The Future of Nuclear Medicine at the Turn of the Century

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Nuclear medicine is able to translate the revolutionary advances in molecular biology and genetics into the care of patients. The focus is increasingly on the process of communication, reflected in in situ chemistry in all organs of the body. Nuclear medicine is able to characterize “recognition sites” that make possible communication among the cellular components of a system as complex as the living human body. Molecular messengers and receptors both on the surface and within cells control the energy supply and the enormously complex information-transfer and biochemical processes that characterize all living systems.

Structurally specific molecules, including hormones, enzymes, neurotransmitters, and cytokines, search out and bind to molecular receptors, in the process controlling the biochemistry within and on the surface of the cells. The mosaic that eventually is the picture of one’s life depends on the interactions of structurally specific molecules that can now be examined throughout the living body.

Life is maintained because atoms and molecules can recognize each other. Disease can be viewed, not as the result of something foreign invading our body, but rather as a failure of one or more of the billions of biochemical messenger systems, including those that tell cells when to divide and when to stop dividing, when to deposit lipids on the surface of blood vessels, or when and how to react to microorganisms or damaged tissue—disease as dissonance. Molecular messenger systems make possible the integration of highly specialized cells as the whole organism struggles to survive and reproduce.

Parkinson’s disease is an excellent example of how the technology of molecular nuclear medicine can characterize disease at the molecular level, and sort out the heterogeneous patients who suffer from movement disorders. Even patients with the mildest form of Parkinson’s disease have gross deficiencies of the pre-synaptic dopamine-secreting neurons that can be detected by in vivo measurements with radioligands that bind to pre-synaptic dopamine transporter molecules on the terminals of certain pre-synaptic neurons. Such molecular characterization of a disease can be used to select patients for clinical trials of pharmaceutical treatment early in the process of disease, with the hope of preventing its progression, if not reversing the underlying disease process. Not only can the in vivo chemical characterization by nuclear medicine be used to “make the diagnosis,” but can also be used to play treatment, and monitor its effectiveness in the individual patient.