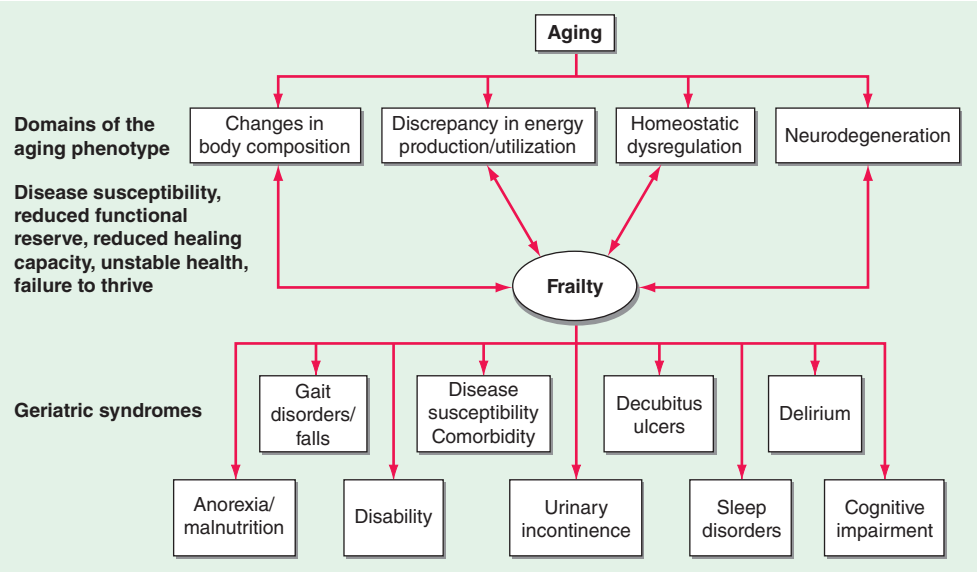

FIGURE 11-7 **A unifying model of aging, frailty, and the geriatric syndromes.**

absorptiometry, CT, or MRI. In healthy men and women in their twenties, lean body mass is, on average, 85% of body weight, with roughly 50% of lean mass represented by skeletal muscle. With aging, both the percentage of lean mass and the percentage represented by muscle decline rapidly, and these changes have important health and functional consequences.

Balance Between Energy Availability and Energy Demand Release of phosphate from ATP provides every living cell with the energy required for life. However, the storage of ATP is only enough for 6 sec; therefore, ATP is constantly resynthesized. Although ATP can be resynthesized by anaerobic glycolysis, most of the energy used in the body is generated through aerobic metabolism. Therefore, energy consumption is usually estimated indirectly by oxygen consumption (indirect calorimetry). There is currently no method to measure true "fitness," which is the maximal energy that can be produced by an organism over extended periods. Thus, fitness is estimated indirectly from peak oxygen consumption ($MVo_{2\ peak}$), often during a maximal treadmill test. Longitudinal studies have demonstrated that $MVo_{2\ peak}$ declines progressively with aging (Fig. 11-10), and the rate of decline is accelerated in persons who are sedentary and in those affected by chronic diseases.

A large portion of energy is consumed as the "resting metabolic rate" (RMR)—i.e., the amount of energy expended at rest in a neutral temperature environment and in a postabsorptive state. In healthy men and women, RMR declines with aging, and such decline is only partially explained by the parallel decline in the highly metabolically active tissues that make up lean body mass (Fig. 11-11). However, persons with unstable homeostasis due to illness require additional

TABLE 11-2 **EXAMPLES OF ASSESSMENT OF THE FOUR DOMAINS OF THE AGING PHENOTYPE**

Approach to Assessment	Body Composition	Energetics	Homeostatic Regulation	Neurodegeneration
Self-report		Self-reported questionnaires investigating physical activity, sense of fatigue/exhaustion, exercise tolerance		
Physical examination	Muscle strength testing (isometric and isokinetic) Anthropometrics (weight, height, BMI, waist circumference, arm and leg circumference, skin folds)	Performance-based tests of physical function		Objective assessment of gait, balance, reaction time, coordination Standard neurologic exam, including assessment of global cognition[a]
Laboratory values	Biomarkers (24-h creatinuria or 3-methyl-histidine)		Nutritional biomarkers (e.g., vitamins, antioxidants) Baseline levels of biomarkers and hormone levels Inflammatory markers (e.g., ESR, CRP, IL-6, TNF-α)	
Imaging	CT and MRI, DEXA	Magnetic resonance spectroscopy		MRI, fMRI, PET, and other dynamic imaging techniques
Other	Hydrostatic weighing	Resting metabolic rate Treadmill testing of oxygen consumption during walking Objective measures of physical activity (accelerometers, double-labeled water)	Stress response Response to provocative tests, such as oral glucose tolerance test, dexamethasone test, and others	Evoked potentials Electroneurography and electromyography

[a]Mini Mental State; Montreal Cognitive Assessment.

Abbreviations: BMI, body mass index; CRP, C-reactive protein; DEXA, dual-energy x-ray absorptiometry; ESR, erythrocyte sedimentation rate; fMRI, functional MRI; IL-6, interleukin 6; PET, positron emission tomography; TNFα, tumor necrosis factor α.