

The Cytoplasm of a Cell and the Courtyard of a Siheyuan

I-Wen Lin

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Rule to Build:

"A public shared space is present in order to allow interactions and synchronization between different compartments."

What:

There are some similarities between the design and function of the Siheyuan's courtyard and the cytoplasm of a cell. The cytoplasm of an eukaryotic cell is the gel-like substance that fills the space within the membrane and outside of the nucleus (Alberts et al., 2009). A Siheyuan is a historic architecture in China and Taiwan. It is a Chinese quadrangle that has four side-wing houses, which enclose a courtyard (Siheyuan Culture).

How:

The space within an eukaryotic cell membrane and outside of the nucleus is occupied by the gel-like material called cytoplasm (Figure 1). There are a few functions of the cytoplasm: a) supports the cell's structure, b) contains and holds different cell compartments together, c) provides paths for molecules traveling, d) serves as a medium for biochemical reactions to occur (Alberts et al., 2009). The shape of the cell is maintained by the cytoplasm, which takes up most of the cell's space – approximately 70% of the cell's space and 70% of its volume is contributed to the water (Wikipedia). When the water concentration across the cell membrane alters, the volume of cytoplasm also changes. In a hypotonic environment, the water will enter the cell and the cell will enlarge or even burst. In a hypertonic environment, the water will leave the cell and the cell will shrink (Helmenstine, n.d.). In addition, the gel-like cytoplasm functions as the medium for all the organelles, various cell compartments, other cell-essential molecules, and so on. It contains, stores, and holds the suspensions together, providing connection between different parts of the cell (Nair, n.d.) (Figure 2). The jelly like fluid links various organelles to each other, offering spaces for interactions between cellular compartments and paths for transporting molecules around the cell. The cytoplasm consists about 70% of water that helps to deliver substances within the cell. Different enzymes, salts, sugars, amino acids, ions, and other small molecules are found and dissolved in the cytoplasm. Organic molecules or biological messages must travel through the cytoplasm in order to reach other parts of the cell (Gorlich and Kutay, 1999). For example, after a ligand binds to membrane receptor, a signaling pathway occurs in the cytoplasm and transmits the message down to the destined cell compartment (Alberts et al., 2009). One of the most important aspects of the cytoplasm is that this is the place that most cellular activities occur. The organelles and other cell-essential materials all suspend in the cytoplasm, making this gel-like fluid a perfect place for biochemical reactions to take place. 70% of the cytoplasm is made up by water – the universal solution, allowing different molecules/macromolecules that are vital for cell living to dissolve and float around in the cytoplasm (Gorlich and Kutay, 1999). The enzymes in the cytoplasm help to break down larger materials into smaller molecules for further use. Naturally, cytoplasm becomes the best place for metabolic reactions to happen (Nair, n.d.). For example, the process of breaking down glucose into pyruvate molecules and releasing energy is called glycolysis, which occurs in the cytoplasm of the cell. Many preparatory works of molecules in order for further use by different cell compartments also occur in the cytoplasm. After breaking into smaller pyruvates, these smaller sugar molecules then can be taken by the mitochondria for generating energy by the citric acid cycle (Alberts et al., 2009). Overall, the cytoplasm is the supportive and binding medium for a cell.

The Siheyuan's courtyard, just like the cytoplasm, is surrounded by four side houses, each performing like the cell membrane that draws out the boundary of inner and outer cell (Figure 3). The courtyard takes up most of the area of the Siheyuan, providing a basic square shape for the Chinese quadrangle (Beijing's Siheyuan). When the

environmental condition changes, the size and shape of the courtyard house will also vary. The amount of sunlight, for example, is inadequate in the north. Therefore, the courtyard is square and spacy in order to absorb more sunshine. However, in the south where the daylight is strong, the courtyard becomes narrow and elongated to reduce the amount of sunlight (Beijing's Siheyuan). The housing structure of the Siheyuan is divided into various departments – the northern-wing house, the eastern-wing house, the western-wing house, and the southern gate. All the side rooms have their doors facing toward the courtyard (Lo, 2010) (Figure 4). People have to cross the courtyard in order to travel from one place to another compartment. The courtyard allows people from various houses to interact and coordinate with each other (Lo, 2010). Many activities such as watching shows and viewing the garden are hold in the courtyard, involving and connecting family members together. Also, housework such as preparing food or washing clothes is done in the courtyard. The finished items are then sent to the specific rooms.

Why:

The principle of the need of a public shared space is upheld within an eukaryotic cell. The presence of the cytoplasm gives the cell some advantages that keep this type of organisms in the evolutionary history. First, by being the medium that hold all its suspension together, the cytoplasm supports the interior cell structure and maintains the basic shape of the cell. Without this cushioning liquid, the cell loses its inside organization and consistency easily (Nair, 2010). Second, the 70% of water in the cytoplasm enhances the transportation between different compartments. The gel-like fluid helps molecules to travel efficiently within the cell membrane so important materials can deliver to destined cellular sections and exchange between organelles. This advantage allows different cellular compartments support and “communicate” with each other, assuring that the cell obtains what it needs and is in its optimal condition (Gorlich and Kutay, 1999). Third, the cytoplasm is the public mutual area that all organelles have access to and it contains many cell-essential materials (such as enzymes) in dissolved forms. Therefore, it is easier and more effective for biochemical activities to occur in here. And when the cellular reactions are done, the products can be taken by specific organelles that suspend in the cytoplasm. This design of cytoplasm allows the metabolic activities within the cell to work most efficiently and naturally (Nair, 2010).

The history of Siheyuan can be traced back to 3000 years ago. It originates from the Zhou Dynasty of ancient China and has evolved to the perfection in the Yuan Dynasty (Lo,2010). The design of the Chinese quadrangle is meant to suit the standards of daily life and harmony with the nature (Lo, 2010). All the side houses face the courtyard so every family member has easy access to the yard and to other people. Also, the courtyard is often designed into garden with flowers and trees, resembling the heaven, the earth, and the nature. The courtyard of Siheyuan has evolved that it not only enhances the convenience of daily life but also enriches the inner peace of the residents (Lo, 2010).

Figures:

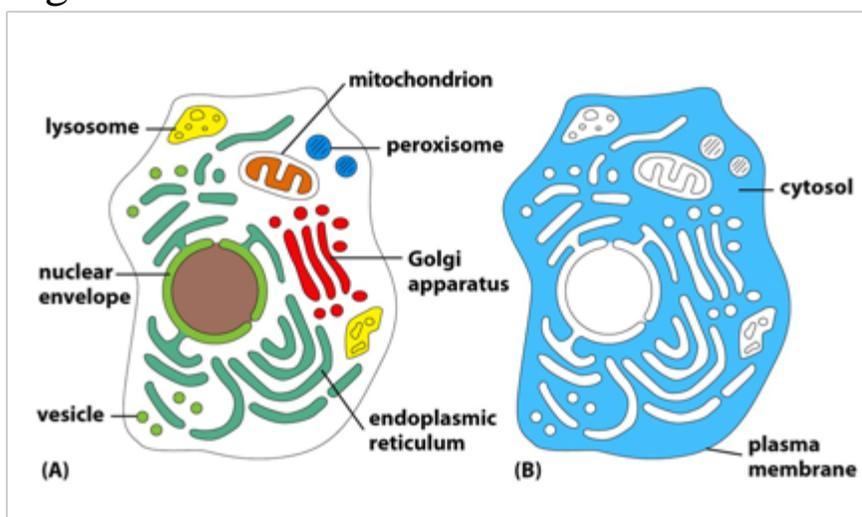


Figure 1: The cytoplasm (cytosol) occupies the space within the plasma membrane and outside of the nucleus (the blue part in 1B). It serves as the medium for all organelles and other molecules (Alberts et al., 2009, figure 1-24).



Figure 2: The cytoplasm is filled with organelles, proteins, and other cell-essential molecules (Alberts et al., 2009, figure 1-26).

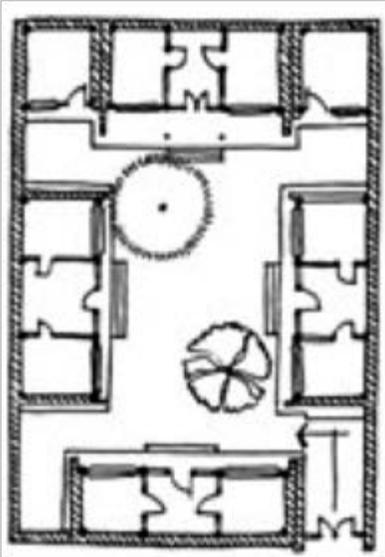


Figure 3: A floor plan of a Siheyuan (Adapturbia at <http://adapturbia.files.wordpress.com/2012/09/siheyuan-joshua-metz.png>)

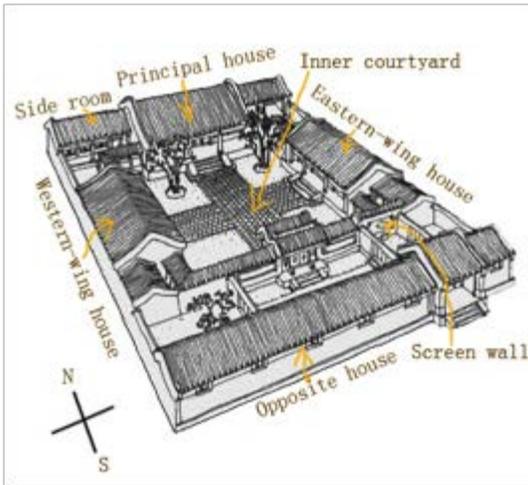


Figure 4: A sketch image of a Siheyuan (China Tour at http://www.chinatourguide.com/beijing/Siheyuan_Culture.html)

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