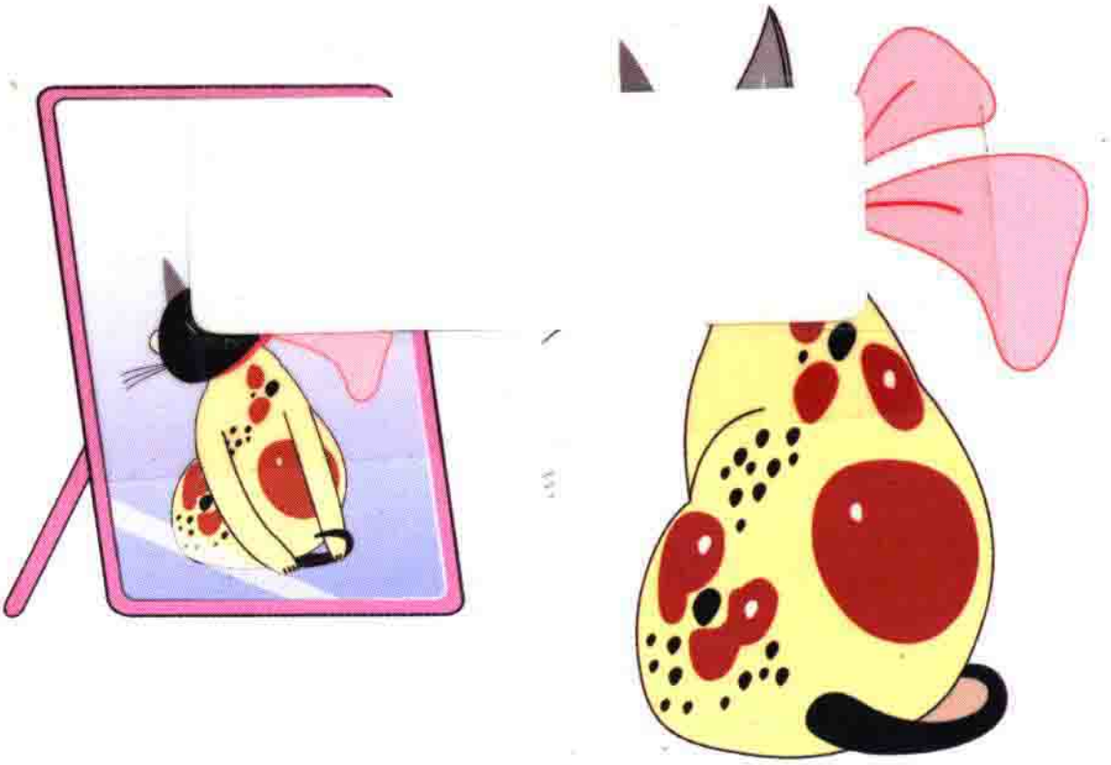
汉字生理学

PhySinology — Physiology in Sino characters

主　编　Cheng Hwee Ming〔大马〕　林　丽

副主编　徐锡明



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内 容 简 介

本书采集了54个汉字(词),用原创性、趣味性"字形"图,描绘了其生理学含义;并且,用简单易懂、活泼风趣的英语,诠释了其中包涵的生理学核心知识。本书的特色在于将汉字的字形结构与生命功能完美结合,从专业的角度为医学生解读生理学知识,并从科普的角度为公众解读生命科学的基本知识,是一本富有中国文化气息的原创性、知识性和趣味性读物。

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汉字生理学

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FOREWORD

It has been a satisfying project to co-write this book which has a title with a newly-coined word 'Phy*Sino*logy'. This word was birthed by the fusion of 'Physiology' and '*Sino*' (meaning Chinese). Written in a popular style, this book is useful for all students of Physiology as well as the reading public who has some basic appreciation of human biology or Physiology.

The purpose of 'Phy*Sino*logy' is to tap the richness and creative diversity of the Chinese language characters to explain some key aspects of Physiology and to make learning this medical science enjoyable.

My pleasure in completing this book has to do with my personal and educational background. My historical roots are in China. My father came over to Malaysia from Fukien Province, China in the 1930's. I was born a year just after Malaysia obtained Independence from England in 1957. My ed-

ucation was in English-medium school system, inherited from the British who ruled the country for a period after the Second World War. As such, unlike my parents, I do not read and write Chinese, although I speak a smattering of conversational Mandarin.

My academic connection with medical schools in China was an offshoot of the annual Inter-Medical School Physiology Quiz (IMSPQ) I initiated in 2003. This year at the 12th IMSPQ, we expect 90 medical school teams from 23 countries. The Second Military Medical University (SMMU) is a regular participant since the first appearance at the 7th IMSPQ in 2009. My co-author Dr. Li LIN accompanied the SMMU Team at the 10th IMSPQ in 2012.

I have had the privilege of teaching Physiology (in English obviously!) to medical students in Shanghai at Tongji University, also a consistent presence at each IMSPQ since 2010.

The idea of writing and describing major Physiology terms, integrated with insights and inference from the components/strokes of the Chinese characters/ideograms, was thus a natural progression to combine my interest in language, my specialty in Physiology and my Chineseness!

From Fukien to Shanghai, this 'Phy*Sino*logy'

book is the product of a 50 + yr personal and academic journey.

Dr. Li LIN was most enthusiastic when I first approached her with the concept of writing this 'Phy*Sino*logy'. Xi-Ming, our co-author was one of the prize winners at the 10th IMSPQ.

I hope readers will enjoy this book and also share the 'phy*Sino*logic' knowledge with their friends.

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Chapter 1 Cell and General Physiology

1.1 生理学 (Physiology)

The Chinese word '生理学' corresponds to the English word 'Physiology'. It is not just a literal translation of the word Physiology, but a perfect interpretation of the sciences of Physiology. In Chinese, 生 means life, 理 means logic, and 学 means science. In that way, '生理学' makes the meaning of 'science for the logic of life', which is really the essence of Physiology, and coincidently matches the title of a physiology book 'Logic of Life: the Challenge of Integrative Physiology' published by Boyd and Noble in 1993.

The human body is a wonderfully designed organi-

sm. The body is not merely a random collection of cells. Walter Cannon (1871—1945), Professor of Physiology at Harvard Medical School used the description the 'Wisdom of the Body'.

The many different organ systems have their own unique special roles in a healthy body. In addition, there are collaborative interactions between different organs to serve the needs of the body and to meet the stresses that challenge the body. Even exercising is a demand on the body e.g. for increased blood flow and increased CO_2 removal from the body. Interactively, the lungs and the kidneys complement each other in the regulation of body fluid and blood pH. Our brain neurons are sensitive to pH so the surrounding medium of the cells is sensitively maintained at optimal physiological pH. Since our heads are above our hearts and humans spend most of their waking hours in the upright posture, there is a need to maintain a normal arterial blood pressure to ensure normal cerebral blood flow. Both the heart and the kidneys respond to blood volume/pressure changes. Arterial baroreceptors and intra-renal baroreceptors respectively are activated when blood volume/pressure is reduced.

Nerves and hormones physiologically participate in homeostasis. There are also neuro-endocrinological pathways that provide focused responses to particular

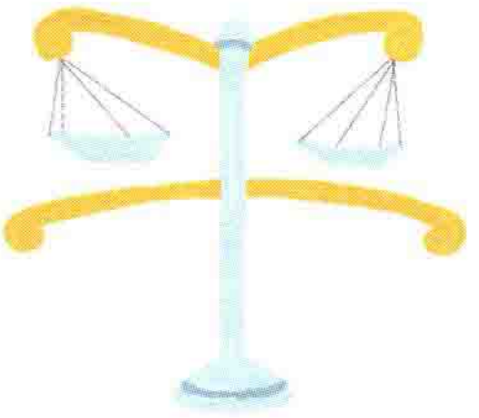
events in a person's body. When a person is being born during his mother's labor birth pangs, neuroendocrine reflexes from the uterus to the brain release a neuro-hormone called oxytocin that potentiate the uterine contractions during parturition.

The sympathetic nerves to the kidneys stimulate secretion of a hormone, renin that enables the kidneys to conserve sodium, the major cation in the extracellular fluid in sodium homeostasis. In water balance control, the neuro-hormone vasopressin that is synthesized by hypothalamic neurons is secreted either more or less depending on sensory afferent signals arriving from arterial baro-receptors and volume receptors in the heart and pulmonary vasculature.

There is much logic and coherence in the wise and elegant functional design of the body. When we exercise, the metabolic changes in the muscles all appropriately have vaso-dilatory effects. This obviously helps to sustain the increased blood perfusion to the exercising muscles. Tissue hypoxia, increased local CO_2, local hyperkalemia and muscle acidity all relax the vascular smooth muscle of the arterioles that supply the muscles. This is not just a good coincidence but what I see as a 'meta-physiological' wonder of the human body.

1.2 平衡 (homeostasis)

A major key concept in understanding Physiology is the word 'homeostasis', which was coined by Walter Cannon in the 20th century. Just as '平' is very symmetrical and stable in structure, 'homeostasis' refers to stability and constancy in physiological activities. 'Homeostasis' was first conceptualized by the French physiologist Claude Bernard (1813—1878). Dr. Bernard talked about the 'constancy of the internal environment' of cells. This is the extra-cellular fluid (ECF) which includes the blood and the interstitial fluid which is between the vascular compartment and the cells.



As a non-Mandarin educated Chinese physiologist in Malaysia, the two sets of characters that share identical components which mean homeostasis and sense of equilibrium visually interest me. Indeed, homeostasis is about balance and maintaining a normal physiological milieu for cells to function optimally.

In Physiology we talk of a variety of regula-

tions as acting for sodium balance, water balance, potassium balance, calcium balance, pH balance. For example calcium homeostasis or balance is achieved by a variety of hormones, including parathyroid hormones, vitamin D and calcitonin. Three main organs are involved in calcium balance, the intestines, the bones and the kidneys. Calcium concentration is kept low in the ECF/blood, ~2.5 mmol/L. The imbalance of calcium will lead to patho-physiologic events. In hypo-calcemia, abnormal increase excitability of nerve and muscle can result in a hypo-calcemic tetany. If this muscle spasm affects the respiratory muscles, it obviously can suffocate the person.

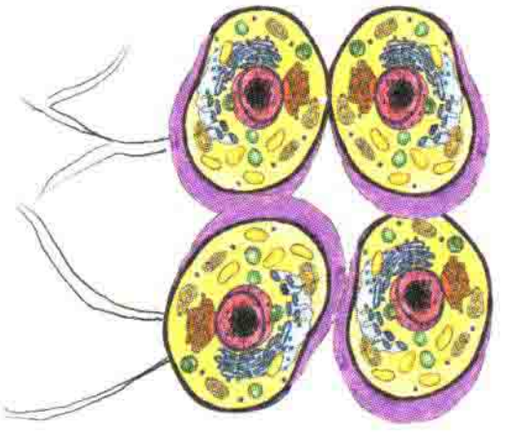
Potassium balance is equally essential especially as ECF potassium affects heart functions. Potassium is carefully controlled and maintained at around 4.5 mmol/L. Elevated potassium in the ECF/blood (hyper-kalemia) can lead to inactivation of sodium channels in cardiac cells that are critical for action potential generations. The heart can stop beating if the hyper-kalemia is not treated.

The pH balance or regulation is also an amazing characteristic of normal Physiology. The normal pH of ECF at 7.4 is equivalent to 40 nano-Moles/L of hydrogen ions. A nanoMole is 10^{-9} of a mole. The neurons especially are sensitive to pH

and acidic coma is a condition that can occur for example in uncontrolled diabetes mellitus. On a normal diet, we add to our bodies daily a large surplus of acid in the range of moles of H^+. The normal pH of 7.4 is efficiently defended by three levels of control. There is the first line immediate buffering by chemical buffers in the ECF as well as intracellular buffering. The lungs remove the major acid input produced daily by metabolism, carbonic acid. Finally, the kidneys can excrete all the non-carbonic acids by secreting hydrogen ions. The kidneys also replace the main chemical buffer component, bicarbonate that is consumed by initial acid neutralization. The normal urine is generally acidic.

1.3 细胞 (cell)

A cell is the most basic functional unit of a body. The right component of '细' looks like a 'closed' cell with four parts, which represent multiple subcellular organelles. In contrast, the right component of '胞' looks like a 'half-open' cell with



'antenna' and 'pseudopodium', which represent active intercellular communications.

Every cell has a boundary cell membrane, a nucleus, the cytoplasm and organelles within the cytoplasm (like mitochondria, Golgi bodies, lysosomes). A single cell organism has direct contact with its environment to support its relatively simple cell functions. For a multicellular organism, there is now a need to ensure that cells that are not in direct contact with atmospheric oxygen are supplied with the gas needed for cell metabolism. The blood circulatory system in concert with the respiratory system serve this essential physiology.

The left zigzag component of '细' indicates that every cell respond to various stimuli that regulate its function. Some of these stimuli are circulating hormones, released from endocrine glands and reach the target cells via the blood communicative stream. All cells have receptors that bind and respond to these diverse stimuli. Some receptors are present on the cell membranes. Other receptors are present inside the cytoplasm and lipid-soluble steroid hormones pass through the cell membrane and bind to cytosolic receptors.

The function of specific cells are also 'electrically zapped' or innervated by nerves. The gastric