



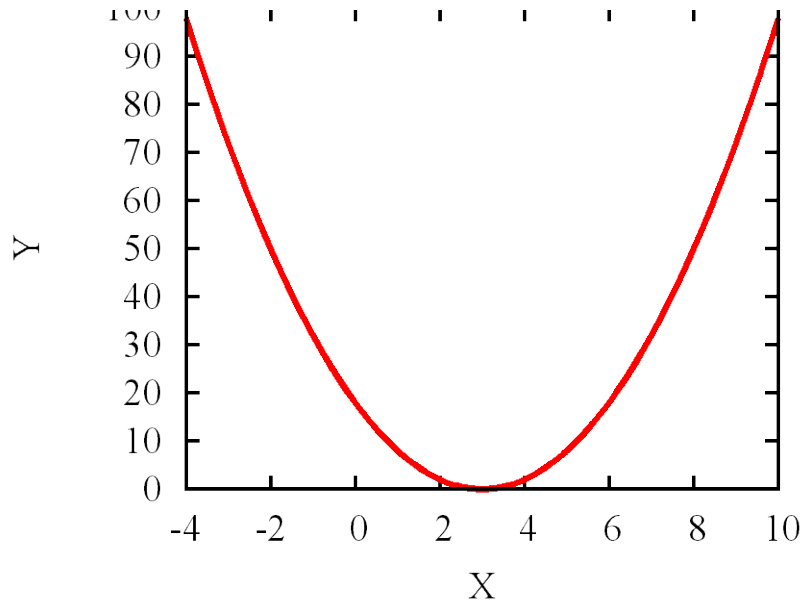
BIOMATHEMATICS

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Differentiation and its applications

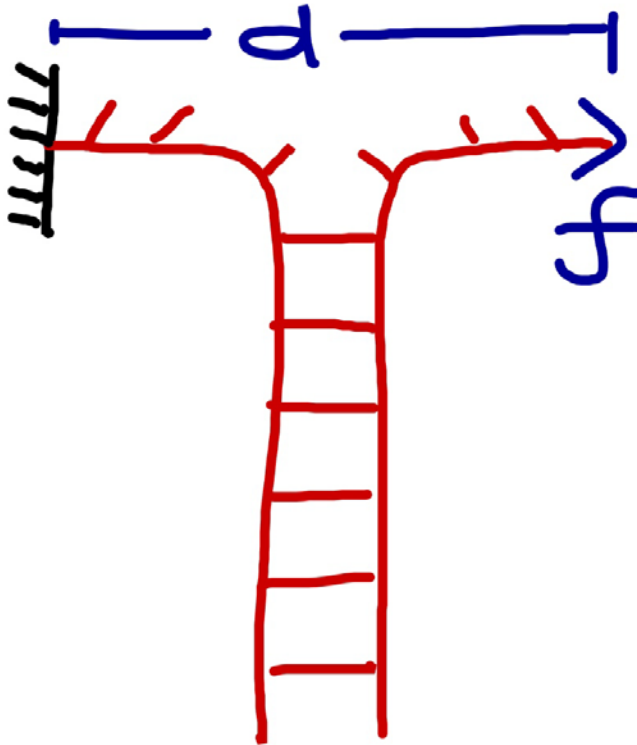
Force: derivative of energy



$$E = \frac{1}{2} kx^2$$

$$f = -\frac{dE}{dx} = -kx$$

DNA unzipping by force



$G(f)$: Gibb's free energy

If we know Gibb's free energy we can predict distance vs force relation

$$d = \frac{dG(f)}{df}$$

Plotting curves

How the ideas from calculus that we learned so far can help us in plotting functions ?

Clue: We can, now, figure out locations of maxima and minima

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Recipe for sketching $f(x)$

- Evaluate $f(x)$ at 3 points: $f(\infty)$, $f(-\infty)$, $f(0)$
- Find out the points where $f(x)=0$
- Calculate the points where the function has maxima and minima (i.e. $df/dx=0$)
- Find out which one is a maximum ($d^2f/dx^2 < 0$) and which one is a minimum ($d^2f/dx^2 > 0$)
- Evaluate the function at maxima and minima
- Make a schematic sketch using the above information

Sketching $f(x)=x^3-3x$

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$$f(x \rightarrow \infty) = \infty$$

$$f(x \rightarrow -\infty) = -\infty$$

$$f(x \rightarrow 0) = 0$$

Sketching $f(x)=x^3-3x$

2. Find out the points where $f(x)=0$

$$x^3-3x=0$$

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2. Find out the points where $f(x)=0$

$$x^3-3x=0$$

$$\Rightarrow x = 0, x = +\sqrt{3}, x = -\sqrt{3}$$

Sketching $f(x)=x^3-3x$

3. Calculate the points where the function has maxima and minima (i.e. $df/dx=0$)

$$\rightarrow df/dx=3x^2-3=0$$

$$\Rightarrow x = +1, x = -1$$

Sketching $f(x)=x^3-3x$

4. Find out which one is a maximum ($d^2f/dx^2 < 0$)
and which one is a minimum ($d^2f/dx^2 > 0$)

$$\rightarrow d^2f/dx^2 = 6x$$

$$\Rightarrow x = +1 \quad \text{Is minima}$$

$$x = -1 \quad \text{Is maxima}$$

Sketching $f(x)=x^3-3x$

5. Evaluate the function at maxima and minima

$$\begin{aligned} \text{At } x=+1, \\ x^3-3x=-2 \end{aligned}$$

$$\begin{aligned} \text{At } x=-1 \\ x^3-3x=2 \end{aligned}$$

