathematical model



1. Nutrient absorption rate is proportional to surface area

$$A = k_1 S$$

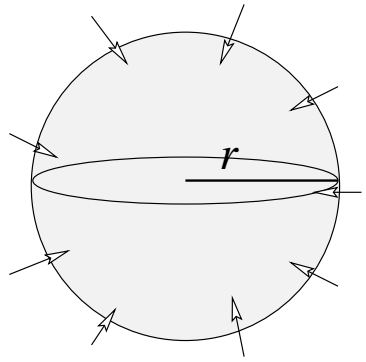
A mathematical model



1. Nutrient absorption rate is proportional to surface area

$$A = k_1 S = k_1 4\pi r^2$$

A mathematical model

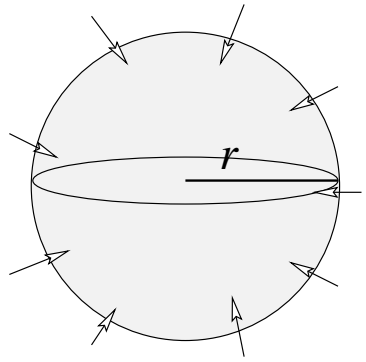


1. Nutrient absorption rate is proportional to surface area

$$A = k_1 S = k_1 4\pi r^2$$

2. Consumption rate is proportional to volume

A mathematical model



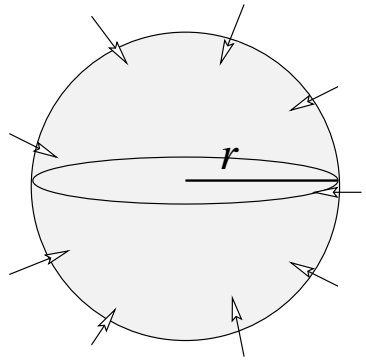
1. Nutrient absorption rate is proportional to surface area

$$A = k_1 S = k_1 4\pi r^2$$

2. Consumption rate is proportional to volume

$$C = k_2 V$$

A mathematical model



1. Nutrient absorption rate is proportional to surface area

$$A = k_1 S = k_1 4\pi r^2$$

2. Consumption rate is proportional to volume

$$C = k_2 V = k_2 \frac{4}{3}\pi r^3$$

where k_1 and k_2 are positive constants.

Cell shape

$$A(r) = 4\pi k_1 r^2 \qquad C(r) = \frac{4}{3}\pi k_2 r^3$$

Q1. Which of the following is true?

A. Absorption is greater than consumption for sufficiently large cells and vice versa for small cells.

B. Consumption is greater than absorption for sufficiently large cells and vice versa for small cells.

C. Both A and B are possible, depending on k_1 and k_2.

Cell shape

$$A(r) = 4\pi k_1 r^2 \qquad C(r) = \frac{4}{3}\pi k_2 r^3$$

Q1. Which of the following is true?

A. Absorption is greater than consumption for sufficiently large cells and vice versa for small cells.

B. Consumption is greater than absorption for sufficiently large cells and vice versa for small cells.

C. Both A and B are possible, depending on k_1 and k_2.

Power functions

- A function of the form $f(x) = ax^n$ (where a is a constant and n is an integer) is called a **power function**.

Power functions

- A function of the form $f(x) = ax^n$ (where a is a constant and n is an integer) is called a **power function**.
- The integer n is called the **degree**, and a is called the **coefficient**.

Power functions

- A function of the form $f(x) = ax^n$ (where a is a constant and n is an integer) is called a **power function**.
- The integer n is called the **degree**, and a is called the **coefficient**.

Example

$$A(r) = (4\pi k_1)r^2 \quad \text{and} \quad C(r) = \left(\frac{4}{3}\pi k_2\right) r^3$$

are power functions with **independent variable** r.

Power functions

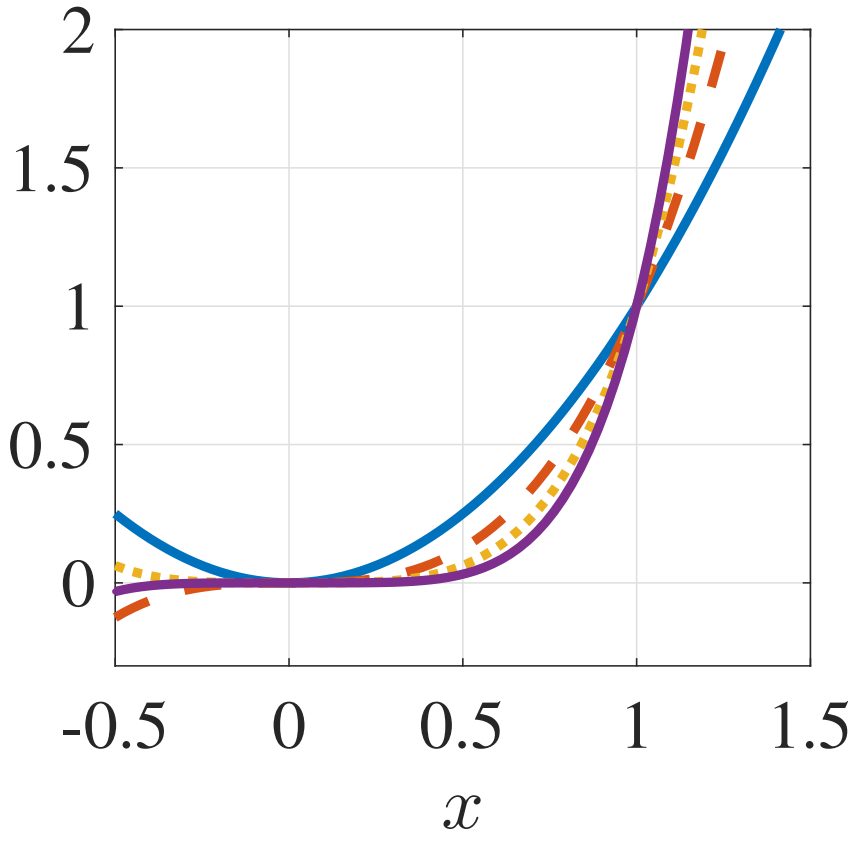
Q2. Match!

A. Red: x^3, blue: x^2, purple: x^5, yellow: x^4.

B. Red: x^5, blue: x^4, purple: x^3, yellow: x^2.

C. Red: x^3, blue: x^4, purple: x^5, yellow: x^2.

D. Don't know, please explain.



Power functions

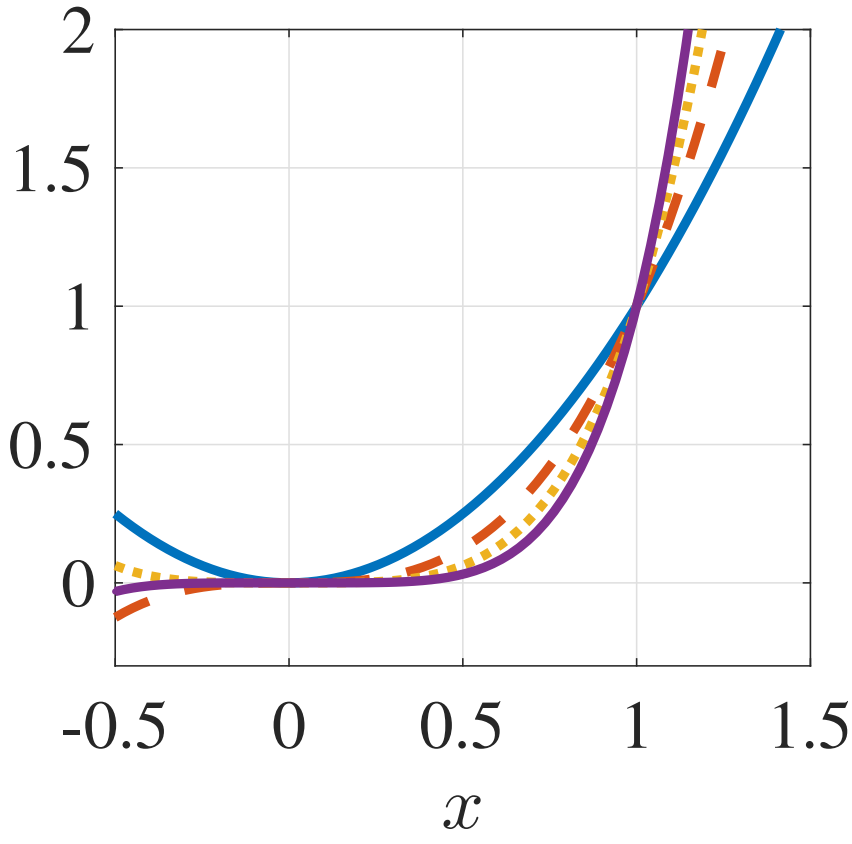
Q2. Match!

A. Red: x^3, blue: x^2, purple: x^5, yellow: x^4.

B. Red: x^5, blue: x^4, purple: x^3, yellow: x^2.

C. Red: x^3, blue: x^4, purple: x^5, yellow: x^2.

D. Don't know, please explain.

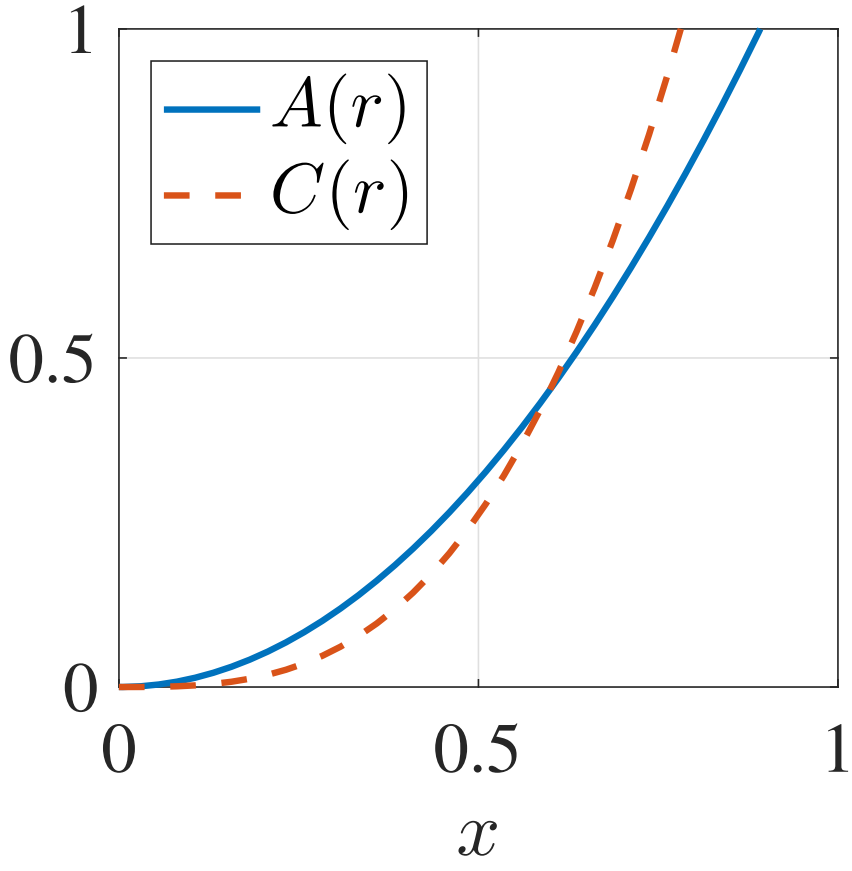


Cell size

$$A(r) = 4\pi k_1 r^2$$

$$C(r) = \frac{4}{3}\pi k_2 r^3$$

Consumption is greater than absorption for sufficiently large cells and vice versa for small cells.



Limit on cell size

- **When** is the absorption rate greater the consumption rate?

Limit on cell size

- **When** is the absorption rate greater the consumption rate?
- i.e., for **which values of** r is the absorption rate $A(r)$ bigger than the $C(r)$?

Limit on cell size

- **When** is the absorption rate greater the consumption rate?
- i.e., for **which values of** r is the absorption rate $A(r)$ bigger than the $C(r)$?

$$A(r) = 4\pi k_1 r^2 > \frac{4}{3} k_2 \pi r^3 = C(r)$$

$$r < 3\frac{k_1}{k_2}$$

Does this make sense with the plot above?

Limit on cell size

Q3. Which of the following cells can survive?

A. $r < 3\frac{k_1}{k_2}$

B. $r = 3\frac{k_1}{k_2}$

C. $r > 3\frac{k_1}{k_2}$

Limit on cell size

Q3. Which of the following cells can survive?

A. $r < 3\frac{k_1}{k_2}$

B. $r = 3\frac{k_1}{k_2}$

C. $r > 3\frac{k_1}{k_2}$

What about bigger cells, such as neurons, *Caulerpa prolifera*, or eggs?

Today...

- Course info

Today...

- Course info
- Cell size and mathematical models

Today...

- Course info
- Cell size and mathematical models
- Power functions: $f(x) = ax^2$ versus $g(x) = bx^3$. Which is bigger? For which x?