

## Integrative Medicine Research

journal homepage: [www.imr-journal.com](http://www.imr-journal.com)

## Hypothesis

## The five elements of the cell

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## ARTICLE INFO

## Article history:

Received 18 August 2017

Received in revised form

29 September 2017

Accepted 12 October 2017

Available online 18 October 2017

## Keywords:

Cellular organelles

Five elements

Human organs

## ABSTRACT

Everything in the surrounding universe can be attributed into five elements. Human organs can be also linked to the five elements. Cells, the smallest unit of the human body, consist of cellular organelles as little organs. Here, we extended the concept of the five elements to a cellular level via the human organs, theoretically re-evaluating the overall association of cellular organelles in maintaining the homeostasis of cellular functions.

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## 1. Introduction

Similar to how Greek philosophers have discussed the origin of all things in the universe, ancient philosophers in China also debated on how the origin and consequence of all things can be explained and cycled. They postulated that the universe is composed of five fundamental elements, and then they developed the theory of how the universe was created and it undergoes a cycling process. The ‘five elements theory’ not only defines the character of each element, but also emphasizes the mutual interaction and rotation of the elements under an interactive system.

The five elements (五行), or five phases, are orderly classified by five materials as follows: wood, fire, earth, metal, and water.<sup>1</sup> Each element has its own literal and philosophical

meaning. The wood-type is represented by a tree that grows straight and is abundantly spreading out. The fire-type is represented by a state of combustion that generates heat. It is likely that the earth-type will establish a foothold to newly change an outdated system. The metal-type is represented by the formation of hard crystal. Lastly, the water-type is represented by a stream that seems to run out of a solid melting.<sup>1–5</sup> The attributions of each element in itself do not reveal their identities, but rather, reveal their color when under reciprocal interaction. There are two flows among the five elements, i.e., the mutual nourishment cycle (相生) and mutual restrain cycle (相剋), which have organically positive or negative influences on each other.<sup>5,6</sup>

## 1.1. The characteristics of the five elements

On the concept of five elements, everything, including forms

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<https://doi.org/10.1016/j.imr.2017.10.002>

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of matter or even spirit, can be classified, and arranged into each of the five elements. Following the examples of the five phases, either the features or the appearance of all things can be used to categorize them into their own unique five phases. In terms of shape, the wood-type appears as long sticks, fire-type is symbolized by an inverted triangle, earth-type stands for wide ground, metal-type describes images of sharp edge, and water-type depicts the shape of a running stream. In addition to shapes, color is also applied to the five phases. Blue is a symbol of the wood-type; red is representative of the fire-type; yellow represents feeling comfortable and symbolizes soil, not only fostering but also supporting, the earth-type; white is the metal-type color of polished iron and silver; and black, which represents the ability to hide, is associated with the water-type.<sup>1,5</sup>

### 1.2. The practical application of the five elements

Doctors who practice traditional Chinese medicine (TCM) have put the five elements theory into practice, extending it to clinical practice as a form of five element acupuncture (FEA), which was introduced by a British acupuncturist, Dr J.R. Worsley.<sup>7</sup> FEA is now a popular alternative treatment worldwide, including in Europe, Australia, and the United States. According to Dr Worsley, human bodies are composed of a combination of the five elements.<sup>7</sup> A deficiency among the five elements are thought to cause illness. Thus, practitioners diagnose the deficient elements in the patients and treat illness by supplying the deficiency using FEA.<sup>8,9</sup> There is also another FEA method, called Sa-Ahm acupuncture, in Korea. In Sa-Ahm acupuncture is applied on points called Five-Shu (五輸), which is five flows of qi (氣) divided by five elements at limb distal part below elbow or knee joint.<sup>10</sup> Thus, even if there are differences among countries, the five elements theory can be practically applied to alternative medicine in the worldwide.

### 1.3. The five elements and human organs

Prior to the introduction of functional organs under anatomical system, TCM had already established the human organic system, applying the above concept to human organs, consequently categorizing human organs according to the five elements, during China's Warring States Period (770–221 bc). The classical book of Huangdi Neijing (also called the Inner Classic of the Yellow Emperor) connected each organ to five elements linked to natural phenomena, particularly weather; however, they lacked an explanation for causal relationships.<sup>11,12</sup> Although it is still ideological theory, which is yet to be proven, TCM has developed this theory and applied it to functional organs and anatomical systems. TCM divides the human organic system into five organs, i.e., the liver, heart, pancreas (including spleen), lung, and kidney, which correspond to wood-, fire-, earth-, metal-, and water-type, respectively. The liver plays a role as the first of the five-phase cycle, supplying energy originating from glucose, fatty acids, and amino acids to the whole body, and even converting extra energy to glycogen storage, hormones, and proteins. Oriental medicine refers to the heart as the ruler of the human body, circulating blood, oxygen, nutrients, and waste. It is tied to the impression of furious flames. The pancreas is part of the diges-

tive system. It produces insulin, which induces target cells to absorb glucose as an energy source that supplies the body. This function has been likened to that of the earth-type, which fosters crops. As the lid of the body, the lung is a respiratory organ for breathing, or the exchange of gas. The exchange of carbon dioxide and oxygen occurs in the lung, giving it metal-type attributes. Finally, the kidney plays a role in filtering the body's waste for removal and producing urine. Water, excreted from the kidney is reminiscent of the flow of a river; therefore, the kidney has a water-type attribute.

### 1.4. The five elements and cellular organelles

The cell is functionally and structurally the smallest unit of the human body. By maintaining communication between extracellular and intracellular environments, cellular organelles perform the diverse functions required for cells to grow, divide, synthesize, package, and survive. The cellular organelles include the endoplasmic reticulum (ER), Golgi apparatus (GA), mitochondria, lysosome, and plasma membrane (PM), which envelopes the cell. Considering the concept of the fractal theory, i.e., typical self-similar patterns, cellular organelles may correspond to human organs. Thus, it then follows that cellular organelles can be classified as little organs.<sup>13</sup> As explained above, since the five organs can be based on five phases, this can also be applied to the five cellular organelles. This means that human cellular organelles can also be orderly divided into five parts, where the ER, GA, lysosome (including vacuoles), mitochondria, and PM, correspond to wood-, fire-, earth-, metal-, and water-type, respectively. The ER is composed of three kinds of structural forms: cisternae, vesicles, and tubules. The ER can be structurally and functionally divided into the rough ER and smooth ER. The rough ER is involved in the synthesis of protein due to the many ribosomes lining its inside, while the smooth ER is involved in lipid, glyco-gen, and steroid synthesis.<sup>14,15</sup> Thus, the main function of the ER is synthesis. Proteins that are synthesized at the ER are modified to direct them to their destinations. Like packaging in the post office, the GA acts as a central transport system and plays an important role in modifying, sorting, and packaging macromolecules for transportation. Each molecule cannot perform its functions until it has matured at the GA.<sup>16</sup> Although each molecule completes its function at its destination, the by-products that are generated by metabolic processes need to be eventually recycled or removed. As the cellular digestive organelle, the lysosome contains hydrolase enzymes in its acidic compartment that can digest metabolic products or waste. In addition to the lysosome, vacuoles are also able to help process cellular waste. The function of vacuoles is to contain waste or water to isolate harmful contents from the cell. Like the lysosome, some vacuoles also have digestive function through maintaining an acidic internal pH and containing hydrolytic contents.<sup>17,18</sup> Mitochondria provide the cell with energy (i.e., adenosine triphosphate) via oxidative respiratory phosphorylation, using oxygen, to carry out diverse metabolic tasks, such as apoptosis, calcium signaling, cellular metabolism, etc.<sup>19,20</sup> Finally, the PM, acts as a selective filter, and separates the internal part of cell from the outer environment. It selectively transports ions, inorganic, and organic molecules through the membrane. The

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