The Nasal Turbinates

To paraphrase A. C. Huntley the nasal turbinates are a series of boney, shelf-like structures in the nasal passageway that are covered with a layer of tissue well supplied with blood, and a layer of mucous. In an adult male elephant seal, there are about 3 ½ square feet of tissue covering the nasal turbinates.

Figure 1. In a living animal these blades are covered with moist tissue.

As to heat, the cool inhaled air passes over the warm turbinates. This both warms the air and cools the turbinates. The air continues to warm as it enters the lungs. Remember the air has to come in contact with the lungs to exchange oxygen and carbon dioxide. When the seal exhales just seconds later, the body temperature air is much warmer than the turbinates, and loses much of its heat back to them. For example, Huntley found that air entering the body at 57 degrees would leave the body at 70 degrees even though it was at 96 degrees before being exhaled. It is hard to imagine this all happening with each breath, but the air is in very close contact with both the lung and turbinate surfaces as it moves.

You especially appreciate a breeze on a hot day because the moving air cools you by evaporating your perspiration. In the nasal turbinates this is part of the water conservation process. The inhaled air also evaporates moisture from the turbinates. This further cools the turbinates and adds moisture to the inhaled air. The air in the lungs is body temperature and has picked up as much moisture as it can hold. As the exhaled air reaches the cooled turbinates much of its moisture condenses onto the turbinates, just as breathing onto a cool windowpane causes moisture to condense out of your breath. This condensed water drains (post nasal drip) and is retained by the body. The seal retains about 70% of the moisture picked up by the inhaled air. If the air is cooler than the 57 degrees used in the example above, the process is even more efficient at recapturing water and heat. At the surface, a seal breathes several times a minute and this happens with each breath. When ashore, elephant seals often follow the same pattern of breathing as they do at sea; short periods of breathing followed by longer periods of apnea, this allows the turbinates to continue their efficient water conservation.

The nasal turbinates also function in olfaction (odor detection). Compared to land mammals, the heat exchange/water conservation portion of the elephant seal nasal turbinates is about 3 times larger, while the olfactory portion is about 3 times smaller. This is assumed to be an evolutionary trade-off; since the seals don't use odor to hunt, much of the turbinate process has been turned over to water and heat conservation.

The Contribution of Nasal Countercurrent Heat Exchange to Water Balance in the Northern Elephant Seal
Anthony C. Huntley, Daniel P. Costa, et. al.

Aquatic adaptations in the nose of carnivorans: evidence from the turbinates
Blaire Van Valkenburgh, et. al.