



**Figure 6.6.** Kinetic patterns of growth and product formation in batch fermentations:  
 (a) growth-associated product formation, (b) mixed-growth-associated product formation,  
 and (c) nongrowth-associated product formation.

*Luedeking–Piret* equation. If  $\alpha = 0$ , the product is only non-growth associated, and if  $\beta = 0$ , the product would be only growth associated, and consequently  $\alpha$  would then be equal to  $Y_{P/X}$ .

Some of the concepts concerning growth rate and yield are illustrated in Example 6.1.

#### Example 6.1.

A strain of mold was grown in a batch culture on glucose and the following data were obtained.

Time (h)	Cell concentration (g/l)	Glucose concentration (g/l)
0	1.25	100
9	2.45	97
16	5.1	90.4
23	10.5	76.9
30	22	48.1
34	33	20.6
36	37.5	9.38
40	41	0.63

- a. Calculate the maximum net specific growth rate.
- b. Calculate the apparent growth yield.
- c. What maximum cell concentration could one expect if 150 g of glucose were used with the same size inoculum?

**Solution** A plot of  $\ln X$  versus  $t$  yields a slope of 0.1 h.

$$\text{a)} \mu_{\text{net}} = \frac{\ln X_2 - \ln X_1}{t_2 - t_1} = \frac{\ln 37.5 - \ln 5.1}{36 - 16} \approx 0.1 \text{ h}^{-1}$$

$$\text{b)} Y = -\frac{\Delta X}{\Delta S} = -\frac{41 - 1.25}{0.625 - 100} \approx 0.4 \text{ g cells/g substrate}$$

$$\text{c)} X_{\max} = X_0 + YS_0 = 1.25 + 0.4(150) = 60.25 \text{ g cells/l}$$