

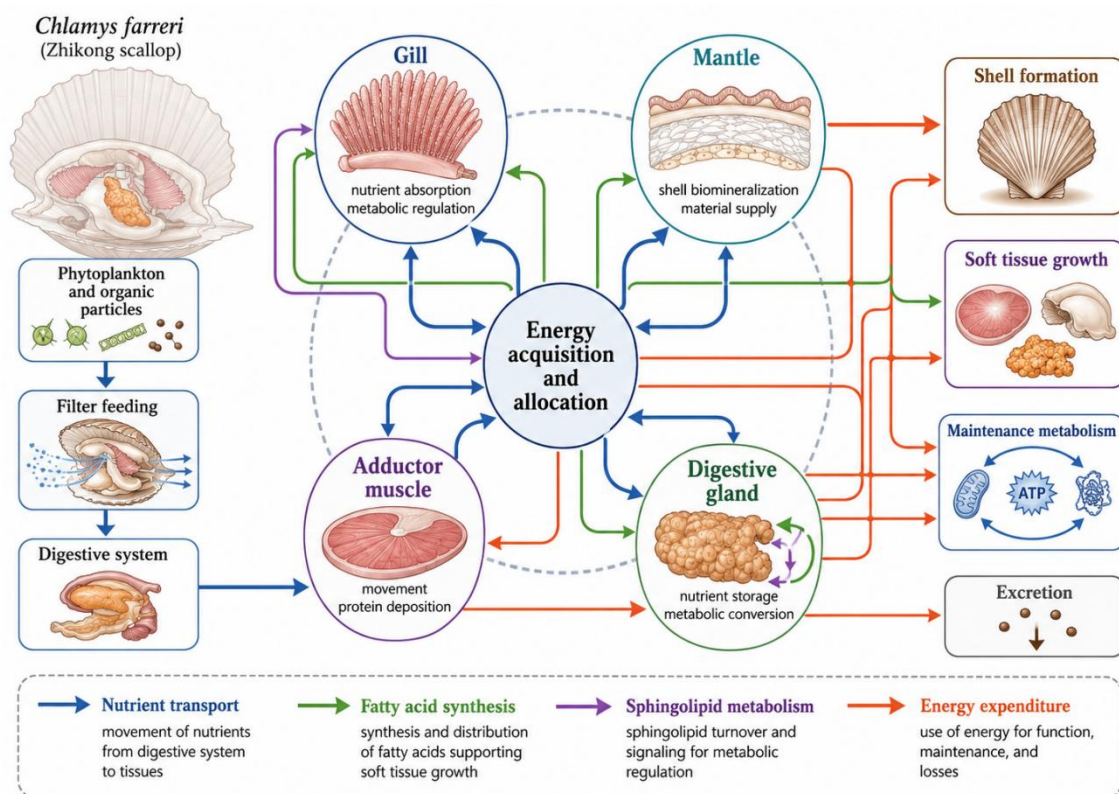


Figure 1 Conceptual model of energy acquisition, tissue-specific metabolism, and growth allocation in *Chlamys farreri*.

Energy obtained from filtration feeding is distributed among shell formation, soft tissue growth, maintenance metabolism, and excretion through coordinated functions of the gill, mantle, digestive gland, and adductor muscle

This compensatory capacity has clear limits when stress becomes acute, combined, or prolonged. Under high temperature and *Vibrio anguillarum* challenge, glycogen reserves declined rapidly, cellular energy allocation fell, and the combined stress imposed greater energetic costs than either factor alone, supporting the view that summer mortality can arise from energy being diverted from growth toward defense and repair (Wang et al., 2012). Oxygen limitation produces a similar breakdown in performance: dissolved oxygen below 4.5 mg/L reduced survival and depressed immune responses, while separate hypoxia experiments estimated an LC50 of 1.8 mg/L and linked rising mortality to disrupted metabolic homeostasis despite depressed respiration and escape-related activity (Li et al., 2019). Overall, the growth and survival of *Chlamys farreri* are governed by a tightly linked physiological system in which feeding plasticity, metabolic allocation, and stress tolerance jointly determine production outcomes. This physiological and ecological framework directly supports the study of stocking density, because density can alter food availability, metabolic demand, and exposure to thermal or hypoxic stress that ultimately shape scallop growth performance and survival.

3 Ecological Drivers of Stocking Density Variation

3.1 Interspecific and intraspecific competition

In suspended culture systems, the first ecological constraint on stocking density is competition for limited food particles within and around the culture unit. Across scallop farming studies, growth declines consistently as stocking density increases, and comparative analyses indicate that this effect is mainly driven by reduced access to suspended food rather than by density alone as an abstract crowding variable. Experimental work that separated living scallops from space-occupying dummies showed that growth fell sharply when density was increased with real animals, but not when space was filled by non-feeding dummies, demonstrating that food depletion is the principal mechanism behind density-dependent growth reduction in suspended scallop culture.