3. $$p(\underline{v} \mid \underline{h}) = \frac{p(\underline{h}, \underline{v})}{p(\underline{h})}$$

$$p(\underline{h}, \underline{v}) = \frac{\exp(-E(\underline{v}, \underline{h}))}{Z}$$

$$E(\underline{v}, \underline{h}) = -\underline{a}^T \underline{v} - \underline{b}^T \underline{h}$$
$$- \underline{v}^T \underline{W} \underline{h}$$

$$p(\underline{v} \mid \underline{h}) = \frac{1}{p(v)} \frac{1}{Z} \times$$
$$\exp\left[\underline{a}^T \underline{v} + \underline{b}^T \underline{h} + \underline{v}^T \underline{W} \underline{h}\right]$$

$$\tilde{p} = \frac{1}{Z'} \exp\left[\underline{a}^T \underline{v} + \underline{v}^T \underline{W}\, \underline{h}\right]$$

$$= \frac{1}{Z'} \exp\left[\sum_{j=1}^{n_v} a_j v_j + \sum_{j=1}^{n_v} v_j W_{j,:} \underline{h}\right]$$

$$= \frac{1}{Z'} \prod_{j=1}^{n_v} \exp\left[a_j v_j + v_j W_{j,:} \underline{h}\right]$$

$$p(v_j = 1 \mid \underline{h}) = \frac{\tilde{p}(v_j = 1 \mid \underline{h})}{\tilde{p}(v_j = 1 \mid \underline{h}) + \tilde{p}(v_j = 0 \mid \underline{h})}$$

$$= \frac{\exp\left[a_j + W_{j,:} \underline{h}\right]}{1 + \exp\left(a_j + W_{j,:} \underline{h}\right]}$$

$$= \sigma\left(a_j + w_{j,i} \underline{h}\right)$$