# "same" "state" Homeostasis and Organ Systems

Since life first evolved, it had to maintain itself, or, more accurately, it had to endure the present and to prevail into the future. **Homeostasis** is the combined control mechanisms of the body which "ensures that *life is regulated within a range that is not just compatible with survival but also conducive to flourishing, to a projection of life into the future of an organism or a species.*"<sup>1</sup> This means that all organisms since bacteria are actively engaged in staying alive, and in becoming better at staying alive. This is the source of evolution, changing through time to become better at living, by producing more offspring that continue to change.

For the first 3 billion years of life on Earth, it was microscopic, consisting of bacteria, archea, and for the last billion years, the first eukaryotes. It was these late comers who evolved to be bigger. The bacteria and archea were restricted to being microscopic because when they doubled their length, or diameter, their surface area would increase in two dimensions, height and width. The volume, meanwhile, would increase in all three dimensions, height, width and length, growing faster than the surface area. This results in the **surface-area-to- volume-ratio** decreasing (see the Surface Area:Volume Ratio notes). Eukaryotes have evolved many strategies to change the SA/V ratio to allow them to overcome its constraints on size. They evolved double-membrane organelles like vacuoles and cytosomes to store chemicals required for metabolism, allowing them to not rely solely on transport across cell membranes. For animals, the most significant development is organ systems, which allows them to break the size constraint that kept the other organisms small by effectively delivering the chemicals of life to every cell of the body. In animals, the organ systems ensure that life endures and prevails by supporting the **secondary functions** for animal life.

Recall when we studied bacteria, that all life needs to maintain the self, and maintain the species. These two functions are the **primary functions**, requiring the first control mechanisms of homeostasis to evolve and apply to all life. The first primary function, to maintain the self, is supported by secondary functions that may differ between the Domains and Kingdoms of life. In animals, to maintain the self, we must:

- 1. Protect the self from external assaults and internal assaults.
- 2. Eat food and breath oxygen to provide energy; circulate the food and energy throughout the body; and remove the metabolic wastes from the body.
- 3. Be able to move from place to place to find food.
- 4. Coordinate our movements to increase the likelihood of finding food; and coordinate the growth resulting from getting food.

<sup>&</sup>lt;sup>1</sup> The Strange Order of Things: life, feeling, and the making of cultures, Antonio Damasio (Pantheon Books, 2018) p 25.

A fifth secondary function supports the second **primary function**, maintain the species. That is all animals must:

5. Reproduce, sexually and or asexually.

So, we have five secondary functions supporting the two primary functions. The organ systems evolved as animals became larger and inhabited more ecosystems. Vertebrates, who comprise the largest animals to have ever lived, have **eleven organ systems**. The following lists the organ systems by primary function and secondary function. If interested, this format will make it easier to memorize your organ systems. Primary functions are in **red**, secondary functions are in green and organ systems are in blue.

# I. Maintain the Individual

# i. Protection

- 1. INTEGUMENTARY SYSTEM consists of the outer surface of the animal, the integument, whether it is skin, cuticle or shell, and all the accompanying organs, such as hair, feathers, glands, spines, etc. It protects the organisms from external environmental and biological assaults.
- 2. IMMUNE SYSTEM all cells, cell products and organs, like white blood cells, antibodies and lymph nodes, engaged in defending the body from internal assaults from parasites and pathogens.
- ii. General Digestion and Absorption of Nutrients
  - 3. DIGESTIVE SYSTEM the structures and organs involved in physically or chemically breaking down other organisms into chemicals for energy, growth and maintenance of the body, and ridding the body of undigested waste (feces).
  - 4. RESPIRATORY SYSTEM the structures and organs, including lungs and gills, associated in obtaining oxygen for the body so it can be used in reactions to provide energy for metabolic purposes, growth and maintenance. It also removes carbon dioxide waste from the body.
  - 5. CARDIOVASCULAR SYSTEM the structures and organs, including hearts, blood sinuses and blood vessels, that circulate fluids throughout the body to deliver the chemicals from digestion and oxygen from respiration to all the cells of the body for metabolism, growth and maintenance. It also removes the wastes from cellular metabolism and transports them to organs for removal from the body.
  - 6. EXCRETORY SYSTEM also called the urinary system, consists of filtering organs, like kidneys, that filters cellular wastes from the blood and excretes them from the body. Also regulates the fluid level, or hydration, and salt content of the body, sometimes involving bladders.

### iii. Locomotion - moving from place to place

- 7. SKELETAL SYSTEM consists of structures that provide support for the body, including collagen, mesoglea, calcium carbonate shells, bones and cuticles. Also provides attachment points for muscles aiding locomotion.
- 8. MUSCULAR SYSTEM consists of contractile fibres or bundles of fibres, like muscles, that attach to support elements in the body providing movement from place to place and in manipulating the body within the environment.

### iv. Coordination - coordinates the body in space and the organism in life

- 9. NERVOUS SYSTEM consists of cells capable of transmitting electrochemical signals, neurons, from sensory organs to muscles and may be mediated by larger collections of neurons forming ganglia or brains to coordinate the successful movement of the body. Patterns of neuron firing may be stored for future action. Also receives information from the body systems to ensure everything is working properly. It is very important in maintaining homeostasis.
- 10. ENDOCRINE SYSTEM consists of hormone producing cells and organs that control body rhythms including stages of body development, circadian rhythm, stress response, social attachment and the fear and flight response. (Hormones are chemicals produced in one part of the body but affect another part, such as testosterone which causes human males to grow beards.)

### **II. Maintain the Species**

### v. Reproduce sexually, asexually or both

11. REPRODUCTIVE SYSTEM – consists of organs responsible for producing sperm or eggs and the accessory organs responsible for delivering them to a place where they may combine, whether internally or externally. Not all members of a species need to be reproductive. Therefore, it is the only system that may be harmed with little noticeable physical affect on the individual.

Two primary functions, supported by five secondary functions, performed by up to eleven organ systems.

Not all animals have all the organ systems. As you watch *the Shape of Life* episodes, note when a body system makes an appearance in a phylum. Also note that this list of organ systems is completely inappropriate for the Echinodermata, our closest relative among the animals featured in the episodes. They are truly the most bizarre of all the animals.