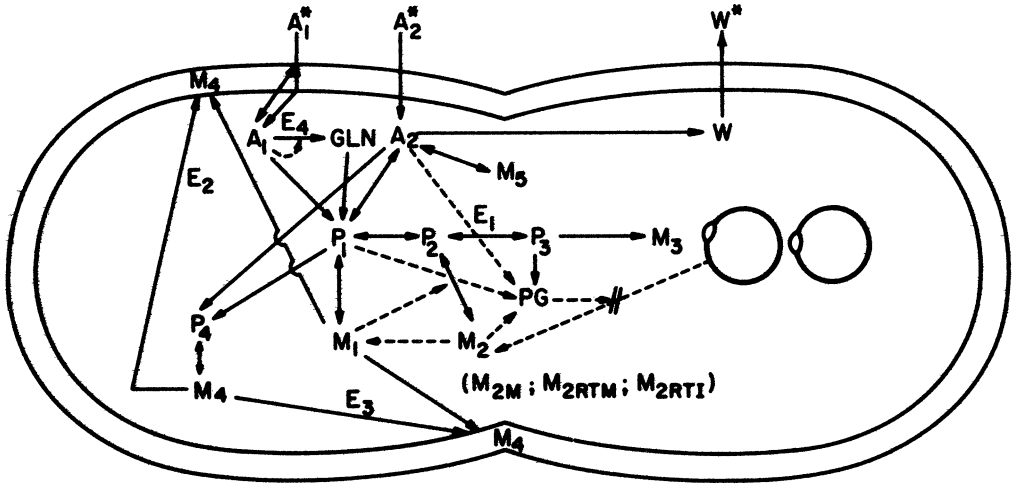

Figure 6.14. An idealized sketch of the model *E. coli* B/rA growing in a glucose–ammonium salts medium with glucose or ammonia as the limiting nutrient. At the time shown the cell has just completed a round of DNA replication and initiated cross-wall formation and a new round of DNA replication. Solid lines indicate the flow of material, while dashed lines indicate flow of information. The symbols are: A_1, ammonium ion; A_2, glucose (and associated compounds in the cell); W, waste products (CO_2, H_2O, and acetate) formed from energy metabolism during aerobic growth; P_1, amino acids; P_2, ribonucleotides; P_3, deoxyribonucleotides; P_4, cell envelope precursors; M_1, protein (both cytoplasmic and envelope); M_{2RTI}, immature "stable" RNA; M_{2RTM}, mature "stable" RNA (*r*-RNA and *t*-RNA—assume 85% *r*-RNA throughout); M_{2M}, messenger RNA; M_3, DNA; M_4, nonprotein part of cell envelope (assume 16.7% peptidoglycan, 47.6% lipid, and 35.7% polysaccharide); M_5, glycogen; PG, ppGpp; E_1, enzymes in the conversion of P_2 to P_3; E_2, E_3, molecules involved in directing cross-wall formation and cell envelope synthesis; GLN, glutamine; E_4, glutamine synthetase; * indicates that the material is present in the external environment. (With permission, from M. L. Shuler and M. M. Domach, in *Foundations of Biochemical Engineering*, H. W. Blanch, E. T. Papoutsakis, and G. Stephanopoulos, ed., ACS Symposium Series 207, American Chemical Society, Washington, DC, 1983, p. 93.)

concentrations. A second consideration, closely related to the first, is that the dilution of *intrinsic* concentration by growth must be considered.

The appropriate equation to use in a nonflow reactor is

$$\underbrace{\frac{d[V_R C_i]}{dt}}_{\substack{\text{rate of change}\\ \text{in amount of } i\\ \text{in the reactor}}} = \underbrace{V_R X}_{\substack{\text{total}\\ \text{biomass}\\ \text{in reactor}}} \times \underbrace{r_{fi}}_{\substack{\text{rate of}\\ \text{formation}\\ \text{of } i \text{ per}\\ \text{unit biomass}\\ \text{based on intrinsic}\\ \text{concentrations}}} \tag{6.60}$$

where V_R is the total volume in the reactor, X is the extrinsic biomass concentration, and C_i is the extrinsic concentration of component i.