Me and My Hormone:

What Can Go Wrong?

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By

May Ng

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To my parents– your unconditional love and support has made me the person that I am today. All that you have instilled in me has led me to many achievements in this lifetime. Thank you and I love you forever.

To my children Brendan, Darren, Corinne– you are my greatest joy and I love you to infinity and beyond.

To my husband Eugene– I choose us.

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ENDORSEMENTS

"An excellent narrative and scientifically impeccable explanation around a complicated subject area that will be very useful to parents, children and young people during their formative years. Highly recommended reading."
—Professor Partha Kar, Consultant Endocrinologist and National Specialty Advisor for NHS England, United Kingdom

"Professor Ng explains the complex science of the endocrine system and hormonal conditions in a clear approach. This book is one of the best out there and is packed with information intended for teenagers, parents, students and professionals."
—James Armstrong, medical student, United Kingdom

"This book written by Professor May Ng is incredibly concise and delightfully readable for parents, teenagers, students and health professionals. Aptly entitled "*Me and My Hormone*" it provides bite-sized information for readers who wish to learn all about how hormones can affect our growth, puberty, health and well-being."
—Professor Ngee Lek, Consultant Paediatric Endocrinologist, Singapore

"May Ng has managed to break down yet more barriers with her 2nd book! As a nurse at the beginning of my specialist career, this book is an excellent, simple, yet informative read all about hormones. This book will become an invaluable resource not only to myself and other practitioners, but also to patients and their families -it's a must-have book!"
—Nicola Slilem, Paediatric Nurse, United Kingdom.

"This informative book provides a simple easy-to-read approach to a complex topic, and the general reader will satisfy a basic curiosity about hormones of the human body and management of hormonal disorders."
—Professor Wan Ariffin, Professor of Paediatrics, Malaysia

"This wonderful book is essential reading for many families, adolescents and young people who may experience hormonal issues but were afraid to ask. I wished I had this book when my son was diagnosed with hormone deficiency."
—Jodi Miller, parent of Josh age 6, United Kingdom

"A very useful book for parents and families with lots of information about how hormones being out of balance can affect growth, puberty and our health. This book should be a blueprint for all readers interested in this topic."
—Mrs Jane Donner, parent of Amy age 14, United Kingdom

"Professor May Ng brings a clear voice to the often confusing medically jargoned body of information surrounding hormones and provides a practical comprehensive resource to understand how hormones can impact all aspects of your health."
—Dr Jarod Wong, Consultant Paediatric Endocrinologist, Glasgow, United Kingdom

"An explanation of hormone disorders that is easy-to-read, from short stature, early and delayed puberty to thyroid, pituitary and adrenal disorders- a must read and fascinating book which describes different hormonal conditions from birth to adulthood, highly recommended for many who want to know more about hormonal issues."
—17-year-old Amy Stewart, United Kingdom

"A clearly written, easily accessible and thorough book on the role of the endocrine system in children and adolescents. May Ng

takes us skilfully through the normal functioning of the hormonal glands before detailing both the problems that can arise and the treatment of these issues in an understandable and logical fashion. This book will be a great addition for both adolescents and parents, as well as those in the medical field who are interested in this area of practice."
—Professor Declan Cody, Clinical Professor of Paediatric Endocrinology, Ireland

"Written by a leader in her field, readers will find a wealth of essential information on the complexities of hormonal disorders in the writing style of May Ng that is user-friendly, clear and readable."
—Professor Michael Weindling, Emeritus Professor of Perinatal Medicine, United Kingdom

"Finally, a book that delivers an easy-to-understand information about hormone conditions! *Me and My Hormone* is presented with credible, researched information that is truly a gem for all families."
—19-year-old Paul Devon, United Kingdom

"If you are a parent or carer of a child who has been referred to hospital for a hormone problem, this book is an absolute must! If a friend of yours is a carer or a parent whose child has been referred or is receiving care for a hormone problem, this book is also a must for him or her. May Ng demystifies the hormonal systems in one's body in an admirably concise and easily understood way. Things are explained in plain English and she touches on the common questions you are likely to ask yourself. It is user-friendly and easy to read. I would recommend this book without hesitation to parents, carers and young people with a hormone problem."
—Dr Mohammed Didi, Consultant Paediatric Endocrinologist, Liverpool, UK.

"*Me and My Hormone* by Professor Ng is a really fantastic resource for so many. It is highly recommended whether you are a patient or parent wanting to know more about hormones, a medical student first encountering the somewhat daunting area of paediatric endocrinology, a junior doctor approaching their membership exams, or a senior doctor as a resource for families. This book is easy to read without lacking in detail or depth. As a trainee doctor, it is without doubt a must have!"
—Dr Victoria Nesbitt, Paediatric Higher Specialty Trainee ST8, United Kingdom

"An excellent hormone book which should be on the shelves of consultants, trainees, medical students and anyone eager to know more about hormones. All of the conditions and normal effects of hormones described are succinct and easy to grasp. The sections on transition and solution-focused approach for healthcare professionals are especially useful."
—Professor Kenneth Chen, Consultant Endocrinologist, Boston USA

FOREWORD

Professor May Ng is a multi-award winning consultant paediatric endocrinologist with many years of experience and has an impressive set of 5 academic degrees under her belt. On taking up her consultant appointment, she realised that there was a need for a series of patient information leaflets for common and less common hormone conditions that she encountered. This book is based on those patient leaflets. May Ng also recognised that endocrinology, or the study of hormones, can be a difficult topic for many, including trainees, nurses and medical students, and that there was therefore a need for a book that was simpler to understand than current textbooks. Such a book would include common disorders from childhood to adulthood such as diabetes and disorders that affect growth and puberty. It would cover the full range of important endocrine and hormone conditions with sections on genetic conditions where those conditions involve the endocrinologist (a specialist in hormone conditions). Thus, there would be a discussion of Klinefelter syndrome, a common genetic condition in males associated with tall stature and infertility, which may often require testosterone therapy. The book would also include a discussion of Turner syndrome, where females may present with short stature and some patients with Turner syndrome may require hormonal treatment during puberty.

Professor May Ng has now written the book that she envisaged. It is aimed at patients, students, trainees, nurses, doctors and anyone interested in hormone conditions. Its style is engaging and easy to follow. I am very pleased to have been asked to write this Foreword, which is about the terms 'hormone' and 'endocrinology'. It is also about messengers and messages.

The body has two ways of sending messages internally: through nerves or through chemicals in the blood. The latter is known as the endocrine system. The nervous systems are high speed, while the endocrine system is slower. The central nervous system sends messages at lightning speed from the brain to peripheral sites, such as muscles, to instruct purposive movements through contraction and relaxation. The autonomic nervous system functions automatically and controls basic activity, such as heart rate and respiration and the fight or flight system. The endocrine system also maintains the body's basic functions but in an entirely different, slower way, acting through chemicals known as hormones. These chemical messengers are produced by one set of cells and travel through the blood stream to exert their effect at distant target cells. All cells are exposed to these blood-borne messengers, but only those with specific receptors respond.

Sometimes a single hormone targets several different types of cells and has a particular function. For example, insulin is produced by the pancreas and has the main effect of driving blood sugar, also known as blood glucose into cells. Other hormones act together as an integrated system, known as an axis. For example, the thyroid gland in the neck takes in iodine and combines it with the amino acid tyrosine to produce thyroid hormones, which regulate metabolism in all cells. The thyroid gland is in turn controlled by thyroid stimulating hormone (TSH), which is produced by the pituitary gland, a gland the size of a peanut at the base of the brain. If blood thyroid hormone levels fall, the pituitary gland produces more TSH, and this stimulates the thyroid gland to produce more hormone. This is known as a feed-back mechanism. The pituitary gland is, in turn, regulated by another gland. This is situated in a part of the brain known as the hypothalamus, which produces TSH releasing factor. Thus, the thyroid gland, the pituitary and the hypothalamus act as an axis in concert.

Hormones may be classified according to their function, e.g. as growth hormones (which regulate growth) and glucose regulatory hormones (which control the cell's take up of glucose). An alternative classification is by their chemical composition: (1) amines (e.g. adrenaline (epinephrine)); (2) peptides and proteins (e.g. all hormones released from the pituitary gland, and insulin); and (3) steroids, which are related to their parent compound cholesterol (e.g. gluco- and mineralo- corticoids, oestrogens and androgens). Although every organ system responds to hormones only a few have hormone production as their primary function (e.g. the thyroid and adrenal glands).

Our hormones are transported by the blood stream and lymphatic system powered by the pumping of the heart. Plants also have hormones, but their movement is passive; molecules pass slowly between cells by diffusion and through specialised tissues. Tubes (phloem) move sugars from leaves to roots and xylem moves water and minerals from roots to leaves and foliage.

The story of hormones took a great leap forward in 1902 with the discovery of a substance called secretin by two English physiologists and brothers-in-law, Ernest Henry Starling (1866-1927) and William Mortlock Bayliss (1860-1924), working at Guy's Hospital and at University College, London. By elegant experiments on the gut and pancreas, they showed that the pancreas responded when the gut was stimulated even when all nerves had been removed and concluded that the mechanism must be through a chemical substance, as yet unidentified. They called this hypothetical substance secretin (an 'internal secretion') and correctly identified secretin as a chemical messenger.

Starling's and Bayliss's main intellectual contribution came three years later when they generalised their concept. They proposed that an important regulator of function (the physiology) of the human body was through chemical substances produced

by one organ and carried through the blood stream to affect the function of other organs distantly. It was previously generally accepted that nerves were the only regulators of organ function ('nervism'). Bayliss's and Starling's work was at first the subject of energetic criticism by eminent European physiologists, notably the Russian Nobel laureate Pavlov, renowned for his work on nerve-mediated reflex salivation by dogs. Bayliss and Starling were able to support their conclusions by further rigorous experiments and the Europeans were convinced. Bayliss summarised the situation neatly: hormones are produced in particular organs, carried in the blood, and, acting as chemical messengers, influence cell processes in distant organs.

Starling gave a public lecture in London in 1905 to lay the basis of modern endocrinology. In that year, Bayliss and Starling took advice from a classicist and came up with the word hormone to describe the blood-borne messengers. The words 'hormone' and 'endocrine' are both derived from Greek. 'Hormone' is from the Greek hormao (ὁρμαω, a substance that sets in motion, stimulates). Other examples of such chemical messengers cited by Bayliss and Starling are adrenaline, an antidiuretic factor from the posterior lobe of the pituitary gland, and a factor from the thyroid gland. Many more have been identified since. The word 'endocrine' was first used in 1914. It is also of Greek derivation from 'endon (ἔνδον)' meaning 'inside' and 'crine' 'krino (κρίνω)' meaning 'to separate, distinguish'.

Although secretin was the first substance to be identified as a hormone, it was not until the 1960s that it was isolated and subsequently synthesised. Its endocrine role was only directly demonstrated in the 1970s. Based on the work of Bayliss and Starling over 100 years ago, it was recognised that the body was regulated by both hormones and nerves.

Professor Ng's book clearly explains the role of hormones and I would highly recommend it.

Professor Michael Weindling, Emeritus Professor of Perinatal Medicine, United Kingdom

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INTRODUCTION

Writing this book has been a labour of love. While my first book *A Journey With Brendan* took more than 10 years to complete detailing the journey as a paediatrician and mother to my autistic son, the idea for *Me and My Hormone* came about more than two decades ago when as a paediatric endocrinologist and researcher looking after patients, I was not able to source a clear, concise and easy-to-read book which explains all about hormones and things that could go wrong from birth through to adulthood. Many of my students, colleagues and families I have encountered over the years wanted to have access to an easy-to-read, bite-sized source for understanding complex hormone conditions. I became convinced that this book was needed.

Untreated hormonal imbalance can have serious health consequences and in the growing years, it can also affect puberty, growth and well-being. For many families, parents, carers, children, adolescents and healthcare professionals, hormone conditions can be confusing and difficult to comprehend. While many books are written in a medically jargoned fashion, I hope that this book will make it easier to understand what is happening to the body and give you, families and carers a chance to ask questions, share a discussion and perhaps find an answer that you may be looking for. I would also advise that if there are specific questions or areas of concern that you have about your own condition, please do discuss this with your doctor.

This book is not meant to be a detailed or exhaustive review of endocrine disorders but is written for everyone who wishes to gain a practical understanding of hormone conditions that can affect their lives. I hope that this book will also be a valuable resource for healthcare professionals, medical or nursing students to read and recommend to those who may wish to increase their understanding of hormonal conditions. The final chapter discusses how healthcare professionals can develop meaningful and supportive ways of communicating with patients and their families.

Finally, be brave to venture and learn. I leave you with one of my favourite quotes and philosophy in life by Lucius Annaeus Seneca,

> "*It is not because things are difficult that we dare not venture. It is because we dare not venture that they are difficult.*"

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Honorary Associate Professor and Consultant Paediatric Endocrinologist, United Kingdom

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WHAT ARE HORMONES?

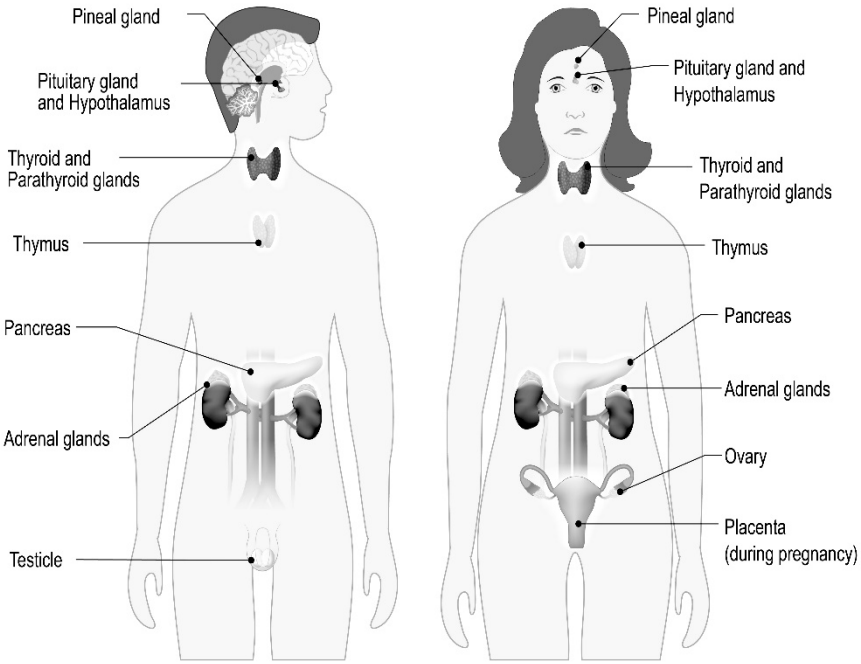
The endocrine system is a group of glands and cells in the human body that make hormones. Hormones are special chemicals which help the body do certain things like maintain metabolism, affect energy levels, maintain blood sugar levels, grow taller, go through puberty and develop into an adult. Hormones travel throughout the body in the bloodstream to the tissues and organs all the time. Hormones work slowly and continuously over time to affect certain organs and tissues through many different processes such as:

Growth
Puberty
Metabolism - how your body gets energy from the foods you that eat
Sexual function
Reproduction
Mood
Energy levels
In addition, men and adolescent boys produce sex hormones in their testes (called testosterone) and women and adolescent girls produce sex hormones in their ovaries (called oestrogen and progesterone).

It usually takes only a small amount of hormone to cause big changes in the cells or the whole body. Laboratory tests can measure hormone levels in the blood, urine or saliva. Hormone disorders can occur if certain hormones are too high or too low

within the endocrine system. Hormone disorders can also occur if the body does not respond to hormones in appropriate ways through problems with genetics or the immune system. Stress, infection and trauma to the endocrine glands can also affect hormone levels.

Endocrine System



The hypothalamus, pituitary gland, thyroid gland, parathyroid glands, adrenal glands, pancreas, ovaries (in females) and testicles (in males) are examples of major glands or organs that form the endocrine system in the body.

Pituitary gland is located in the brain and is often considered as the 'master gland' because it secretes many hormones that regulate the release of hormones from the other glands. For example, it releases growth hormone and other hormones which regulate the function of the thyroid gland, adrenal gland, testes and ovaries.

Hypothalamus is located above the pituitary gland and regulates the release of hormones from the pituitary gland. It is responsible for body temperature, appetite, sleep-wake cycles and moods.

Thyroid is a butterfly shaped gland which is located at the base of the throat and is responsible for regulating metabolism.

Thymus is a gland located in the chest, between the lungs and is important in the development of the body's immune system. It primarily secretes thymosin, a hormone necessary for developing white blood cells called T-lymphocytes, which fight infection. The thymus, unlike most organs, is at its largest in childhood and starts to slowly shrink and become replaced by fat after puberty.

Parathyroids consist of four small glands located near the thyroid gland. They are responsible for regulating the amount of calcium in the body.

Pancreas is an organ that is part of the digestive system, but it is also an endocrine gland that produces hormones which regulate blood sugar levels.

Adrenals are located on top of the kidneys and secrete a variety of hormones that are responsible for regulating blood pressure, heart rate, stress response, metabolism and the balance of water and salt in the body.

Pineal gland is located in the brain and is responsible for producing melatonin hormone which affects the sleep-wake cycle in the body.

Ovaries are part of the female reproductive system and are responsible for producing oestrogen, progesterone and a small amount of testosterone.

Testes are part of the male reproductive system and are responsible for producing the male sex hormone testosterone and sperm.

Endocrine Dynamic Function Tests

Endocrine dynamic function tests are also called hormone stimulation tests. They involve either stimulating or suppressing the endocrine-hormone axis and observing the hormonal response to determine if it is appropriate. Often the endocrine dynamic function tests require a 'stimulant' to be given either orally, administered into a vein (intravenous) or injected under the skin (subcutaneous).

A series of blood tests undertaken at timed intervals to measure the hormone levels that are investigated are usually arranged by the specialist paediatric endocrinologist. Most endocrine dynamic function tests take several hours to complete. Some of these tests require that the individual fast and should not eat or drink several hours before the test.

There are different types of endocrine dynamic function tests that can be arranged to diagnose or rule out different hormone conditions such as:

Growth hormone stimulation test to determine if the pituitary gland is able to produce enough growth hormone

Gonadotrophin Releasing Hormone (GnRH) stimulation test to assess pubertal axis in boys and girls
Glucose tolerance test to rule out diabetes
Adrenocorticotrophic hormone (ACTH) stimulation test (also called synacthen test) to determine if the adrenal glands are producing enough cortisol hormone

Always ensure that you are given specific instructions by the healthcare professional team and let them know of any relevant medications or medical history that may be relevant before having the test.

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NORMAL GROWTH

Growth is an important indicator of good health and adequate nutrition during infancy and childhood. Growth can be affected by a variety of factors such as genetics (height from both parents), hormones, chronic disease, bone disorders, nutrition and emotional well-being. Growth in height usually occurs in spurts and does not follow a constant course from birth to completion of puberty. An important point to note is that there is no significant correlation between the length at birth and the final adult height achieved. Birth size usually depends on environmental factors such as intrauterine nutrition.

Growth in terms of weight and height is usually charted on a Percentiles Growth Chart to enable comparison with an infant or child of the same age. The WHO Child Growth Standards charts are available online which were developed from the Growth Reference Study undertaken between 1997 and 2003 to generate percentile growth charts for assessing the growth of infants and children around the world. For example, a child charted at the 10th percentile for weight would mean that 10% of children of the same age will weigh less and 90% of children of the same age will weigh more. For a child charted at the 90th percentile for weight, 90% of children of the same age will weigh less and 10% of children of the same age will weigh more. Growth monitoring at the doctor's should be done regularly and not just at a single point in time. If there are concerns about the child's growth, it should warrant a referral for an assessment as early detection of any underlying condition is important during the

growing phase. Crossing of growth centiles at any other time apart from puberty is a cause for concern and requires further evaluation.

Rapid growth occurs from birth to about 2 to 3 years of age. After this period, growth tends to slow down to a steady rate where the child will stay on his/her centile for height until the next major growth spurt occurs in early adolescence. The height centile during childhood is crudely correlated with the final adult height such that a child growing along the 50th centile is likely to end up on the 50th centile as an adult. However, bear in mind that the onset, tempo and intensity of the pubertal growth period can be very variable such that the child may also end up at one or two centiles above or below the childhood centile before puberty started.

Assessment of growth include the following:

Charting of height, weight and head circumference onto appropriate growth centile charts
Taking a history
Examination of physical features and general health
Staging of puberty
Measuring of both parents' heights and calculation of mid parental height and range

Mid Parental Height

The heights of both biological parents should be accurately measured as these can be used to estimate the familial genetic adult height potential of the child. To calculate the potential height, a simple formula below to estimate the Mid Parental Height for a child is as follow:

Boys: (father's height + mother's height) divided by 2 + 6.5 cm
Girls: (father's height + mother's height) divided by 2 – 6.5 cm
For both girls and boys, 8.5 cm (3.35 inches) on either side of the mid parental height calculated value (target height) will represent the likely range for their anticipated adult height (+/- 2 standard deviations around target height).

This mid parental or target height can be plotted on a growth chart to estimate the centile that the child should grow along. Parents who are short will normally have children who are also short. Conversely tall parents will usually have children who are tall. Therefore, most normal children will follow their childhood height centiles within the calculated target centile ranges. A child that is on a height centile that is outside of the target range centiles is more likely to have a growth disorder compared to a child whose height falls within the target range centiles.

If there are concerns about growth, usually screening investigations are undertaken which may include the following:

Full blood count
Kidney profile
Calcium and phosphate levels
Coeliac screen
Thyroid hormone function
Chromosome test
Insulin-like growth factor-1 test (IGF-1)
Bone age to assess bone maturity

There are three broad stages of growth: early childhood, middle childhood and adolescence phase.