

There was a typo (N is N2) in the book. Also, it is easy to make the mistake of assuming that the births (terms multiplied by “a”) have to be subtracted from each of the compartments. **THEY DO NOT!** (The parents remain alive; it is very different from moving a person from ”susceptible” to ”infected”!)

```
> dxdt:=gamma*z - b*x + a*(x+y+z)-beta*x*y;
```

$$dxdt := \gamma z - b x + a(x + y + z) - \beta x y$$

```
> dydt:=beta*x*y-(b+alpha)*y-nu*y;
```

$$dydt := \beta x y - (b + \alpha) y - \nu y$$

```
> dzdt:=nu*y-b*z-gamma*z;
```

$$dzdt := \nu y - b z - \gamma z$$

```
> xyz:=solve({dxdt=0,dydt=0,dzdt=0},{x,y,z});
```

$$xyz := \{y = 0, z = 0, x = 0\}, \left\{ z = -\frac{\nu (ab - b^2 - b\alpha - b\nu + a\alpha + a\nu)}{\beta (ab + a\gamma + a\nu - b^2 - b\gamma - b\alpha - \alpha\gamma - b\nu)}, \right. \\ \left. y = -\frac{(ab - b^2 - b\alpha - b\nu + a\alpha + a\nu)(b + \gamma)}{\beta (ab + a\gamma + a\nu - b^2 - b\gamma - b\alpha - \alpha\gamma - b\nu)}, x = \frac{b + \alpha + \nu}{\beta} \right\}$$

```
> #now pick the actual solutions from above
> set
> x:=subs(xyz[2],x);
```

$$x := \frac{b + \alpha + \nu}{\beta}$$

```
> y:=subs(xyz[2],y);
```

$$y := -\frac{(ab - b^2 - b\alpha - b\nu + a\alpha + a\nu)(b + \gamma)}{\beta (ab + a\gamma + a\nu - b^2 - b\gamma - b\alpha - \alpha\gamma - b\nu)}$$

```
> z:=subs(xyz[2],z);
```

$$z := -\frac{\nu (ab - b^2 - b\alpha - b\nu + a\alpha + a\nu)}{\beta (ab + a\gamma + a\nu - b^2 - b\gamma - b\alpha - \alpha\gamma - b\nu)}$$

```

> #Let us check the formulas in the book (N is
> a typo, should be N2)
> N2:=alpha*(alpha+b+nu)/(beta*(alpha-r*(1+nu/(b+gamma))));

```

$$N2 := \frac{\alpha (b + \alpha + \nu)}{\beta (\alpha - r (1 + \frac{\nu}{b + \gamma}))}$$

```

> r:=a-b;

```

$$r := -b + a$$

```

> simplify(y-r*N2/alpha);

```

0

```

> simplify(z-N2*(r/alpha)*(nu/(b+gamma)));

```

0