

ABSTRACT

Along the evolutionary continuum, a kaleidoscope of gas exchangers has evolved from the simple cell membrane of the primeval unicells. The most momentous events in this process were: the intensification of molecular oxygen in the biosphere and its appropriation into aerobic metabolism, the rise of multicellular organisms, the development of a circulatory system and carrier pigments in blood, the advocacy of air breathing, adoption of suctional breathing, and the shift to endothermy. To satisfy species-specific needs for oxygen, some constraints were overcome through transactions that obliged certain compromises and trade-offs. Optimal designs of the gas exchangers for particular phylogenetic levels of development, habitat, and lifestyle have developed only so far as to satisfy prescribed needs. The efficiency of the human lung, for example, falls well below those of certain taxa that are considered to be relatively “less advanced.” Utilizing different resources and strategies, in fascinating processes of conformity, different groups of animals have developed similar respiratory structures. In most cases, the analogy reflects evolutionary convergence in response to corresponding selective pressures rather than common ancestry. *Anat Rec (New Anat)* 261:25–44, 2000. © 2000 Wiley-Liss, Inc.