• Recall that you have some very quick rules for computing the derivative of a function at a letter location. Assuming that $a$, $b$ and $n$ are constants:

$$\frac{d}{dx}(a) = 0$$

$$\frac{d}{dx}(x^n) = nx^{n-1}$$

$$\frac{d}{dx}(e^x) = e^x$$

$$\frac{d}{dx}(\sin(x)) = \cos(x)$$

$$\frac{d}{dx}(\cos(x)) = -\sin(x)$$

$$\frac{d}{dx}(\ln(x)) = \frac{1}{x}$$

$$\frac{d}{dx}(af + bg) = a\frac{df}{dx} + b\frac{dg}{dx}$$

• Be able to express a complex function in terms of its “insides” and “outside” pieces.

1. First determine what the “insides” (or stuff) is and call it the variable $u$.

   $$u = \text{stuff}$$

2. Rewrite the function in terms of $u$. Your outside function should be one of the basic functions listed above.

3. Find the derivative of $u$ (the insides) in terms of $x$ (labeled $\frac{du}{dx}$) and $f(u)$ (the outside) in terms of $u$ (labeled $\frac{df}{du}$).

4. Use the **Chain Rule** to find the derivative by multiplying the derivatives together.

   $$f'(x) = \frac{df}{dx} = \frac{df}{du} \cdot \frac{du}{dx}$$

5. Rewrite the final answer only in terms of the original variable $x$.

Once one gets good at finding the insides and outsides the above steps can be put together.
For example if \( f(x) = \ln(x^2 - x^3) \), then

Insides: \( u = x^2 - x^3 \)  
Outside: \( f(u) = \ln(u) \)

The derivatives of the inside and outsides are

\[
\frac{du}{dx} = 2x - 3x^2 \\
\frac{df}{du} = \frac{1}{u}
\]

Multiply the results together and rewrite only in terms of \( x \).

\[
f'(x) = \frac{df}{dx} = \frac{df}{du} \cdot \frac{du}{dx} = \left(\frac{1}{u}\right)(2x - 3x^2) = \left(\frac{1}{x^2 - x^3}\right)(2x - 3x^2) = \frac{2x - 3x^2}{x^2 - x^3}
\]

Recall \( u = x^2 - x^3 \) so replace \( u \) with its formula in \( x \).

- You can find more examples of using the Chain Rule
  - In your text book in section 3.4 on page 199.
  - At [Khan Academy](https://www.khanacademy.org) and more, linked from that page.

- An **antiderivative** is any function such that if you take its derivative you get the original function.
  - Be able to check guesses for antiderivatives and determine if they are correct or not.
  - Be able to fix a guess for an antiderivative if it is close but slightly off.
  - Be able to find multiple antiderivatives for a single function.
  - Be able to find antiderivatives yourself via ‘guessing and checking’ method.