

## Summary of Transformations

Below are the typical transformations on any parent function  $y = f(x)$ . The descriptions assume the values for  $a$ ,  $b$ ,  $c$ , and  $d$  are all positive.

### *Rigid Transformations*

**Function Translations (Shifts)** – Given the parent function  $y = f(x)$ ,

- $y = f(x) + d$  causes a shift up  $d$  units (add  $d$  to each  $y$ -coordinate).
- $y = f(x) - d$  causes a shift down  $d$  units (subtract  $d$  from each  $y$ -coordinate).
- $y = f(x - c)$  causes a shift right  $c$  units (add  $c$  to each  $x$ -coordinate).
- $y = f(x + c)$  causes a shift left  $c$  units (subtract  $c$  from each  $x$ -coordinate).

**Function Reflections (Flips)** – Given the parent function  $y = f(x)$ ,

- $y = -f(x)$  causes a vertical flip over the  $x$ -axis (negate each  $y$ -coordinate).
- $y = f(-x)$  causes a horizontal flip over the  $y$ -axis (negate each  $x$ -coordinate).

### *Non-Rigid Transformations*

**Function Dilations (Stretches/Shrinks)** – Given the parent function  $y = f(x)$ ,

- $y = af(x)$  causes a vertical stretch by a factor of  $a$  when  $a > 1$   
(multiply each  $y$ -coordinate by  $a$ ).
- $y = af(x)$  causes a vertical shrink by a factor of  $a$  when  $0 < a < 1$   
(multiply each  $y$ -coordinate by  $a$ ).
- $y = f(bx)$  causes a horizontal shrink by a factor of  $b$  when  $b > 1$   
(divide each  $x$ -coordinate by  $b$ ).
- $y = f(bx)$  causes a horizontal stretch by a factor of  $b$  when  $0 < b < 1$   
(divide each  $x$ -coordinate by  $b$ ).