Let A be the area (the dependent variable) and r be the radius (the independent variable). As the radius changes from r to $r + dr$, the area changes from πr^2 to $\pi(r + dr)^2$. Therefore,

$$\begin{aligned} dA &= \pi(r + dr)^2 - \pi r^2 \\ &= \pi[r^2 + 2r\,dr + (dr)^2] - \pi r^2 \\ &= 2\pi r\,dr + \pi\,(dr)^2. \end{aligned}$$

The $\pi\,(dr)^2$ is called a "second order" term; we can neglect it because it's *very* small (smaller than dr itself). Thus

$$dA = 2\pi r\,dr,$$

or

$$\frac{dA}{dr} = 2\pi r.$$