Intestinal epithelial cell turnover (proliferation, migration, differentiation, and apoptosis) and gut barrier functions are dynamic processes that are markedly affected by nutritional status, the route of feeding, and the adequacy of specific nutrients in the diet. Emerging studies are defining potential therapeutic roles for specific nutrients and diet-derived compounds (including arginine, glutamate, glutamine, glutathione, glycine, vitamin A, zinc, and specific lipids) in gut mucosal turnover, repair, adaptation after massive bowel resection, and barrier function. The role and regulation of endogenous bowel flora in generating short-chain fatty acids from diet-derived fiber and other diet-derived compounds and the effects of these agents on gut function are increasingly being elucidated. Results of these investigations should define new nutritional methods for trophic and cytoprotective effects on the intestine in conditions such as inflammatory bowel disease, malnutrition, and short bowel syndrome.