G (Genotype)	P(Phenotype)	Proportion
xx	Blue	p^2
Xx	Brown	$2p(1-p)$
XX	Brown	$(1-p)^2$

$$\mathbb{P}\left(G(k)=Xx \mid P(F)=P(m)=P(K)=\text{Brown}\right) = \frac{2p}{1+2p}$$

$$= \sum_{G(m),G(F)} \mathbb{P}\left(G(k)=Xx,\ G(F),G(m) \mid \#\right)$$

$$= \sum_{G(m)G(F)} \mathbb{P}\left(P(k) \mid G(k)\right)\mathbb{P}\left(G(k) \mid G(m)G(m)\right)\mathbb{P}\left(P(F) \mid G(F)\right)\mathbb{P}\left(P(m) \mid G(m)\right)$$

$$\times \mathbb{P}\left(G(F)\right)\mathbb{P}\left(G(m)\right)$$

$$= \sum_{\{XX,Xx\}} \mathbb{P}\left(G(k)=Xx \mid G(F)G(m)\right] \cdot \mathbb{P}\left(G(F)\right)\cdot\mathbb{P}\left(G(m)\right)$$

$$\sum_{\substack{G(F)\\G(m)\\G(k)}} \mathbb{P}\left(G(k) \mid G(m),G(F)\right) \cdot \mathbb{P}\left(G(F)\right)\mathbb{P}\left(G(m)\right)$$

$\mathbb{P}(G(F))\mathbb{P}(G(m))$	G(F)	G(m)	XX	Xx	xx
$[(1-p)^2]^2$	XX	XX	1	0	0
$(1-p)^2 2p(1-p)$	XX	Xx	1/2	1/2	0
$2p(1-p)^3$	Xx	XX	1/2	1/2	0
$(2p(1-p))^2$	Xx	Xx	1/4	1/2	1/4

$$num = 2p(1-p)^3 + \tfrac{1}{2}\,4p^2(1-p)^2 = 2p(1-p)^2$$

$$den = (1-p)^4 + 2p(1-p)^3 + \tfrac{1}{4}\,4p^2(1-p)^2 + 2p(1-p)^2 = (1-p)^2 + 2p(1-p)^2$$

$$\frac{num}{den} = 2p/1+2p$$

#2)

$$X = 203,\ N \sim Geom(p = 1/100),\ \mathbb{P}(N) = p(1-p)^{N-1}$$

$$\mathbb{P}(X|N) = \frac{1}{N} I(X \le N)$$

$$\mathbb{P}(N|X) = \frac{\mathbb{P}(X|N)\,\mathbb{P}(N)}{\sum_{\tilde{N}} \mathbb{P}(X|\tilde{N})\,\mathbb{P}(\tilde{N})\,p(1-p)^{\tilde{N}-1}} = \frac{1/N\, I(N \ge X)\,(1-p)^N}{\sum_{\tilde{N}=X}^{\infty} 1/\tilde{N}\,(1-p)^{\tilde{N}}}$$