1) $y = \text{sigmoid}(a) \Rightarrow \frac{dy}{da} = y(1-y)$

$\Rightarrow \frac{d}{da} = \left(\frac{1}{1+e^{-a}}\right)$

$$\frac{d}{da}(1+e^{-a})^{-1} = -(1+e^{-a})^{-2} \cdot \frac{d}{da}\left(\frac{1}{1+e^{-a}}\right)$$

$$= \frac{d}{da}$$

$$\Rightarrow -(1+e^{-a})^{-2}\frac{d}{da}(1+e^{-a}) = -(1+e^{-a})^{-2}\left[\frac{d}{da}(1) + \frac{d}{da}(e^{-a})\right]$$

$$= -(1+e^{-a})\left[0 + \frac{d}{da}(e^{-a})\right]$$

$$= -(1+e^{-a})^{-2}\left(e^{-a} \cdot \frac{d}{da}(-a)\right)$$

$$= -(1+e^{-a})^{-2}\left(e^{-a} \cdot \frac{-d}{da}(a)\right)$$

$$= (1+e^{-a})^{-2}(e^{-a} \cdot (1))$$

$$= (1+e^{-a})^{-2}(e^{-a})$$

$$= \frac{e^{-a}}{(1+e^{-a})^2}$$

$$= \frac{e^{-a}}{(1+e^{-a})(1+e^{-a})}$$

$$= \frac{1}{1+e^{-a}} \cdot \frac{e^{-a}}{1+e^{-a}}$$

$$= \frac{1}{1+e^{-a}} \cdot \frac{e^{-a}+1-1}{1+e^{-a}}$$

$$= \frac{1}{1+e^{-a}} \cdot \left(\frac{1+e^{-a}}{1+e^{-a}} - \frac{1}{1+e^{-a}}\right)$$

$$= \frac{1}{1+e^{-a}} \cdot \left(1 - \frac{1}{1+e^{-a}}\right)$$

$y = \frac{1}{1+e^{-a}}$

$$\boxed{\frac{dy}{da} = y(1-y)}$$