FROM SOLSTICE TO EQUINOX AND BACK AGAIN:

The influence of the midpoint on human health and the use of plants to modify such effects

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INTRODUCTION

In these few pages I will try to outline how seasonal variation in temperate regions may influence human health. My interests in biology and plant population ecology inform my approach to clinical medicine which, as a medical herbalist, draws upon the therapeutic properties of plants. There are parallels and homologies between plants and animals in their biochemistry: we all share the same environment driven by sun, water and air. I shall focus on patterns of human response to environmental fluctuations with especial reference to light intensity and day length and thence to the stretching of these adaptations at threshold seasons. Observations in the response of people and animals to seasonal variation were made in ancient and classical times and modern interest in the subject—now called Chronobiology—has received intense scientific scrutiny. Modern clinical medicine, however, has made little use of the many useful findings.

The subject involves several disciplines. I shall try to integrate them into this paper as I do into my practice. Although the sciences of human physiology are quite abstract, their determinants are all around us in the natural world. Human health is my subject and its relations with the sun, moon, and plants. I shall turn over themes in biology and touch upon these ideas from different points of view, and hope to establish a thread from these many strands. The form is more circular and elliptical than linear, more like the order in a game of cards than a narrative, for this is not a text–book. However, to provide some organising direction, the text divides into four sections:

1. THE CLOCKS WITHIN:
   ADJUSTING FROM DAY TO NIGHT
2. HEAVENLY TIME
3. THE CLOCKS WITHIN:
   ADJUSTING FROM WINTER TO SUMMER
   AND BACK AGAIN
4. ADAPTATION:
   THE CAPACITY TO MANAGE
   CHANGE AND TRANSITION

Humans are confronted in their lives by random events yet live in a world which is shaped by predictable physical cycles. We do not know what the day has in store for us, but we know at least that it will be a day. Even when faced with a rare total eclipse of the sun, the observant human might notice that other creatures settle down for the night apparently without distress. The essential focus of this paper is on our resolution of these seemingly opposite conditions of life, a resolution that we call health.

1. THE CLOCKS WITHIN: ADJUSTING FROM DAY TO NIGHT

HEALTH AND RHYTHMIC CHANGE

Health from a biological point of view may be defined as the fitness of an individual to match challenges from the environment. Some of these challenges will be random, or appear to be so, and therefore unpredictable. Our fitness to manage random fluctuations in our environments seems to be enhanced if we are able to conserve stable strategies for meeting those fluctuations which are predictable. The tricky manoeuvre is to make our adaptive behaviour flexible enough to deal with alteration yet regular enough to resist responding to every perturbation. In other words, our health requires that we are adequately sensitive to external events while at the same time capable of ignoring some signals. For survival, we need both healthy concern and healthy indifference; the trick is to learn when to invoke one and not the other. Health requires us to develop a buffer zone that is robust without rigidity.

An important attribute of the healthy response, then, is the ability to discriminate between isolated chance events and predictable change. One cannot judge whether an event is part of a pattern unless one has an internal pattern book against which it can be matched. Only then can the secondary assessment be made about whether the event is a risk or an opportunity.

Fluctuations in our physical external environment challenge the stability of our internal environment. These environmental fluctuations are predictable insofar as they are rhythmic. The behaviour of most creatures is determined by these fluctuations and so, in the pre-technological age in which we evolved would give us clues about the availability of food. Aperiodicity is potentially dangerous because it is unknown; periodicity can be accommodated because known. Such knowledge may lead to prey and alert us to the danger of predators.

The most important observable and predictable rhythms in nature derive from the movements of the 3 bodies: earth, sun and moon:

1. Earth's spin produces a single dian period divided into the binary cycle of night and day
2. Emergence from one phase of the cycle into its opposite, produces transition zones: the narrow crepuscular phases of dusk and dawn
3. Earth's tilt produces in high latitudes the binary cycle of winter and summer
4. Emergence from each phase of this longer cycle also produces transition zones: the seasons of autumn and spring
5. The movement of tides generated by the moon influence most creatures, especially those who feed in the transition zones between land and sea
6. The annual cycle derived from earth’s orbit is a cumulative measure of ageing and success in feeding and reproduction.

The observation of such rhythms after the event serves no adaptive purpose. For organisms to use the information, they must be able reliably to predict it and to be alert before its onset. For such an operational device, there must exist some internal analogue of external periodic events. While the existence of such a timing mechanism was postulated in ancient times, it was not located until late in the twentieth century and its functions validated experimentally. This central timer consists of paired structures in the forebrain, each containing about 8000 nerve cells. These clumps of nuclei lie close to other well–known regulatory centres which are known to determine rhythmic vital functions such as respiration, heartbeat and temperature control, as well as the less determinate periodic needs of feeding and excretion. It is unlikely that there is this one body–clock: rather it seems an indispensable regulator of all the other pacemakers and oscillators that are distributed throughout the body. Their location will be discussed later on in this section.

To be adaptive, all oscillators need to perceive and respond to rhythmicity in the external world, and to learn from the outcomes. To respond effectively, the clock itself must be able to adjust its rhythm to changes in the environment. These changes must be periodic: it would be of no value responding to yesterday's weather, (especially in the British Isles). The six cycles listed above do not vary measurably within a human lifetime while many other cycles are too variable to measure. Even temperature is only secondarily a useful predictor when conjoined with the primary external cues, night and day: the regular alternation between light and dark, known as the photophase and scotophase.

VARIABILITY

Variability is a signal characteristic of living organisms, and variance—the range of characters which any individual may exhibit and the bounds within which any individual may inhabit—provides an important measure for biologists. In this respect, living beings resemble the weather, which is forever changing but within certain bounds: winds of 400mph have never been recorded on this planet, though they are a constant manifestation on the surface of Jupiter. Weather derives in turn from climate which shows a much slower variability, thus climatic change is generally more predictable than the weather. Climatic change is likely to alter the bounds of variance of weather in a particular place over a timescale usually measured in decades and often longer than a human lifespan. Climate derives in the main from the obliquity of the earth's axis about its orbital path around the sun, but is also profoundly influenced by latitude and other geographical effects, especially proximity to thermal reservoirs. Earth's spin and orbital velocity have changed and will continue to do so but with predictable and astronomically slow periods. There are cycles on the surface of the sun which seem to affect weather but other solar cycles and those within the earth's magnetic core probably influence climate, but these have long periods which we are not yet able to predict. Other changes in the crust and mantle produce both slow and fast effects like tectonic drift, which cannot affect human lifetimes, and earthquakes and volcanism which do very often in all our lifetimes. Solar irradiance decreases with latitude simply because of the spherical curve of the earth but while high latitudes receive less irradiance, their seasonal climates derive more from the tilt of the earth's axis. While this angle of obliquity varies a little, the period of this variation is 41,000 years. Together with the equinoxes which precess every 22,000 years, these variations, whatever their effects on climate, must place negligible strains upon human adaptability, to say nothing of the fluctuation in the eccentricity of earth's orbit which clocks in at 96,000 years. None of these fluctuations could be detectable by direct human perception.

Weather and climate provide us with expected bounds of variance against which we may plan our lives. The measure of predictability is itself variable, depending upon where we live. By accommodating variability we reduce the adaptive strain upon ourselves, that is: if we adapt we remain healthy, if not, we become ill. Accommodation involves both anticipatory behaviour and internal mechanisms which constantly sample the outside world and calibrate responses, and our responsiveness. Most of our adaptive mechanisms reduce our responsiveness to predicted change and increase our responsiveness to unexpected change. If you live in Britain, you will know that cyclonic low pressure weather tends to dominate over more stable anti–cyclonic systems. It has been shown that some individuals are very susceptible to the *alternation* between these two periods of weather, and that it is the relative speed and the amplitude of the oscillation at the boundaries of the two phases that causes their transient illness, manifesting as headache, nausea, visual and balance disturbances, irritability and other disorders of mood.

Health as a state of stable equilibrium in the face of variability is a biological and ecological idea to which modern medicine has yet to return.

LIFE AS INFORMATION

The life of those tiny single–celled creatures which are able to move, such as amoebae, is dominated by the chemical environment in which they find themselves. They move away from impoverished, toxic or hostile environments and move towards those that are rich in nutrients. This ability to move along chemical gradients provides the necessary precursor to multicellular life. While most bacteria are *relatively* passive to the environments they exploit, they share with all strains of life the ability, by means of chemical codes, to learn and replicate, and so evolve. As for green plants and fungi, the plant body does not itself move but colonises environments by dispersing spores, sometimes enclosed in elaborate propagules such as fruits and seeds. Inside the apparently static plant body, all is movement and flux using chemistry and physics just as amoebae do, even seeming in extreme environments to defy physics.

These constellations of chemical signalling pathways, these kaleidoscopic interactions of stimulus and response are contained within the bodies of trees and people alike. In the architecture of life, we see only the larger material agents of life as in a tree trunk or a human skeleton, but these are products of internal chemistry: the process of managing and storing electrochemical information.

Practitioners of medicine have always relied upon the visible body and the experience and behaviour of the person to come to conclusions about their inner state. As often as not, the inferences made are pragmatic, or they depend more explicitly upon some theory of knowledge. Until the modern period, such theories about the inner state had to generalise internal behaviour from phenomena in the larger world that were visible to the human eye. Unseen forces were held to be responsible but could not be identified without a microscope or telescope. Nor could chemistry and physics as a unifying theory of matter and energy develop into the contemporary notion that all life can be construed as patterns of information. Indeed, if the laws of thermodynamics are interpreted this way, a useful convergence of understanding may be achieved between the concept of entropy in the physical world with that of the struggle against disorder in an informatic living being. Order must be enclosed in a container to differentiate it from the external world with its random movements against the backdrop of periodic movements. This demarcation requires a reproducible structure. Any structure which does not learn to maintain itself will be swept into the randomness of the physical world.

STRUCTURE & FUNCTION

In any motile body visible to the unaided eye, we think of structure as the thing we see, and function as a behaviour of that structure. So, a hand might be an example of a structure and knitting might be an example of a function. In such a view, taken by architects, designers and osteopaths, as well as by common sense, the two are interrelated in such a way that it hardly makes sense to speak of them separately, though often we do. If, however, we focus on the inner (endocrine) life of the being, the structure is the normative state of the system and the function is the adaptive response of that unseen "structure": what it is and how it works. These two interconnected worlds: the musculoskeletal with its visible skin and palpable blood supply on the one hand, and the unseen biochemical "structure" on the other, reflect the development from creatures without backbones (that relied to a greater extent on biochemical shapes in solution rather than solid physical structures) to all the vertebrate animals, including ourselves. The nervous system is the intermediary state: information passes by a chemical network embedded in a fixed physical structure. Although less fluid than the endocrine system, the chemical neurotransmitters which connect the solid nerve cells are really hormones which do not flow in the circulation: rather they are fixed at a certain location between nerve cells. The internal organs belong with the musculoskeletal and vascular in that they are perfectly visible at postmortem: after the event, so to speak.

Like Russian dolls, the inner structure is embedded in the nervous system which in turn is embedded in the musculoskeletal and vascular matrix, the organic continuum. When we speak of reacting to the environment and incorporating useful responses (learning), clearly all levels of structure must respond to environmental stimuli. The incorporation of learned responses takes place ultimately within the nucleus of the cell—within the epigenetic machinery along with the activation and reformulation of the DNA itself. The hormone system is the ultimate mediator of the process using the parallel and integrated nervous system as its cofactor. We call this nested series of "structures" the ***terrain***—the inner landscape. It confers our individuality upon us as surely as does our genetic inheritance. One could speak of the terrain as the "reader" of, and informer to, our genes.

The kind of medicine that I practice, as part of a European tradition, attempts to enable the patient's *terrain* to adapt more easily to the circumstances faced, and so reduce distress and discomfort. The interpretation of the state of the patient's *terrain* relies on present and historical structure, its manifestation in physical signs, and the personal experience of symptoms. I use plants exclusively as medicinal agents (along with dietetics) with the aim of modifying the functionality of the *terrain*, and further hope to influence even its **structure**. It is time to remove quotation marks from adorning this word, as we take it to mean a real but intangible form just as some architects[1] dispute the usefulness of the mantra "form follows function and function follows form"[2]. If we effect change only in function, the symptoms will resume when the medicine is discontinued.

STABLE EQUILIBRIUM IN THE FACE OF VARIABILITY

"Nothing is constant except for change." This motto of Heraclitus is true only in a limited sense when applied at the microscopic scale in living systems. Within, all is movement about a constant point of equilibrium. Even the "point" is a fluctuating area around a mean, but this mean is constant and expressible as a narrow range of variance. The body requires a constant environment with respect most urgently to temperature and pH[3], a measure of the acid-base status of body fluids. These states are the invariant positions around which fluctuations swirl.

Biochemical reactions would be too slow to support life without the constant participation of essential catalysts at every stage. These enzymes and their cofactors are exquisitely specific and precise. In blood and tissue, they can only operate within these narrow ranges of temperature, and at a pH a little above that of pure water[4]. These equilibria are kept in place by buffering agents found in the blood and body fluids. Lungs, kidney and skin work constantly to maintain reservoirs of these buffers. This is the core of homeostasis: keeping the internal environment roughly[5] the same in the face of pressure to change.

This pressure is unrelenting. The metabolic costs incurred by homeostasis have to be met by feeding. The transformation of food into bodily function and structure generate waste which in turn disturb the necessary chemical equilibrium, as does growth itself. Just as life depends upon the physical world of earth, sun, moon and air, with constant movement against unbending laws, so we must maintain two parallel streams, one of fixity, one of constant change. We spend our lives in excursion from rest to activity then a return to rest. To remain constant we must move, as Heraclitus said. There are many short and even micro–cycles but the day itself is the basic unit of adaptation because it is tied to the shortest evident astronomical cycle. The critical attribute of any day is to prepare for our next, and the next.

It was assumed from the time of Hippocrates (the first to discuss seasonal and diurnal effects on health) that the predictable alternation between dark and light within 24 hours had somehow to be measured within the body. A sea–captain in the service of Alexander the Great (356–323 BCE) measured and notated the course of movements of tamarind and mimosa leaves during daylight hours. Both Galen (130–201CE) and Avicenna (980–1037CE) observed and speculated on biological rhythmicity. Botanists

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1 Expressed eloquently by architect David Chipperfield in a recent interview as he discussed his restoration of Berlin's Neues Museum. The interested reader could follow the philosophical discussion in 'Function and fiction', chapter 11 of The nature and aesthetics of Design David Pye London 1978.

2 An article of faith of the Bauhaus movement in architecture and design and a principle of osteopathic assessment and treatment.

3 The theoretical neutral point of pure water pH 7 provides a measure of aqueous solutions where points below 7 are deemed acidic while those above are basic or alkaline. Blood is kept between 7.35 and 7.45.

4 In body cavities, by contrast, the pH will vary very considerably; for example, the need to digest different kinds of nutrient from our food requires powerful acid in the stomach and alkali in the small intestine. The saliva must be kept alkaline if it is to inhibit the buildup of acid on teeth which would encourage bacteria and demineralisation.

5 Homeo means similar, not the same; if the term was homo– rather than homeo– stasis, the qualifier 'roughly' would be excluded. At death, the temperature of the body merges with that of the environment and its pH plummets.

and physiologists of the European enlightenment proved that rhythmicity was more than a response to cyclical change and had to be driven by an endogenous timer. Following centuries of reasonable assumption, the cellular basis for the clock was not demonstrated until the twentieth century.

Any ecological niche is framed by the geological and climatic forces that operate there and the food sources they permit, along with the diverse competitors and risks of obtaining it. Fluctuations in atmospheric temperature and pressure, humidity and levels of luminosity are stressors which may influence our ability to compete successfully for food. The rate of change (weather) is a local affair while climate sets the range of variation. To distinguish between the variant and invariant provides us with the gift of prediction. Prediction is of great value if we can act upon the knowledge. In an obvious and immediate way, if we feed by day it is most competitive to know when to expect daylight before it arrives. We now know that this internal alarm clock is provided by the least variant hormonal cycle, namely that of cortisol to which we will return later. For cortisol to wake us up, its secretion must be set by a timer that is able to predict daylight. Given that the primary source of all food on the planet is the product of photosynthesis, whether we are nocturnal or not, it is the assurance of earth's rotational invariance that must set the clock.

The obvious place to look for a clock is where homeostatic measurements are made, given that our very lives depend upon them. The integration of sensory inputs from without (and from perceived needs within) occurs in a small region at the base of the brain called the hypothalamus[6]. Here is located the setting of the primary thermostat where specialised cells secrete hormonal commands to correct any internal deviation from the norm. The hypothalamus monitors the volume and constitution of the blood and sends corrective signals as needed. While kidneys and lungs, as well as the blood itself, maintain acid-base levels within narrow limits, this small part of the brain assesses from moment to moment how well buffered and protected we are to environmental stressors. It sets also our long–term responsiveness to change. We need at times to ignore variation while at other times our lives depend upon our predicting it, sensing it and adapting to it. To recognise variation, we must have a model of invariance. The earth's rotation provides the most reliable and obvious example. To manage the paradox of stability within flux—the goal of life cannot be to stand still—the hypothalamus is the obvious place to find the timekeeper. To locate the hypothalamus in your minds, place your index finger of one hand just above the bridge of your nose, where the third eye is said to repose, and the index finger of the other at the same height in front of and above the top of your ear: the organ sits where imaginary lines from each finger intersect. It is not an exaggeration to call the hypothalamus the organ of homeostasis, controlling temperature, pressure and volume of blood, as well as basic drives for food and, through the attached pituitary gland, for sex.

In the image below, you may find it in purple above the smaller pea-like pituitary gland to which it is joined by a stalk, taking the height from just above the top of the eyebrow arch:

6 'hypo' means below; the thalamus is a relay station for sensory and postural information and helps set thresholds for pain and arousal.

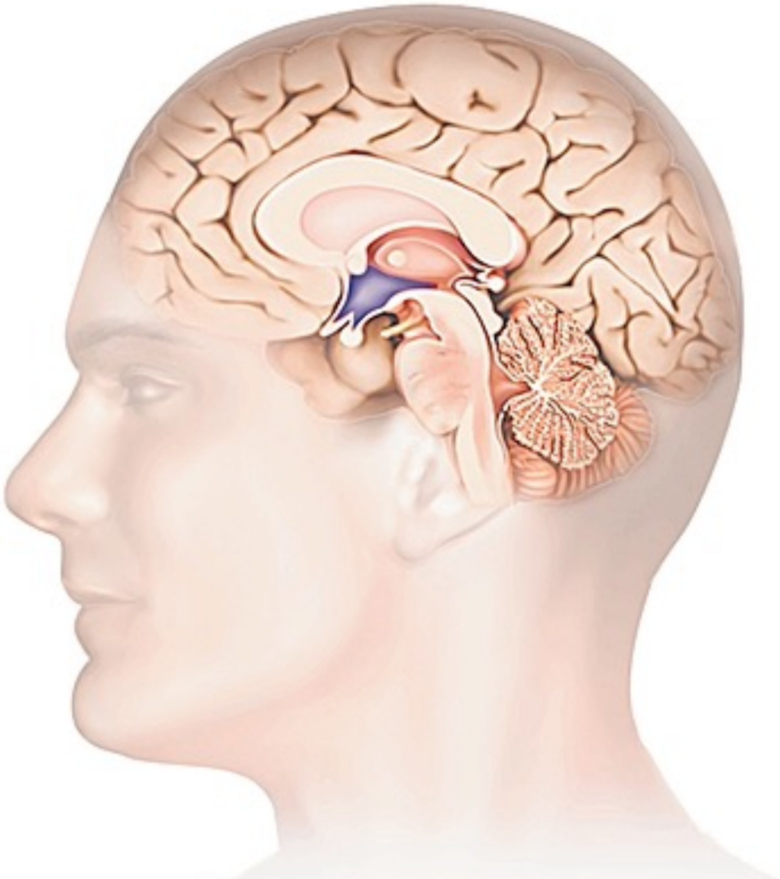

Figure 1.1

A paired group of structures within the hypothalamus known as the suprachiasmatic nuclei (each containing about 8000 cells) were, in the early 1970s, demonstrated to be the site of our biological clock. The clock is strategically located between the pineal gland and the eyes. In birds, the pineal gland is directly able to detect changes in light as it sits on top of the head under a thin skull. In mammals, however synthesis of melatonin in the pineal gland as a photoresponse depends upon the retina at the back of the eye.

It had been thought that the eyes were concerned only with vision, focussing light onto cells of the retina which detect full–colour daylight and diminished night light. Information from these two kinds of detectors—known as rods and cones—are integrated by a third kind—known as ganglion cells. All three of these cell types converge into the optic nerve, sending the optical data into the visual processing centres of the brain. It has been demonstrated that these ganglion cells detect light independently of rods and cones: that is, visual information for image construction is separate from luminosity. This property accounts for the detection of the rhythmic alternation between full daylight and night and *not* for random variations in daylight, such as when the sun is concealed by cloud. In other words, these ganglion cells of the retina detect the liminal periods of dawn and dusk. The optic nerves leave the back of the eyes and cross over to the opposite side. This area of crossover is known as the optic chiasm and so explains the name of the suprachiasmatic nuclei mentioned earlier, and locates the hypothalamus close to the back of the eyes.

In summary: the retina detects periodic changes in luminosity as well as in the visible world itself. Detectors of variation in the light/dark cycle might be expected to be near to the eyes, as indeed in the late twentieth century they were so found. These cells oscillate in unison to regulate the expression of certain genes which alternately promote then degrade a small group of proteins that in turn control major physiological and metabolic functions. The chemical transduction of light for vision in the retina are photopigments based upon the fat–soluble Vitamin A. These have long been known, one might say elucidated. The signal for the phase switch, however, is thought to be chemically related to pigments found in plants. These *cryptochromes* are related to the water–soluble Vitamin B_2 and are responsive to blue light of the same frequency that stimulates seasonal recognition in photoperiodic plants. The picture is further complicated by the recent discovery of melanopsin which is chemically related to the opsins needed for vision, thus providing a bridge between the photic and non–photic functions of the eye, between the realms of homeostasis and circadian rhythms.

Strictly speaking, the suprachiasmatic nuclei (SCN for short) is not so much a clock as a pacemaker. Its oscillatory signal provides rhythmicity for organs, tissues and cells and is thus more of an orchestral conductor. The major organs are thus given a score to work from, or an approximate timetable so better to organise and meet the challenges of the day.

Apart from our need for protection from weather and avoidance of danger, food is our foremost challenge. As the liver is the body's 'glucostat' and major processor of food, relations between this organ and the hypothalamus (where need and appetite are integrated) can be shown to be not only strong but also rhythmically controlled. The eye, liver and other organs are calibrated by the SCN so that perception can be correlated with effective behaviour. These relations are timed by the least variant cycle in the biosphere: the alternation between night and day which constitutes our index of predictability. The shift between these phases, the crepuscular time, is what physiologists call the *zeitgeber*, the synchronising signal. The organism is said to be entrained to this alternating cycle. When the time between these two phases shifts beyond a certain threshold, the entrainment has to be re-calibrated to preserve the integrity of the metabolic functions that the SCN orchestrates. The eye and SCN can detect visual cues easily and quickly but peripheral oscillators such as the thyroid gland and liver will experience a lag. These readjustments have to be accommodated and so place a load on adaptation which some individuals bear more easily than others.

All circadian rhythms are entrained by light and are said to be temperature compensated. This means that it is light variation and not variation in temperature provides the signal for change. Photoperiodic plants assess day-length—the most reliable index of their capacity to make food—by measuring the distance between dawn and dusk, signalled by blue light at a wavelength of a little above 450nm equivalent to a frequency 610 THz. These plants respond to shortening or lengthening of day-length by sealing or unsealing buds and by withdrawal or elaboration of photopigments, especially chlorophyll. In high latitudes, the threshold at which they embark or disembark from major metabolism starts to change midway between the solstice and the equinox when the climate as measured by temperature might give no warning of the impending change.

CHANGE IN A FIXED ENVIRONMENT

Homeostasis is our response to a changing environment. Circadian rhythm gives us warning of the onset of a predictable environment, the length of the daylight phase. While tissue which is independently circadian is found only in the brain—in the paired suprachiasmatic nuclei in the hypothalamus—the timekeeper does direct other organs to comply with its timetable. The rhythm of about ('circa') 24 hours is sustained even in the artificially contrived absence of daylight so, as a response learned from experience of the predictability of daylight, this rhythm has been incorporated into genes which generate proteins in a cyclical fashion. The period of this cycle lies between 23 and 27 hours. It is plausible but not proven that our need to predict the time of dawn relates to our need to search for food in daylight hours. What has been proven is that precise and obligatory measurement of the slow graduation in time between dawn and dusk is crucial to the migration dates of birds and many hibernatory animals, as is the opening and sealing of buds in photoperiodic plants. In birds, the pineal gland is at least as sensitive a photoreceptor as the eye, and may be so in the human foetus. Bodily tissues are more opaque than a thin bird's skull but, even so, summer light can penetrate into tissues deep in our bodies.

To reset the circadian system in adult humans requires a very bright life sustained for at least 20 minutes[7]. The visual system, by contrast, is about 1000 times more sensitive and so can form images in conditions of very low light intensity. Both of these photoreceptors lie close together in the retina, yet one responds to random fluctuations in light while the other only to rhythmic variations. Whereas the pineal gland is crucial to successful migration in birds, its effects in humans may seem be subordinate to the eyes, visual cortex and SCN. It may be, however, that it plays a subtle hand in the longer term uses to which any of us put daylight: in the fields of drive, ambition, stamina and strategy[8]. In less speculative vein, it is important to appreciate that the circadian system compensates against fluctuations in temperature and so seasonal change responds to changes in daylight length and not to sensations of ambient heat or cold.

DEFINITION OF ADAPTIVE HEALTH

Health at the primary level may be defined as the ability of an individual to manage predictable circadian, tidal and seasonal transitions without signs or symptoms of stress and to recover quickly from aperiodic and unpredictable troughs and surges without detectable loss of function.

Health at the secondary level is the ability of an individual to compensate for transitions without the accumulation of deficits or surplus' which secondarily lead to signs or symptoms. Health in this sense implies an ability to recover from unpredictable events in a time proportionate to the size and duration of the stressor.

This kind of measure of an individual's ability to adapt to transition is a useful reductionist device for biologists but, of course, to become an "individual" is to have emerged from a long series of transitions. While homeostasis is maintained without consciousness, adaptation requires it. Human consciousness must necessarily arise from

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7 This is a simplification. Low light, noise and social cues do have an effect upon the zeitgeber, but not as marked as high lux values.

8 There is a very complicated effect of melatonin upon part of the pituitary gland that stimulates our reproductive system in pulsatile bursts of activity. These also influence levels of prolactin, the hormone that stimulates a nursing mother's milk but is crucial to all men and women as a seasonal modifier of metabolism.

development and maturation. The triumph and dilemma of human consciousness implies memory and the ability, the need even, to anticipate the future and to predict the behaviour of others. To estimate, to plan and to remember all require distributed functions in the brain and body but they must be brought to bear at the instant and locus of action. The notion of locating consciousness is a forlorn hope and belongs to an earlier search for correspondences such as Descartes' imagination of soul inhabiting the pineal gland. There is one simplification, however, that is amenable to measurement. The many neural and endocrine pathways and the several organs involved in adapting to circumstances coincide with the integrative centre of homeostasis: the hypothalamus. Here the remembered past and projected future converge in the adaptation of the terrain to the present.

As we match current states with memory, the hypothalamus relays information to the present. The *terrain*—the inner landscape—provides many of the settings for the speed and amplitude of such adaptive activity. According to the work of Drs Duraffourd and Lapraz, these are inaugurated from the sixth week of our mother's pregnancy with us and reach finality of this first 'imprint' by the thirteenth week of gestation. The embryological stage reached is that of gastrulation which is the first fundamental and irreversible differentiation into the 3 germ layers[9]. The *terrain* is further configured at birth and during development with different hormonal axes dominating stages up to the age of 7 (but with an age difference between girls and boys). Configuration is considered to firm up again in early, middle and late puberty. The opportunity for re-calibration effectively ends with the closing of the epiphyseal plates of the long bones when we reach our greatest height. How can a small region of the brain exert such control?

It is important here to emphasise that the hypothalamus is not an operative centre: there is no such thing. We must be careful not to slip into thinking that we have within us some centre of command and control with peripheral servants doing the work. Rather, it is an integrator of information within and without. Because there are neither organs nor nervous system at such an early stage of pregnancy, the information is exclusively biochemical. The hypothalamus does not yet exist. Information in the macromolecules within the nuclei of the cells of the embryo is coordinated by hormones and the interactions limited by enzymes. This web of information constitutes the ***terrain***: creating nodes of interaction about which cascade a nexus of feedback loops. Envisage a relational state rather than a physical structure but one that our tangible structure cannot be constructed without: it is our initial constitution, modifiable by experience. It resists deformation and change, yet is adaptable enough for it to be non–deterministic. In this way, we have the capacity both for stability and for change, for resistance and adaptability.

Once the embryo has become a foetus and eventually a new-born baby, the terrain in its endocrine sense is migrated to the hypothalamus and—via the pea–sized gland attached to it, known as the pituitary—to the endocrine organs and the rest of the body. Refer back to Figure 1.1.

The operation of these hormones (which I shall detail in section 3) is related to the circadian oscillator in the neighbouring SCN. The timing of the operation of the

9 They are: 1: the ectoderm: skin, nervous system, eye lens, pituitary and mammary glands, 2: the mesoderm: muscles, bones and other connective tissue, including the heart, 3: the endoderm: thyroid, lungs; most of the respiratory & urinary tracts, digestive tract & ancillary organs

endocrine system is set by **cortisol**, one of the hormones of the adrenal gland that is stimulated directly by the pituitary hormone ACTH[10] and entrained both to circadian rhythm, and to contingent stress, by the hormones CRH and ADH[11] from both the hypothalamus and the pituitary. Details in Section 3.

Although adrenaline can be secreted extremely rapidly (and broken down within a very few minutes), it is not typical in that respect: most of the hormones we are considering take up to 20 minutes to reach a stimulatory concentration in the blood. It is quite obvious that most daily functions could not operate at these time-scales. What if I want to scratch the back of my neck, or to avoid a puddle, to say nothing of fight-or-flight manoeuvres? This kind of everyday eventuality is what the voluntary nervous system and its muscular attachment is for. However, the organs which supply the effector muscles and skeleton—notably the heart and blood vessels—are not under voluntary control. They get their settings from the Autonomic Nervous System which in turn gets much of its calibration from cells within the hypothalamus. The ANS is composed of two opposing sections, using different neurotransmitters (which are really hormones–*in–situ*). One division is for feeding and sleeping (and thinking and imagining), the other for *ACTION*. These divisions are called the Parasympathetic and Sympathetic, the latter has to be dormant at night and released by day. The former dominates not only sleep but also the digestion and assimilation of food and ideas.

The other hormones of the pituitary and hypothalamus exert control over the organs of digestion, metabolism and excretion in parallel with the complementary and reciprocal activities of the secretions from Parasympathetic and Sympathetic nerve endings. The small intestine itself is replete with hormones which mimic or match those from the hypothalamus and other parts of the brain.

All of this must be timed and orchestrated. If the hypothalamus is the conductor and the pituitary lead violin, the SCN is the score to which all must refer but from which all may improvise if circumstances require.

THE RHYTHMIC CIRCADIAN SYSTEM

The oscillating cells of the SCN are really part of a confederation which includes the retina and the pineal gland, where melatonin is synthesised. This hormone maintains sleep though it does not initiate it, but it does promote drowsiness.

The retina contains 3 layers of tissue; two of them—rods and cones—are responsible for light collection for image formation by the brain. The third—known as the ganglionic layer—signals light intensity. This is the principal source of the daily resetting of the clock. The important point to grasp is that the SCN once set on course keeps roughly to a daily (circadian) cycle if daylight is seen or not and will only gradually drift out of synch with the actual daylight if kept artificially in the dark. This results in a stable predictor of daylight during the night so that the dayshift hormones, so to speak, are primed in readiness before dawn. The adaptive advantage is clear: we are ready for the day even if light is obscured by thick cloud or heavy fog. When bright light is seen again, the clock is reset and so the acquired rhythmicity is reinforced.

10 Adreno- Cortico- Trophic- Hormone.

11 Corticotropin-Releasing-Hormone and Anti-Diuretic-Hormone; both go by other names, especially in American texts.

The hypothalamus is thus the regulator of those hormonal cycles that do change coupled with hormones, notably cortisol and melatonin, that do not. This resolves the tension between the needs of homeostasis and the requirement to adapt to an environment that may spring surprises. This region of the brain also integrates the two branches of the autonomic nervous system which have been mentioned before, namely the Parasympathetic and Sympathetic. Within the former, there are two kinds of receptor. Now, digressing for a moment, the word 'receptor' in physiology more often than not refers to a protein embedded within the thin membrane border that encloses the cell, though sometimes such proteins are found within the cell itself and sometimes within the nucleus of the cell. Proteins are chains of amino acids and are characterised, coded as it were, by the order of these 20 or so amino acids used within the body. Because these amino acids have quite different chemical structures from each other, the chain as it assembles into a protein acquires a characteristic 3-dimensional shape, parts of which may be tethered to other distant parts and so create huge convoluted shapes in solution, almost nest–like. A hormone has its transforming effect by dint of its complementary attraction to such a nest and then binding with the protein and changing its shape. If the receptor protein has its tail within the cell, any change from above will signal a need for change below. This shape-shifting induced by a hormone or similar substance triggers change within the cell. Within the Parasympathetic division of the Autonomic Nervous System, the two kinds of receptor are named *nicotinic* and *muscarinic* because their activity can be mimicked by creatures such as the tobacco plant *Nicotiana tabacum* and the fly-agaric mushroom *Amanita muscaria*.

The nerves of the parasympathetic dominate vegetative states and so supply all the organs of digestion, maintaining tone in the smooth muscle of the digestive tract and inhibiting supply of blood to the muscles. These nerves, secreting the neurotransmitter acetylcholine to receptors throughout the digestive system allow us to store materials for growth, repair and reserves for activity. The sympathetic does quite the reverse and, by secreting amines such as the neurotransmitters adrenaline and noradrenaline, sequesters the blood supply away from the digestive organs to the muscles. Although we may feed (and even sleep) by daylight, we cannot eat while asleep and we cannot reach that state in an environment drenched in adrenaline or substances like caffeine which evoke its effects. Digestion and sleep on the one hand, activity (with athleticism at the extreme end) on the other. '*Perchance to dream:'* digestion involves also the imagination: the absorption and storage of information as well as substance. The smoothness and facility of the cycling between these two complementary systems is a characteristic embodiment of the *terrain* and makes its appearance in the new–born whose qualities of feeding and sleeping may be an indicator of a life to come.

For a successful life, the alternation between the dominance of the parasympathetic and that of the sympathetic, between acetylcholine and adrenaline, must be adaptable to environmental change but it must also be responsive to the relatively unchanging alternation between night and day. Indeed, as Claude Bernard, who discovered the hormone glucagon, pointed out in 1859, we can only achieve independent life by maintaining constancy within[12]. To reinforce this recognition of the variable against the

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12 *La fixité du milieu intérior est la condition de la vie libre*. This notion was amplified by the phrase attributed (probably falsely) to Louis Pasteur in describing innate immunity: *Le germe, ce n'est rien. Le terrain, c'est tout*.

backdrop of the invariable, the pacemaker in the SCN is reset each day. Of course, the ambient temperature may vary considerably and erratically; homeostasis defines the tolerable limits of change while the circadian system codes for the periodic variation. By noting smooth variation, unlike random, aperiodic and abrupt changes like temperature and humidity, the pacemakers generated by the SCN are able to measure the rate of change in day-length and so anticipate thresholds which will in a measurable future, require metabolic change. Transition from summer to winter must be predicted long before the onset of cold.

Peripheral clocks like the liver

Timers and timing invest our bodily functions. This timing is endogenous, that is to say that a pulse is generated in the SCN and can then be modulated by changes in the diurnal environment. Almost anything physiological that can be measured reliably exhibits a maximum and a minimum at certain times of day and night. Even homeostatic norms—so narrowly fixed that they may respond to change—alter in their responsiveness according to the diurnal phase. One of the variables most stable in its variation with the light/dark cycle is body temperature. Peak efficiency occurs with the highest values, while the lowest will have energy sparing effects. This oscillation is probably not a driver but an output state, a result. Almost certainly there must be a circadian rhythm for alert wakefulness which must anticipate the onset of daylight before dawn. This effect follows the surge of the hormone cortisol, secreted from the outer layer of the adrenal glands. This daily surge has been shown to be remarkably constant throughout the world to occur close to 4 a.m. and thereby ties the hormonal system to the SCN. The steep rise in cortisol peaks at 8 a.m. The surge of this vital hormone correlates with the statistical finding that the majority of births and deaths occur during this period of the day. Homeostasis also requires a rest and therefore generates a cycle for sleepiness, a state maintained by melatonin secreted by the pineal gland and possibly by photoreceptors elsewhere. If the homeostatic pacemaker is to achieve sleep, it must disallow body organs or systems that would inhibit it, which is why the liver—as the metabolic centre and clearing house—must follow the dictates of these two opposing pacemakers, one for sleep the other for wakefulness. Conservative cultures tend to reinforce these cycles and can probably only emerge in predictable ecosystems with a constant food supply.

However, we are not automata: desires, needs and circumstances may impel us to frustrate the synchrony of the wake/sleep cycle by eating at a time when the liver is not at peak efficiency[13]. The kitchen staff may have gone home, but the chef can be roused from his bed!

Changing seasons

In northwestern Europe we enjoy or suffer as many seasons as there are months, each of which has been emblematic of particular change in the flora and landscape. Descriptive calendars—pictorial or in verse—held a mirror to the activity of hunters, shepherds, gardeners and farmers. These emblems, as we all know, gave names to phases of the year which have persisted from our prehistory and were appropriated into the Christian era. Our temperate climate gives us gradual change and rarely sees the abrupt and

13 Another circadian clock in another part of the hypothalamus to the SCN has been postulated to take over the control of activity during times of starvation. The idea is highly plausible and probable, but experimental proof is not yet complete.

predictable swings of those deep within a high latitude continent. Our weather is often "unseasonable" which is another way of saying that we have weather while others have climate.

While there may be 13 months in the 12 adjusted solar phases, each one presenting early hunters and farmers with gradual adaptive challenges, it is important not to confuse this gradualism with the seasons, of which there only two: summer and winter.

Most animals are either nocturnal or diurnal in habit though have programmed suspensions of habit. Migrating nocturnal birds, for example suspend their photophase preference during their long flights. In evolutionary time, nocturnality may have been an adaptation to the dehydrating effects of the sun and to minimise the deleterious effects of ultraviolet radiation on DNA. Diurnality would have to wait for a covering skin able to conserve moisture. Humans have devised a pigment system to protect against damage from ultraviolet rays while using their power to synthesise the steroid cholecalciferol, the prohormone which conveniently doubles as vitamin D. Some few species of animal are crepuscular, showing peak activity at dawn (matutinal) or at dusk (vespertinal) or, like the giraffe and rabbit, at both times. Crepuscular animals are nervous creatures: they have sought a food niche when diurnal predators are settling down and nocturnal predators have yet to be fully roused. Living on the edges promotes a heightened state of awareness which may be exhausting to maintain. As in the day so in the year, the edge between summer and winter is a slow, long wait.

THE CALENDAR AND HUMAN HEALTH

The treatment of dysregulation of the menstrual cycle with its periodic flow is likely to form a large part of any herbalist's working life. Most other conditions might give the impression that they are not periodic, especially where the sufferer discerns no calendric pattern, but aperiodicity is rare in biological systems which tend to entrain metabolic processes to external rhythms. The most pervasive entrainers are light and darkness. The biosphere is of course embedded in that rhythmic alternation between the two and may be said to have emerged from the physical non living world[14]. As mentioned in the Introduction, the study of rhythmic biological processes is called chronobiology, though given our planet's period of axial spin, the term is almost synonymous with the term circadian physiology. The approximation implicit in circa (about) reminds us that organisms are not at all like clockwork: rather they wobble about a mean. Because of the earth's elliptical orbit, not all 24 hours are of identical length but vary from aphelion to perihelion, to say nothing of the huge variations in daylight length. The tilt of the earth which gives us these seasonal changes allows for the ranges of temperature to be moderate and permit life to adapt to rhythmic changes which would be impossibly large without the 23 degree deflection. It is very probable that geological distortions of our magnetic field as well as the direct effects of the rocks on humidity, ionisation and other elements of the micro–climate influence human health, but these will not be discussed here as we are more able to travel away from a particular environment than we are to escape night and day. Besides, the subject has been considerably less studied and so there is less evidence to present. It is so much more complex that it would be difficult to

14 Even here,—in radioactive decay, for example—periodicity is commonly found.

imagine how to generate a comprehensive hypothesis. By contrast, the orbits of the earth, the sun and the moon are at least computable.

THE BORDERLINE

Circadian clock allows us to organise ourselves alternately between the nocturnal and diurnal with a period of between about 23 and 27 hours, resetting the pacemaker daily. The transition time in the tropics is too brief to allow the emergence of successful crepuscular animals. They belong to high latitudes where the transition zone lengthens with distance travelled. While the clock is an oscillator with a regular period, it is also an alternator and distinguishes between two phases marked by two invariant hormones: cortisol and melatonin. The former is the more powerful driver and gives the lead to the cycling of the other hormones, with the thyroid hormones as setters of the basal metabolic rate in close pursuit.

The resetting of the pacemaker to some extent compensates for seasonal fluctuations. Plants measure the length of day and so measure the other alternation, between summer and winter. Their capacity to make carbohydrate diminishes as the daylight period shortens.

What we call spring and autumn are larger and more gradual alternations of the borderline periods analogous to dawn and dusk. Resetting of thresholds for functions of cortisol and thyroid are made each day to prepare us for the coming day and the night that follows. Parallel adjustments have to be made in early autumn and early spring for them to provide anticipatory adaptations. This is why the *zeitgeber* must be temperature compensated each day and perhaps even more during each borderline season. This zone of the *warning* of change induces in some individuals more than others a change in perception, a liminality of mood, of an awareness of the finity of resources, even of an impending crisis.

2: HEAVENLY TIME

PHOTOPERIODIC PLANTS AND THE MIDPOINT

I have had to get used to the meteorologist on television declaring the first day of June to be the start of summer, blithely going on, just three weeks later, to speak of midsummer. To be fair to them, they are marking cultural ideas about weather rather than climate, but I was surprised to read in an article on chronobiology that:

> In the Northern Hemisphere 21 December marks the beginning of winter, when the North pole is maximally tilted away from the sun.

The solstice is more appropriately a middle point and indeed is called midwinter's day. Now there may be reasons of weather and culture to so describe the seasons, but from an evolutionary and biological point of view, the intensity and duration of light determines the seasonal response. Vitamin A, which is required to generate the photopigment rhodopsin in the retina, is stored in large quantities in the liver, so even if dietary sources are meagre in the winter, impairment of visual acuity is not particularly likely. Even at very high latitudes, seeing in the dark is as essential as daylight vision. The situation is not the same for cholecalciferol (D3), the other fat–soluble vitamin which can also be stored but for which demand may be greater.

Thirty-four degrees is the highest latitude at which Vitamin D can reliably be synthesised in the skin on every day of the year, cloud cover and other obstacles permitting. This puts the inhabitants of Los Angeles, Rabat, Tripoli, Beirut, Bagdad, Peshawar, Nanjing, Osaka, Santiago and Buenos Aires, Cape Town, Sydney and Perth under low pressure to store this crucial prohormone in their livers. Above latitude 40 degrees there is insufficient light to make Vitamin D between early November and early March[15] before 10 am and after 3pm, and even in these middle hours, 40% of the body needs to be exposed for ten to fifteen minutes. At latitude 50, the relevant period is mid–October until mid–March between the hours of eleven and one. Above latitude 52, Vitamin D cannot be synthesised in the skin at any daylight hour from late September until just before the vernal equinox in March. The photoactive pigment Chlorophyll plays, as one might expect, a large part in the signalling pathways that determine strategies in broad–leaved woody plants. Haeme, the other photoactive pigment on which our survival depends, resembles it in structure. Not all green plants are photoperiodic. Studies suggest that the genera that exhibit this mode appear to have evolved between latitudes 34 and 44 degrees. To give Europeans a local hint, this range includes the spot at which Avignon sits.

This photoperiodism may be co–evolutionary with the deciduous habit but whether deciduous plants migrated to higher latitudes is uncertain as the interpretation of pollen data is complicated by the relatively recent interglaciation and concurrent mountain building. The effects of melting over the past 10,000 years show regional and continental differences which depend upon the orientation of mountain ranges. The situation is most complex in central Asia and the Caucuses. In the Americas, the axes of

15 With converse dates in the Southern hemisphere. I am using dates in the Northern hemisphere for ease of reading and because it contains so much more landmass at higher latitudes and larger populations reside there.

the larger and higher mountain ranges tend to lie North–South, so that floristic flow after the melt that created the Great Lakes in the North was relatively rapid and uninterrupted whereas in Europe the higher mountain ranges are orientated West–East and so act as floristic barriers. All of these factors may contribute to variation in human steroid metabolism[16] as different populations interact with local plants for food and medicine and feed for livestock. All of these influences serve as reminders that some qualification is needed in interpreting the response of the individual to seasonal shifts in day-length and how great a variance humans exhibit on account of our foraging mobility and adaptability. Nonetheless, we cannot feed ourselves without light.

Photoperiodic plants are strongly temperature compensated and regulate their feeding and reproduction by measuring day-length. They measure the time elapsed between a burst of blue light after one scotophase[17] and the next occurrence of light of this predominant frequency before the next scotophase. In a similar way that animals entrain their metabolic activity to circadian rhythms, plants cycle complementary proteins matched by rhythmic switching on and off genes involved in 'timing'. These proteins and their respective genes are part of what is known in plants as the phytochrome system and has analogies with our own set of photoreceptive and photo-activating systems. Just as humans need to be woken up before there is any appearance of light, so these plants need to anticipate the equinox as a presage of early summer. The blue light signal for the phase switch has four robust daylength markers: the equinoxes and solstices. When there is an adequate duration of light for reliable photosynthetic feeding, the flower buds are primed to succeed the leaves. In plants more reliant on mean ambient temperature, the flowers may arrive before the leaves, with energy obtained from stores made the previous summer. You may observe this in the English countryside. Blackthorn[18] is a very common hedgerow shrub in brilliant white flower by early March, or earlier in a mild year, before or with the leaves. Later on, in the same hedge or nearby, as it is the commonest shrub in the countryside, Hawthorn[19] will flush into leaf. It will flower some weeks later in May. These species of *Crataegus* afford us a good example of a photoperiodic predictor that operates in a fashion analogous to ourselves. At the time of year when people are wont to remark "the evenings are drawing in," it is instructive to examine the buds of Hawthorn. The bud scales will be tightly sealed and the abscission line between bud and stem will darken indicating that it has lost its porosity. These manoeuvres will enable leaves to be shed very rapidly at the onset of cold, but the temperature response is secondary. Species like those in *Crataegus* have understood that the main period of feeding is over, that during the following three months it can photosynthesise only at very low efficiency. It appreciates in July that the peak has past and sets in train the measures I have just described to protect its buds. These buds are effectively embryos that are sealed to survive the winter: called organs of perennation by botanists, they are vital to the survival of the plant. If the summer solstice is the peak and the following equinox marks the threshold of effective feeding, it cannot

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16 Steroids form a large and very important class compounds which include the sex hormones and Vitamin D; a key start–up molecule in their biosynthesis is cholesterol.

17 This is the dark phase of the light/dark cycle and contrasts with the photophase.

18 No. 139 Blackthorn *Prunus spinosa* L in Barker (2001) Medicinal Flora - Field Guide to Medicinal Plants of Britain & Northwestern Europe

19 No. 137 Midland Hawthorn *Crataegus laevigata* (Poiret)DC, & No.138 Hawthorn, Whitethorn, Maythorn, *Crataegus monogyna* Jacq in Barker (2001)

wait until then to shut down metabolic expenditure and protect itself from the inevitable dark phase. It must set all this in train by the midpoint.

We can theorise when this midpoint occurs then test the date by simple observation. No expensive laboratory equipment is needed, though an achromatic hand–lens helps to see the beauty of the detail. The validating procedure calls for nothing more than a stroll down the lane!

We should expect to see these changes midway between the solstice and the equinox. If the earth's orbit around the sun were circular, we should just count dates. Dates themselves are approximate labels for the actual astronomical events; otherwise the date of the solstice would be invariable. The number of perturbations in the orbits and angles of tilt, and some of the long cycles, some of them precessional, make all calendars inherently inaccurate in the long term but convenient in the short with all the adjustments built into them. Given all these fudges and bodges, and based upon stabilising the date of the 4 poles of the year at about the 21st, we arrive at the two **midpoints** of August 6th and February 6th. If these are true, they give us the **first days** of **autumn** and **spring** respectively**.** By extension, you will count to May 6th and November 6th as the first days of summer and winter respectively.

It was in the first week in February 1963, when it was icy cold, that I first made a point of examining Hawthorn buds. Red lines could be seen entering the bud in the axil of the leaf scar from the previous year. The tips showed signs of loosening. This was beside the Thames in Teddington, Middlesex. I have made an examination of the buds in the first weeks of August and February in southern England in most years since that date and have found the initial observations to be repeated. You may wonder why I chose to verify events which have empirically been known to be true for so long. The manipulation of the flowering of Short–day and Long–day plants provide the basis for the huge business of floristic horticulture. These are defined as those plants that need, respectively, to perceive a critical shortening or lengthening of days to initiate flowering. My interest is to observe it in nature and to see if there are any correlations with human physiology.

Earth's orbit is not circular but elliptical, which adds but one factor to the inaccuracy of the match between events in the heavens and how we notate them for everyday convenience. The ellipse our planet makes is not, however, very eccentric. A circle is said to have an eccentricity of zero, with ellipses having a value between above zero and lower than one, at which it becomes so flattened that it effectively becomes a line. In a sense, the number is just an index of the degree of deformation of a circle. (Visualise squashing a ball.) Earth's orbit is nearly circular with a current value of about 0.0167. It waxes and wanes mainly following the gravitational pull of the other solar planets. The principle effect of the eccentricity is to make the actual length of a day–and–a–night[20] in the northern hemisphere's late spring and summer a little longer than the rest of the year. More influential on the midpoint is the latitude because as the day's duration increases or decreases between the solstices, the rate of increase gets larger the higher the latitude. Although this rate of change of daylength at high latitudes is most marked near the equinoxes, the rate of change flattens out at each solstice and approaches zero as the change goes from increase to decrease, or vice versa.

20 known as the circadian or nycthemeral cycle

TRANSITION

For all these approximations, the midpoint can be realistically described as an arithmetic mean about which phase transition will occur. Although the hormonal and metabolic processes in plants may take many weeks, the photic trigger will be measured over just a few days. The *phase transitions* between the light and dark seasons we call autumn and spring. The quantitative and qualitative separation between summer and winter does not really appear below latitude of 34 degrees, as we have already discussed. The rate of change increases with latitude. The question we are asking is how we humans manage the transition as the latitude increases. Much more of the landmass above 40 degrees lies in the Northern hemisphere and it is in Europe where much of the epidemiological observations have been made. It has been observed, long before the recent advances in chronobiology, that hospital admissions for peptic ulcer in northern Europe showed very high peaks in August and February. A peptic ulcer causes much pain and distress, and some types are associated with poor outcomes in the long term. In the short term, an acute incident carries the very real of the ulcer eroding an artery with the ensuing haemorrhage a threat to life, hence the hospitalisation. Other inflammatory conditions show some peaks according to season, often also in August and February. This is apart from the coughs and colds of winter in Northern latitudes that are predictable enough to drive healthcare planning. From my early years in clinical practice, I could not fail to notice annual or biannual rhythmicity in certain inflammatory and reactive conditions, mostly in spring but also in autumn, which is how I came to have a close interest in the subject. Experience of more than 35 years has confirmed rather than confounded these early observations of mine.

The timing of oestrus and mating in most mammal species that have been studied show unmistakeable rhythms that are highly determined by availability of sunlight, and therefore food. We are less constrained: circannual rhythms in humans can be modulated by many other environmental and social cues. Besides, as we did not evolve in high latitudes, our gene pool for this adaptation will not be uniformly rich. Still, the sun remains the time-giver and timekeeper of all our lives.

3 THE CLOCKS WITHIN: ADJUSTING FROM WINTER TO SUMMER AND BACK AGAIN

DRAMATIS PERSONAE

How, then, does the hypothalamus communicate with the body and set up the adaptive metabolic and immune responses? It first relays the information via the pituitary gland.

First, it secretes four sets of 'releasing factors'[21] which direct the anterior lobe of the pituitary gland (pictured in Figure 3.1 below) to secrete half a dozen or so different hormones, each of which will stimulate a specific target organ or type of tissue. These few potent intermediaries are a handful of key players in a vast population of cells, to say nothing of enzymes and other catalysts.

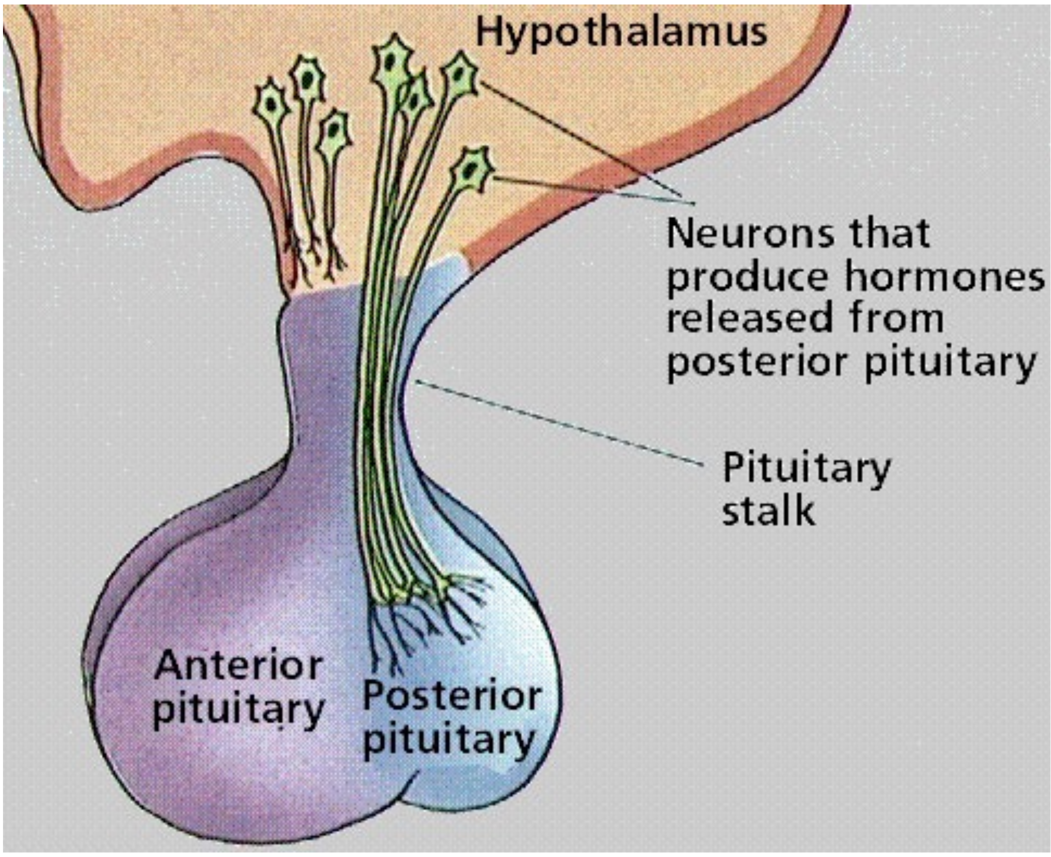

Figure 3.1

These hormones with their target organs are listed in table 3.1 below:

21 the most important are: Growth Hormone Releasing Hormone (GH–RH), Thyroid Stimulating Hormone Releasing Hormone (TRH), Corticotropin-Releasing-Factor or Hormone (CRF or CRH already mentioned in Section 1)

Hormone name	Abbreviation	Target endocrine organ
AdrenoCorticoTrophic Hormone [also Melanocyte Stimulating Hormone]	ACTH [& MSH]	Cortex of Adrenal gland
Follicle Stimulating Hormone	FSH	Gonads & other reproductive tissue
Luteinising Hormone	LH	Gonads & other reproductive tissue
Thyroid Stimulating Hormone	TSH	Thyroid Gland
Growth Hormone	GH	Most cells & Tissues
Prolactin	PRL	The Breast but also Liver & other Tissues

Table 3.1

The target organs in their turn secrete their own hormones as shown in the table below; the righthand column in the table above duly becomes the lefthand column in the table below:

Endocrine organ	Hormones produced
The paired **adrenal glands** sited above the kidneys produce a number of different steroids as shown on the left: [the supplementary effect of MSH which induces pigmentation by melatonin (otherwise a response to UV light) is often the result of chronic maladaptive stress]	Corticosteroids especially **Cortisol** Mineralocorticoids especially **Aldosterone** **Androgens**: Male hormones which may compensate for gonadal activity
Thyroid gland	Thyroid hormones usually abbreviated to T_3 and T_4
Ovaries and **testes**	Oestrogen & testosterone & progesterone
Cells in almost all growing tissues	Factors that increase uptake of proteins & fats
The **Breast**; also Liver & other Tissues	Factors that modulate the immune system

Table 3.2

The effect of rising levels of these hormones in the blood will be to switch off the initial stimulating hormone at the pituitary and so create a series of negative feedback loops. Growth Hormone (GH) and prolactin (PRL) operate more complex networks, with the latter under inhibition rather than stimulation from the hypothalamus. Prolactin seems also to have reciprocal relations with Dopamine, a hormone and neurotransmitter that could be likened to the adrenaline of the Central Nervous System (though it has an opposite inhibitory action in some situations).

The two hormones of the posterior lobe of the pituitary are very fast acting: Anti–Diuretic–Hormone (ADH) rapidly polices the state of hydration of the whole body while the effects of oxytocin in sex, childbirth and lactation are rapid, and operate in concert with other drives and functions. Impulses such as thirst, hunger, desire as well as fear and rage are integrated in the hypothalamus to allow their discharge as behaviour unless inhibited from cortical centres.

These hormones mentioned in the tables and text above (a score or so) are the main players but there is an ancillary cast of thousands; nor does this simplified basic plan explain the constant interdependence between the organs which serve as the theatres of operation.

The kidney is not only an excretory organ: besides its role in the elimination of waste and the maintenance of global pH, it functions also as an endocrine organ that regulates the bone marrow. Likewise, the small intestine for all its primary digestive activity, produces a larger array of different hormones than does the hypothalamus itself.

Secretory activity is not the only measure of the complexity: the hypothalamus serves to integrate not only the function of the organs but to create major spheres of influence in the hormonal system at large. The overall consequence of each of these hormonal sub–systems (of which there are four **axes)** is outlined in the table below:

The Four Axes:	**Adrenal** [General Adaptation System]	**Gonadic** or Reproductive	**Thyroid**	Somatic or **Growth**
Key product:	Cortisol	Oestrogen, progesterone & testosterone	Thyroxine	Growth Hormone
Chemical type:	Steroid	Steroids	Iodinated amino acids	Protein
Influence upon Autonomic Nervous System:	Tends to attenuate α–sympathetic receptors	Tends to amplify parasympathetic (female) and β–sympathetic (male)	Tends to attenuate β–sympathetic receptors	Will tend to amplify parasympathetic receptors
Overall metabolic effects	CATABOLIC	**ANABOLIC**	CATABOLIC	**ANABOLIC**

Table 3.3

Catabolic activity means a net breaking down of materials overall while the opposite **anabolic** activity refers to the building up of larger structures from smaller ones at either the molecular, cellular or tissular level. Catabolism will always precede anabolism for the simple reason that to construct anything, the constituent materials must be brought to site. Intuitively, one would think it easier to build a body when it is stationary, and so it is: anabolism functions mostly during sleep at night, and the active catabolism by day. This alternation of metabolic function matches the sleep/wake cycle.

This division of labour is by no means absolute: a ruminant part of the day is allotted to feeding on the products of the activities of gathering and hunting (or shopping as it has become). This pause allows the parasympathetic to recover dominance from the sympathetic. As discussed earlier, the hypothalamus integrates and controls the different divisions of the autonomic nervous system (ANS), so it should come as no surprise to learn that each endocrine axis will tend to favour the distribution of one or other as is shown in the table above. It must be stressed that the axes work only in concert towards the unitary building and maintenance of life. The deep perception of yin and yang is not so much the contrast but the interpenetrative nature of life so expressed. Just as altruism can only co–exist alongside self–fulfilment, so the deepest sleep is penetrated by the highly active REM sleep, with its dreams of another world. So, in the *terrain*, the gonadic axis could achieve nothing without the somatic. While maleness and femaleness may be initiated on their journey by chromosomes, the somatic growth hormones work side by side with the sex hormones. The plural is required here: all people require all of them. While prolactin might make mother's milk, it also engages the boy and man. To descend into metaphor, if oestrogens are our sculptress and androgens our carpenter, then prolactin might be the plasterer, the finisher. As all materials come from the sky, sea and earth, the generator of the terrain is outside ourselves and so the part of us that feeds exhibits more neurohormonal activity than even the brain. Connecting the brain with the digestive tract and, in health, seamlessly integrating them is the Autonomic Nervous System, to which we must now return.

To add another feature of the opposing but complementary functions of the two[22] sides of the ANS, Sympathetic fibres have two classes of activity named after the first two letters of the Greek alphabet. For the most part, their actions are opposed so that smooth muscle will dilate as the result of stimulation by beta fibres, while by that of alpha fibres, they will constrict. Smooth muscle is found in sphincters which control flow of secretions or excretions through a tube and in the walls of blood vessels, so controlling their state of functioning. My colleague and mentor Dr Jean–Claude Lapraz highlights this innervation by the alpha–sympathetic as a state or transition phase. He uses a number of illustrative analogies; for example, the Parasympathetic he likens to the loading of a gun, the alpha to cocking the trigger and the beta to shooting. I think of the starting gun in a race and like to simplify the figure to: "**on your marks,** *get set, GO!*

Table 3.4 summarises the sequence:

Parasympathetic	Sympathetic	
Nicotinic and Muscarinic receptors	α–sympathetic	β–sympathetic
Congests by fluid secretion and retention by constriction of outflow	Locks closed the congestive state	Discharges the congestive state

Table 3.4

22 The interactions of both within the digestive tube within the enteric nervous system, create almost an additional autonomous division.

The locked, bracing phase of the alpha state[23] particularly affects sphincters in the digestive tract and in the blood vessels, leading to a wide range of symptoms and signs. As the movement from one state to another parallels the transitions in the sleep/wake cycle, it will be appreciated that any constitutional dysregulation of the ANS will be amplified by seasonal transition, signalled by arrival at the **midpoint** in August and February.

Returning to the four axes, the most invariant setting of the circadian system is the hormone **cortisol** which starts its longest and deepest descent two hours before midnight and comes on stream more or less abruptly at 4 o'clock in the morning and reaches its peak four hours later. [As the adrenal axis is the site of primary adaptation, it has been termed the General Adaptation System (GAS)].

The second catabolic axis, that of the thyroid, usually peaks mid–morning with a trough in mid–afternoon. Cortisol wakes us up and resets the clock for the next day. It does so by permitting and setting the activities of the other hormones. The actual events are of course less schematic and are much adjusted by the autocoid hormones, notably: serotonin, melatonin, histamine, dopamine as well as neurotransmitters such as noradrenaline and adrenaline, the amino acids glycine and GABA (inhibitory), and glutamate and aspartate (excitatory). People with dissociation between levels in their brain and in their periphery will no doubt experience turbulence in their daily perceptions. I suspect that such imbalances account for those who show undue sensitivity to meteorological turbulence, especially high winds.

There are at least two dozen other known modulators of neurohormonal function including opioid peptides and other polypeptides, to say nothing of what we have yet to learn. Cortisol is catabolic in that it is a glucocorticoid which means that it mobilises and maintains energy at the expense of protein. Too much cortisol will thereby thin the skin. A thinner skin offers less protection and will induce hypersensitivity. People who are emotionally thin–skinned will inevitably be so physically and will have been subject to elevated levels of circulating cortisol for a long time, perhaps during their time in the womb.

Cortisol gets its name from cortex, whence the adjective cortical. The *materia medica* of the doctors and anatomists of the Renaissance in North Italy consisted largely of medicinal plants; they were in effect botanists and herbalists. With the introduction of better lens', they noticed, particularly the pioneer anatomists at the medical school in Bologna, the apparent similarities between plant and animal tissue. Just as the outer *bark* of a plant differentiated from the inner *pith*, so the outer region of various organs such as the brain and adrenal[24] gland, seemed likewise to be so differentiated. In the *lingua franca* of the day, Latin, bark and pith were cortex and medulla respectively. Cortisol, then, is secreted by the 'bark' of the adrenal gland! The 'pith' is really a Beta–sympathetic organ that secretes adrenalin and some dopamine!

Orthodox medicine, in so far as it makes these hormonal axes explicit at all, is concerned with vertical relationships between pituitary and target organ. For a doctor, the first line of endocrine investigation is likely to be a blood test. Terrain theory, by contrast, brings a very close focus to bear not so much on levels found in the blood, but

23 No association with alpha brain waves is implied or intended.

24 The name means 'close up to the kidney'

upon the *ratio* between the various elements found within the axes. These are horizontal relationships in the sense that they operate at the same physical level as opposed to the vertical, top–down, from pituitary to the body below.

Thus, we get very limited information by measuring a single or even the hormones in one axis alone. For example, to measure cortisol in the blood does not reveal the ratio between cortisol and the various elements of the thyroid axis (i.e., with TRH, TSH and the thyroid hormones themselves; see Tables 3.1, 3.2, & 3.3 above). These inter–relationships will modify feedback to the hypothalamus and pituitary from cells and tissues.

In this way, a patient whose thyroid function deduced from laboratory tests is perfectly normal (euthyroid), and in whom the thyroid gland may therefore be excluded as the cause, for instance, of persistent unexplained fatigue is indeed suffering from dysregulation of the thyroid axis. The thyroid gland is in no way impaired—hence the serum TSH found to be within normal bounds—but the demands made upon the whole thyroid axis by the settings of the adrenal axis result in a dysfunctional fatigue. Whether this will eventually lead to actual thyroid disease will depend upon the relations between it and the demands of the other axes. These demands come from within and without, the capacity to respond draws upon a wider source than a single gland or hormone.

Another kind of dysregulation may follow from an over expression of one of the anabolic axes relative to the catabolic speed of cortisol. Oestrogen, for example, can have a dampening effect upon the thyroid axis. This need not imply that huge amounts circulate but reflect a skewed relationship between hormones higher up in the axis, often in the ratio of FSH to LH. To complicate matters further, the powerfully anabolic hormone prolactin can induce a heightened receptivity of oestrogen–sensitive tissue, a demand which the gonadic axis cannot meet.

The task of the phytotherapist faced with this situation is to discover which hormonal relationships are under strain. Of course these strains may reflect strains in the patient's life or in the life of the mother, or mother's mother as the egg that became the present patient was imprinted with the hormonal relationships created by the exigencies of *their* lives.

The hypothalamus is anatomically very closely connected to a number of structures known collectively as the limbic system. Within these circuits, it has been postulated,[25] memories are stored along with their emotional colour and associations. If so, the limbic system may function as an integrator of drives with capacities. But the traffic flows in both directions which is to say that emotional stress may be generated internally as much as a response to external events, so the hormonal system, especially the adrenal/stress axis has to accommodate internal stressors as much as external ones.

Just as in the homeostatic system, if body temperature, *p*H, oxygenation, blood volume are adequately buffered against fluctuations, the person need not be aware of change, or will recover quickly from abrupt alteration, so in the circadian system such a person will go from day to night, from morning to afternoon and from hunger to satiety with apparent ease.

The person who, at least on occasion, and perhaps periodically, finds difficulty with the adaptations required by alternations in the sleep/wake cycle will have a much greater

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25 The classification is not universally accepted by neurophysiologists and the subject is controversial.

difficulty in the crepuscular seasons of autumn and spring. As the seasons are so much longer than a single day, these much longer transition periods will attenuate the difficulties.

The pre–seasonal syndrome of autumn requires the G.A.System of the adrenal axis to change settings in the thyroid and somatic (GH) axes because prolactin is needed to augment the number of cell–surface receptors. Without these, none of the endocrine changes will produce metabolic benefits. The stimulus will come from hypothalamic TRH[26] and will result in a temporary mismatch between TRH and TSH. This switch will transfer the person to a liminal state and may make him or her feel very unwell, often with some difficult in saying exactly how. Given that the temporary misalignment occurs in the thyroid axis, symptoms of both over– and under-activity (paradoxically at the same time) are not unusual. Testing the thyroid function from blood will report entirely normal. This should come as no surprise as no disease has been caused, but rather a temporary maladaptation.

In a person with such an autumnal syndrome, a rise in the potential for histamine to be expressed is likely: its congestive activity (however uncomfortable) will help store the necessary ingredients for the coming season, just like the squirrel. Responses to insulin will be re–calibrated as a result of changes in the somatic axis: Growth Hormone, prolactin, and insulin all have close structural similarities. Besides, this is an anabolic axis and insulin is the primary anabolic hormone. Winter is a time to store.

As might be expected, spring provides us with an opposite pre–seasonal syndrome to that of autumn. The photic trigger is provided at the midpoint between winter and summer in early February. This seasonal change expected and prepared for by the circannual system in the hypothalamus will eventually requires less heat from the thyroid in its homeostatic function and so the ratio between TRH and TSH will again change, but in the opposite direction. New grass, new proteins.

Liver function must up-regulate to deal with this new situation. A person overwhelmed by these changes may express this as eczema. Fungal conditions (related at least in part to reciprocal relations between thyroid function and insulin) are common in both spring and autumn. Insulin resistance tends to rise. Levels of DHEA, an androgen hormone from the adrenal gland, may rise and so aggravate acne. The heralded summer will be a time of expansion and growth for which the contraction of winter should have prepared us. Small wonder that problems with anabolic and proliferative functions should characterise the vernal syndrome.

As we have just seen, the person who experiences some difficulty with the cycling between night and day will have a much greater difficulty in the transition between the seasons of winter and summer. Such a person invariably suffers some imbalance in autonomic expression. A common manifestation of this is caused by too much or too little **vagal tone**. This refers to the vagus, a major nerve of the parasympathetic branch of the ANS distributed widely throughout the organs of the chest and abdomen. Inappropriate vagal tone will give rise to chesty and digestive problems, as well as those of ears, nose, sinus and throat.

Too much tone in sphincters, from an over–stimulated alpha–sympathetic relative to beta–sympathetic (refer back to Table 3.4) will cause tension and exhaustion. This

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26 Thyrotropin–Releasing Hormone. TSH is Thyroid Stimulating Hormone.

alpha–sympathetic fixation may result also from a reactivity provoked by the transition from parasympathetic to sympathetic. We differ in our capacity to cope with change, whether inclines or declines.

Relativity is the key here: a hill may be as steep at sea level as atop a mountain; to measure the steepness alone as if it were an absolute value without reference to altitude oversimplifies the picture. Absolute values, be they high or low, mean little in themselves. These settings of the ANS in an individual should not be seen in isolation from the many other factors which congregate at the hypothalamus, notably the endocrine state of the terrain as evinced by the constitutional balance between the four axes and the relationships between each and every actor within the whole dramatic entourage.

If a person finds life to be a perennial catalogue of difficulties expressed as tiresome and even disabling symptoms, without any definable disease in place, a therapist using the perspective of the terrain like myself would describe them as suffering from a mismatch between their capacity to adapt and the burdens they place upon themselves or those placed upon them. A phytotherapist is one who uses plants to nudge elements of the terrain towards an easier accommodation of the world by way of the four axes and the autonomic nervous system, modulators of which are to be found in common and readily accessible plants.

4: ADAPTATION: THE CAPACITY TO MANAGE CHANGE AND TRANSITION

UP, DOWN & ACROSS: VERTICAL AND HORIZONTAL

As we have seen, the four endocrine axes emerging from the hypothalamus and pituitary gland each have a fundamental character. They function to maintain metabolic life as summarised in Table 4.1 below:

ADRENAL AXIS General Adaptation System	Prepares and alerts us to the needs of our world and makes available the requisite materials for all our metabolic and structural needs.
THYROID AXIS	Brings the requisite energy for all our metabolic needs.
REPRODUCTIVE AXIS	Uses these materials to build muscle (male hormones) and bone (female hormones) as well as building the means to create new individuals.
SOMATIC or GROWTH AXIS	Builds and feeds the individual; it also builds and feeds the offspring in conjunction with The Reproductive Axis.

Table 4.1

All four axes work in conjunction with each other in **horizontal** connections as much as the **vertical** connection to the target organs as shown in Table 4.2:

ADRENAL General Adaptation System	GONADIC or REPRODUCTIVE	THYROID	SOMATIC or GROWTH
Cortex of Adrenal gland	Gonads & other reproductive tissue	Thyroid Gland	Growth Hormone stimulates most cells & tissues Prolactin stimulates the Breast but also Liver & other Tissues

Table 4.2

In modern medicine (where the primary concern is the preservation of immediate vital function) organ condition is considered almost independently of these hormonal controls. Even in endocrinology, the concern of the specialist is only with the vertical axes, and barely recognise the horizontal. They are concerned with hormones only so far as they are connected with a well–defined presence of disease. Their analysis is binary ('yes there is', *or* 'no there isn't' a named disorder) and so their interest is restricted to the well–defined feedback loops of the vertical axes.

To illustrate the medical approach where the interest is in the presence or absence of pathology, here (axis by axis) are the most common medical investigations:

ADRENAL AXIS	Destruction (usually by autoimmune attack) of the adrenal gland or a loss of its response to ACTH with a resulting loss of circulating cortisol is called Addison's disease. If replacement therapy is not carried out, death is almost certain within a week or two. President JF Kennedy was on permanent medication for this disorder. Although adrenal problems can arise from pituitary disease, destruction of this gland tends to show up more frequently in the Somatic axis. This is because the quantity of 'releasing factors' the four on account of the large share it takes of the gland. (Refer back to the second paragraph of Section 3 & footnote.)
THYROID AXIS	Thyroid disease is relatively common. The site of the disorder is most usually found in the gland itself rather than distributed throughout the axis. Thyrotoxicosis—a condition of raging heat and agitated tremor—is an extreme and exaggerated catabolic state which puts enormous burden on the heart if unchecked for too long. If the thyroid gland is attacked for too long, the opposite cold pole of hypothyroidism results which, if unchecked for too long, would inevitably lead to coma.
REPRODUCTIVE & SOMATIC AXES	Sebaceous acne is a hormonal problem of all four axes, needing the reproductive and growth hormones for the production of sebum. Cortisol in the adrenal axis is also unable to cope effectively in acne. Events in the skin rather than the endocrine cause is usually the focus of treatment by doctors. Polycystic ovarian disease is frequently treated with not particularly good results. Female sub–fertility attracts a good deal of medical intervention. Cancers of the reproductive tracts and their adnexial glands are very common.

SOMATIC AXIS	Giantism and Dwarfism are visually very obvious results of Somatic malfunction that occur before the growing plates are closed, usually by the age of 20. Acromegaly like Giantism is an over-productive condition that occurs after the growing plates have closed and so cannot contribute to height but causes great trouble in bone and connective tissue. Diabetes mellitus is the commonest malfunction of one of the peripheral glands in this axis, the endocrine pancreas, and of its product insulin. Again, whether you have diabetes or do not is measurable and decidable; it rarely calls for subtle clinical judgement.

Table 4.2

Whether or not herbal medicine (or phytotherapy to use a modern name) has any part to play in the treatment of the kinds of disease just mentioned, or any other, is not the purpose of this paper.

The focus of my discussion regards difficulties and common symptoms, such as digestive discomfort, irritable bowel syndrome, headache, cough and persistent catarrh, fatigue and extreme loss of energy, bouts of dizziness and giddiness, to name but a few. These are not failures of homeostasis. From a medical point of view sufferers are deemed normal. These and many other syndromes derive from the circadian system, where the management of the sleep/wake cycle is dysregulated. This does not necessarily involve obvious insomnia, though insomnia itself is often connected with symptoms mentioned above, especially IBS and fatigue. The pivot of the circadian response is the hormone cortisol and, crucially, the ratio between its effective functioning and reserve with that of the other hormones in other axes. These axes are considered as almost separate entities in modern orthodox medicine as I discussed above. The symptoms listed at the start of this paragraph will be more successfully addressed by considering the horizontal relationships at the pituitary and organ levels. It is disorder here as much as the vertical feedback in each axis that compromises well–being. The tension between circadian and homeostatic mechanisms causes friction that may not endanger life but considerably restricts it. Intermittent and unpredictable, such incongruence between the inner and outer worlds may impair the capacity to lead a life out of the shadows. The vulnerable periods are the predictably liminal times: the dusk at the end of summer and the dawn as it arises anew.

Our awakening in early August and early February to each midpoint between solstice and equinox will initiate a change in the adaptive circadian mechanism. Whether the change induces a crisis, whether now or later, depends upon one's individual terrain. The critical period will last potentially until the following midpoints in early November and early May (see Appendix 4). These midpoints between the equinox and solstice mark the termination of the transition zone, and so, logically, the beginning of mid–summer and mid–winter. In my experience it is rare for people to suffer a single crisis but rather two or three peaks followed by a resolution. It may take some time for patients to recognise and act upon the symptoms. Because these seem "to come out of the blue", they carry with them an anxiety as if at the onset of a disease process.

The physician's primary duty is to exclude disease but also to recognise the confusion and distress caused by seasonal maladaptation. Once pathology has been reliably excluded, effective herbal remedies are well placed to provide relief and reassurance when we are out of season. They are chosen "simply" to lower the adaptive burden and support the adaptive mechanism. This is done by assessing the *relative* states between peripheral gland and pituitary and hypothalamic stimulation (the vertical axis) but, with swifter effect, modifying horizontal relationships between the four axes.

The two posterior pituitary hormones oxytocin and anti–diuretic hormone are also implicated in seasonal change. The reason that plants should be taken in pregnancy with great caution is that so many of them are oxytocic and so are at risk of inducing miscarriage or premature labour. The phytotherapist is also quite challenged to find plants that are *not* oestrogenic. Responses to histamine and serotonin in *peripheral* tissues must also be considered as well as their relationship to these hormones in the brain. Assessment is made by the degree and type of agitation, or signs of the opposite, by a tendency to bruise and many other signs that show up on physical examination. Next, the phytotherapist must modify the transition in the ANS between para– and alpha– and beta–sympathetic modes. None of the above manoeuvres can be achieved without stimulating, draining or supporting the organs, especially the liver, but also pancreas and kidney.

Most medicinal plants have activity on one or more hormonal axes, on one or more divisions of the ANS and on one or more of the digestive organs. A list of (mostly native) medicinal plants follows the main body of text in Appendix 1. Naturally, they are arranged in botanical rather than alphabetical order. A selection of commonly found medicinal plants arranged according to their activity upon the terrain rather than upon symptoms or conditions will be found in Appendix 2. Finally, seasonal dietary advice should be given. These precepts will also be found in Appendix 3. The calendar in Appendix 4 maps days of equivalent day length.

Just as the secret of good comedy is *TIMING*, so is the practice of adaptive medication. Persuading the patient to recognise and anticipate the turning midpoint is far better than treating a crisis that is passing.

Some very common maladaptive states are deeply constitutional and are much affected even by a change in the weather. Cyclical fluctuations, whether circadian, circa-tidal or circannual, affect us all but there are those who, when faced with a sudden incline, convert such a change into a homeostatic challenge and so enter into a physiological state of irresolution.

One of the most entrenched forms of such physiological instability is migraine. This name collects together a disparate set of afflictions affecting very many people. They are episodic and have in common a sequence of events which are typical and predictable for the individual sufferer; only some of them terminate with migrainous headache. In clinical practice, one meets with many other presentations to which a different label than migraine is attached or which have no such handy label. Many of them are digestive disorders or catarrhal, or often both. On closer examination diverse episodic conditions have patterns in common. All of them tend to mimic or initiate psychological states in parallel with the physical.

The paradox is that such instability, though triggered by fluctuation, is resistant to change and in that sense the condition is unfortunately *stable*: it may need massive change (like the menopause) for it to budge: sometimes the treatment for turbulence is greater turbulence. Alternatively, a gentle and broadly based biological signal may smooth the turbulence from below, so to speak, effective because ***all*** the endocrine axes and ***all*** divisions of the autonomic nervous system are simultaneously addressed. I do not know of any biological agents that could operate in such a way other than the judicious use of medicinal plants.

Another common maladaptive state (which may and often will develop into a disease) is asthma. Usually seen as a disorder of the respiratory tract, and that is where it is primarily expressed (and so is a risk to life), asthma when considered as a maladaptive state is really a condition of the entire body. Its expression in the lungs derives from a lag in the organism's ability to oxygenate, a crisis which the condition seeks but fails to redress. Because of the similarities of the terrain, Dr Christian Duraffourd calls migraine "the asthma of the brain." Beneath the great differences in presentation between these two conditions lies similar autonomic dysfunction but, crucially, while migraine "uses" serotonin, asthma relies[27] upon histamine. By extension from these ideas, any lag between the present demands and needs facing a person and their capacity to respond at the time will produce symptoms. These symptoms—some tiresome, some disabling, some potentially fatal—shows the terrain at work, playing for time.

The currency of these processes is not primarily hormonal but concerns a simpler and deeper reality, biochemically speaking: that of the major minerals—salts of iron, calcium, sodium, potassium and magnesium—on which all neural, vascular and muscular activity depends. While the mechanisms for longterm maintenance of the calcium economy are complex (and are also hormonal), one of our most urgent requirements for homeostasis is to maintain stable levels of ionised calcium in the blood. Without a constant ready supply of calcium to all muscles and nerves, they will malfunction; the heart is a muscle supplied by nerves. Where the muscles momentarily outstrip supply of minerals, especially magnesium, a co–factor with calcium, they go into spasm.

Now, the experience of cramp in a limb, or a "stitch" is obvious to the sufferer, but many symptoms really owe their odd, transient and inexplicable nature to the tendency of smooth muscles and sphincters throughout the body to develop momentary spasm. The French call this constitutional tendency *smasmophilia* and is a common presentation. Spasmophiles are typically quite resilient but very prone to exhibit seasonal crises during the midpoint phases. If a person does not give in to the symptoms of internal spasm and refuses to slow up, the *smasmophilia* could be said to have failed to provide adequate time lag for the terrain to recover adaptive stability. So on such an occasion the terrain must then move to the second level to provide a defence from this 'wilful' reluctance from its 'tenant'.[28] The agent employed as such a device is found in

27 I am acutely aware that in this section in particular, I seem to assign agency to physiological states. It may be philosophically impure but serves the purpose as rhetorical device.

28 I do hope that I have not stretched this rhetorical device too far.

surface tissues throughout the body: it is the powerful hormone and transmitter called histamine.[29] when invoked it may show up in diverse guises, as allergic rhinitis[30], itchy skin, stomach and head ache, an irritable bowel and many other irritating symptoms.

In this concept of illness, symptoms are viewed as a protective device of the terrain to prevent further, deeper damage. The symptoms are a surface phenomenon and far from being the problem itself, are an indicator that a solution needs to be found to the problem of a temporary lag between needs and capacity. This shortfall in resources is amplified by seasonal transitions, especially from winter to summer and back. Here again the French have a useful phrase—*crise de foie*—to recognise this temporary crisis of seasonal transition[31].

An ecological model is being presented where time and available resources are under critical tension. It is almost the converse of the financial economy where temporary disequilibrium provides the energy needed for development, but then money is not biological and resources can be imagined (for a time). While Bertolt Brecht's cartoon in which he showed a poor man telling a rich man: "I am poor so you can be rich" wanted to tell the truth about imbalances, it did not explicitly point out the other Marxist truth that extremes of imbalance will eventually reach equilibrium. In the Push-pull of trading life there can be no pull without push. By contrast, biological systems must operate far from equilibrium. Biochemical equilibrium, when all the reactants are used up, is reached only at Death.

In global economics, extreme poverty is a dampener on the burgeoning economy of a big exporter. If you make the gap between your world and your export market too great, you will thrive only on reserves. By contrast, in the biological economy, if the incline between stimulus and response is too steep, the organism will be prevented from action by disabling symptoms for as long as is needed to restore integration of points on a more level slope.

This profound recognition of reality, that all things constantly change but that living things stay the same only if they change constantly, was made by Heraclitus unaided by investigative machinery. In our homeostatic yet rhythmic and tidal bodies constancy and change are not opposed but inextricably connected.

Metabolism in the Heraclitian rather than the Aristotelian sense *requires* flux to preserve constancy[32]. The relative constancy of high-level structures like the earth, sun and moon are necessary conditions for flux in low-level materials. Such flux gives rise to us.

The phasic adjustment between the season of light and heat and that of dark and cold is triggered by a shift in daylength. This critical time ushers us into a transition zone. Here we must seek a new equilibrium even before the dark and cold has arrived. The circannual predictor prepares us well in advance and considers our temporary discomfiture a necessary price for our preservation.

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29 From the Greek, *histos* refers to body tissues. Histology is the study of tissue types.

30 Whether hay fever or non–seasonal rhinitis. Between the midpoint and autumn equinox, susceptibility to mould is common. Herbalists are used to hearing their patients tell of "having caught a cold" which often may better be interpreted as a histaminic crisis brought about by the midpoint.

31 'crisis of the liver' in recognition of the central role of this organ in metabolism.

32 Discussed in greater detail in Barker 2004 History, Philosophy and Medicine Phytotherapy in Context second edition pp 47–60

FOUR APPENDICES FOLLOW…

APPENDIX 1

Shorthand name used in Appendix Two	**Plant, Family, Flowering Period** [numbering follows Barker Medicinal Flora]	**Parts used**
	Family 1 Willows & Poplars (Salicaceae)	
Salix	3 White Willow alba L April—May(June)	Dried Bark 2–3(–5) years old; Leaves and young twigs.
	Family 8 Cannabis & Hops (Cannabaceae)	
Humulus	26 Hops Humulus lupulus L July–Aug	Female cones-(strobiles)
	16 The Buttercup Family (Ranunculaceae)	
Anemone	63 Pasqueflower Pulsatilla vulgaris Miller (Anemone Pulsatilla L) April—May ie at Easter or Pasque–tide	Dried aerial parts
	20 The Cabbage & Mustard Family (Cruciferae =Brassicaceae)	
Capsella	94 Shepherd's-purse Capsella bursa-pastoris (L)Medicus January–December	Entire aerial plant, fresh or dried. NB: plants for collection must be free of white fungal coating
	Family 24 Currants and Gooseberries (Grossulariaceae)	
Ribes	113 Blackcurrant Ribes nigrum L	**Fresh buds** Leaves Fruits
	25 The Rose Family (Rosaceae)	
Rubus idaeus Poterium	116 Raspberry Rubus idaeus L June–August 123 Great Burnet Sanguisorba officinalis L June–September 124 Salad Burnet Sanguisorba minor Scop subsp minor May–August Sarcopoterium spinosum (L)Spach (Poterium spinosum L)	Leaves
Alchemilla	132 Lady's Mantle Alchemilla vulgaris L agg. esp subsect Heliodrosium series Pubescentes A, xanthochlora Rothm. June–September	Dried aerial parts
Crataegus	137 Midland Hawthorn Crataegus laevigata (Poiret)DC 138 Hawthorn, Whitethorn, Maythorn Crataegus monogyna Jacq May–June	1 Flowers 2 'Berries' (false fruits) 3 Leaves 4 Bark and Young Twigs
	26 The PeaFlower Family (Leguminosae)	
Galega	150 Goat's–rue, French Lilac Galega officinalis L June–August	Flowering Herb, fresh or dried. Seeds
Glycyrrhiza	152 Liquorice Glycyrrhiza glabra L Cultivated	Root and Stolon
Melilotus	155 Melilot Melilotus officinalis (L)Pallas July–September	Dried aerial parts, Flowers
Trigonella	156 Fenugreek Trigonella foenumgraecum L April—May	Leaves and seeds
Medicago	157 Lucerne, Alfalfa Medicago sativa L June–July	Fresh or dried leaf; seed; sprouted seed.
	30 The Spurge Family (Euphorbiaceae)	
Mercurialis	169 Annual Mercury Mercurialis annua L (May) July–October	

APPENDIX 1

Shorthand name used in Appendix Two	**Plant, Family, Flowering Period** [numbering follows Barker Medicinal Flora]	**Parts used**
	31 The Rue (Or Citrus) Family (Rutaceae)	
	Citrus limon Citrus aurantium dulcis	Pericarp Essential Oil
	39 The LimeTree (Or Linden) Family (Tiliaceae)	
Tilia	184 Large leaved Lime Tilia platyphyllos cSop June 185 Smallleaved Lime Tilia cordata Miller July 186 Common Lime Tilia x vulgaris Hayne, Tilia europaea L June	Inflorescense (including bracts) fresh or dried. [Bark] Fresh leaves
	43 St John's Wort Family Guttiferae Hypericaceae	
Hypericum	196 St John's Wort, Perforate St John's Wort, Hypericum Hypericum perforatum L June–September	Herb (fresh or dried) or flowering tops or flowers for Hypericum oil
	51 The Ivy Family (Araliaceae)	
Hedera	209 Ivy Hedera helix L September–November	
	52 Carrot \Parsley Family Umbelliferae (=Apiaceae)	
Anthriscus	214 Garden Chervil Anthriscus cerefolium (L)Hoffm cultivated\garden escape June–August	Herb fresh or dry
Pimpinella	219 Anise, Aniseed Pimpinella anisum L (Anisum vulgare Gaertner)	Fruit Cultivated
Foeniculum Anethum	226 Fennel Foeniculum vulgare Miller July–October 227 Dill Anethum graveolens L	Fruits, including seeds Leaves Root Fruits Herb
Angelica	235 Garden Angelica, Angelica archangelica L May–June	Root and rhizome (preferably fresh) Fruits Leaf Fresh young Stems
Levisticum	236 Lovage Levisticum officinale Koch July–August	Fruits. Root & rhizome. Leaves
	57 The Olive Family (Oleaceae)	
Olea	261 Olive Olea europaea L var europaea (cultivated) var sylvestris Brot. (wild)	The leaves The fruits
	58 The Gentian Family (Gentianaceae)	
Centaurium	262 Common Centaury Centaurium erythraea Rafn (Erythraea centaurium auct, Centaurium minus auct) June–October 263 Gentian Gentiana lutea L	Herb Roots and rhizomes dried, usually fermented
	59 The Bogbean Family (Menyanthaceae)	
Menyanthes	264 Bogbean, Buckbean Menyanthes trifoliata L April—July	Leaflets, preferably dried
	60 The Periwinkle Family (Apocynaceae)	
Vinca minor	265 Lesser Periwinkle Vinca minor L March—May 266 Greater Periwinkle Vinca major L April—June	Leaves

APPENDIX 1

Shorthand name used in Appendix Two	**Plant, Family, Flowering Period** [numbering follows Barker Medicinal Flora]	**Parts used**
	64 The Borage or ForgetMeNot Family (Boraginaceae)	
Symphytum	285 Comfrey, Knitbone Symphytum officinale L May–June 289 Borage Borago officinalis L June–August (& in a mild Autumn—October)	Leaves Root & rhizome [restricted] Aerial parts, preferably fresh, must include stem; Flowers; Oil
	65 The Verbena Family (Verbenaceae)	
Vitex Verbena	292 Vitex angus–castus L 293 Vervain, 'Verbena' Verbena officinalis L June–October	Fruit Herb, fresh or dried. Flowering spikes [sometimes root]
	The Mint or Thyme Family (Labiatae =Lamiaceae)	
Marrubium	302 White Horehound Marrubium vulgare L June–November	Dried leaves and flowering tops
Lamium	306 White Deadnettle, White Archangel Lamium album L (April) May–October (December)	Flowering tops
Leonurus	310 Motherwort Leonurus cardiaca L July–September	1) Flowering tops, preferably fresh 2) Leaves
Ballota	311 Black Horehound Ballota nigra L June–October	Aerial parts, fresh or dried
Stachys	312 Betony, Wood Betony Stachys officinalis (L)Trevisan (S. betonica Bentham, Betonica officinalis L) June–September	Aerial parts, preferably fresh
Melissa	318 Balm, Lemon Balm Melissa officinalis L June–September	1) Flowering tops, preferably fresh 2) Leaves
Hyssopus	323 Hyssop Hyssopus officinalis L June–September	Aerial parts, usually dried
Origanum Marjorana	324 Marjoram, Wild Marjoram, Oregano Origanum vulgare L July–September 325 Sweet Marjoram Marjorana hortensis Moench/O. marjorana L	Aerial parts, fresh or dried
Thymus	326 Common or Garden Thyme Thymus vulgaris L	Herb, usually dried
Lycopus	328 Gypsywort Lycopus europaeus L June–September	Aerial parts, fresh or dried
Mentha piperita	333 Peppermint Mentha x piperita L (parents: M. aquatica x M. spicata) July–October	Leaves and flowering tops, usually dried
Rosmarinus	335 Rosemary Rosmarinus officinalis L (January) March—May (September)—sporadically at almost any time	Leaves and young twigs, usually dried. Essential Oil
Lavandula	336 Lavender angustifolia Miller (L. officinalis Chaix, L. vera DC) July–October	Flowers. Flowering spikes with upper leaves
Salvia Salvia sclarea	339 Sage officinalis L (May) June–July 339f Clary Sage S. sclarea L	Leaves Leaves Essential Oil
Ocimum	Basil Ocimum basilicum L	Leaves Essential Oil
	67 The Nightshade (or Tomato/Potato) Family (Solanaceae)	
Fabiana	Fabiana imbricata Ruiz & Pavon	Young small branches

APPENDIX 1

Shorthand name used in Appendix Two	**Plant, Family, Flowering Period** [numbering follows Barker Medicinal Flora]	**Parts used**
	74 The Honeysuckle Family (Caprifoliaceae)	
Sambucus	375 Elder Sambucus nigra L June—July Fruit August–September	1 Flowers (Fresh, or Dried quickly) 2 Pollen 3 Fruits must be ripe (unripe fruits cyanogenetic) 4 Leaves (rarely) 5 The bark of 2nd year twigs 6 buds
Viburnum prunifolium	376 Guelder Rose, Cramp bark Viburnum opulus L 377 Black Haw bark Viburnum prunifolium L	Dried Bark
	75 The Valerian Family (Valerianaceae)	
Valeriana	381 Valerian Valeriana officinalis L June–August	Rhizome and roots
	78 The Daisy or Sunflower Family COMPOSITAE (=Asteraceae)	
Inula	401 Elecampane Inula helenium (L) June–September	Roots and rhizomes (preferably fresh)
Achillea	408 Yarrow Achillea millefolium L June–August	Leaves. Flowering tops
Matricaria	410 German Chamomile, Scented Mayweed Chamomilla recutita (L)Rauschert (Matricaria recutita L, Matricaria chamomilla L pro parte) June–July	Entire Flower heads (usually dried)
	424 Tarragon, French Tarragon Artemisia dracununculus L var sativa	Essential Oil
Calendula	431 Calendula, Pot Marigold Calendula officinalis L	Ligulate florets & nvolucral bracts are active but, in practice, whole capitulum. leaves rarely
Silybum Lactuca	438 Milk Thistle, Marian Thistle, Lady's Thistle Silybum marianum (L)Gaertner June–August 450 Great Lettuce, Wild Lettuce Lactuca virosa L	Fruits & seeds Leaves
	81 The Lily Family (Liliaceae)	
Allium sativum	468 Garlic Allium sativum L [probably derived from A. longicuspis Regel from C. Asia]	Bulblets ('cloves')
Convallaria	473 Lily of the Valley Convallaria majalis L May–June	Leaves; Flowers [Fruit highly toxic]
	85 The Grass Family (Gramineae = Poaceae)	
Avena Zea	493 Oats Avena sativa L Wild Oats Avena fatua L July–September 496 Maize, Corn Zea mays L	Stigmas & Styles, fresh or dried
	Zingiberaceae	
Zingiber	Zingiber oficinalis Ginger:	Rhizome

Appendix 2

Tables relating potential activity of selected plants within the human endocrine axes and the autonomic nervous system in human beings

Disclaimer & Acknowledgement

These plants are listed to provide support for the text of this paper and are intended to be of academic interest only. Nothing in this Appendix or the paper as a whole is intended to recommend or to support any self–medication. The use of these plants in untrained hands may lead to considerable harm.

While the choice of plants and this particular synthesis is mine, the attribution of plant properties derives almost entirely from the work of Drs Lapraz & Duraffourd to whom I am indebted for my development as a phytotherapist.

ENDOCRINE AXES

Enhancing Adrenal Axis	Diminishing Adrenal Axis
Calendula Poterium Ribes Rosmarinus Thymus Zingiber (⇑glucocorticoid)	Borago (⇓mineralocorticoid) Vitex (central sedative, ⇓hypothalamic stimulation of pituitary; may boost ACTH in some doses)
Enhancing Gonadal Axis	**Diminishing Gonadal Axis**
Inula Ocimum Vinca minor (FSH stimulant) **Oestrogenic** Angelica, Avena Calendula, Foeniculum Glycyrrhiza, Hedera Humulus, Levisticum Marrubium, Medicago Menyanthes, Salix Salvia, Salvia sclera **Luteo–Trophic** Achillea, Alchemilla Malus **⥣testicular androgens** Zingiber	Borago Lycopus Symphytum (anti–FSH): Salvia sclarea Vitex (inhibits periph Oestrogen receptors) **Anti–Oestrogenic** Malus Vitex **Anti–Luteo–Trophic** Medicago **Anti—Androgen** Humulus Marrubium Medicago
Enhancing Signal in Thyroid Axis	**Dampening effect in Thyroid Axis**
Allium sativum, Avena Salix, Salvia Ess Oil Foeniculum Vitex T4>T3, Zingiber ⇑T4	Convallaria, Fabiana Leonurus, Lycopus Zea
Stimulating Somatic Axis	**Inhibiting Somatic Axis**
Lamium Sambucus **Prolactogenic** Anethum Foeniculum Pimpinella Galega Lamium (Vitex via central loop)	Poterium **Anti Prolactin** Mercurialis annua Poterium Rubus idaeus Anthriscus Vinca minor NB:[⥣FSH]
⬆Oxytocin	**Oxytocin ⇓**
Capsella Foeniculum Viburnum prunifolium Vitex (central)	Anemone Levisticum Salix

AUTONOMIC NERVOUS SYSTEM

PARASYMPATHETIC

Enhancing Vagal Tone	Diminishing Vagal Tone
Capsella Hypericum Marrubium Rosmarinus Stachys Trigonella Verbena Essential Oil Mentha piperita	Achillea Angelica Centaurium EO Cupressus EO Tarragon Hyssopus Lavandula Ocimum Matricaria Menyanthes Thymus Valeriana Viburnum prunifolium **To liver and intestine** Lactuca Gentiana

ALPHA-SYMPATHETIC

Diminishing
Angelica Melissa Melilotus Vitex

BETA-SYMPATHETIC

Enhancing (sympathomimetic)	Diminishing
Cinammomum Citrus limon Centaurium Hyssopus Salvia Silybum Menyanthes Pinus Ribes Salvia Salvia sclarea Zingiber	Allium sativum Angelica Ballota Citrus aurantium dulcis Convallaria Crataegus Fabiana Lavandula Leonurus Lycopus Marjorana Matricaria Mentha piperita Olea Origanum Ocimum Poterium Tilia Valeriana Vinca minor Zea

APPENDIX 3

Should you suffer any digestive, emotional or hormonal upset, or any sleep disruption lasting more than a couple of nights, the first thing to do is to eat LESS food at any one time. Eating the minimum may be enough to avert trouble and revert to normal.

However, there are times when it is better to respond to any such disruption of normal function more systematically: our hormonal clocks, by constantly monitoring the length of daylight hours, tell and enable our bodies how to respond. At certain times of the year, these clocks re–set themselves making us all more prone to upset. The exact dates (which I call solar nodes) differ from person to person and at different stages of life, but tend to occur during the following vulnerable seasons:

- between early to mid–August and October 30, and again
- between early to mid– February and April 30

Some people have four adjustments to make: one early and one late during each of these two seasons; some also suffer mid–summer and/or mid–winter disruptions (usually 10 days after the solstice of June 21st or before that of December 21st). To complicate matters our dates change as we age.
If your digestion is seasonally upset, respond by doing *one* of the following:

a. an absolute fast in which you take nothing by mouth except water despite pangs of hunger for at least six hours
[but not longer than 18 hours without taking further advice]

b. a MONO-DIET for as long as you like
but **never** for more than 28 days

c. a MONO-DIET for a determined length of time
[usually 3, 5, 11 or 21 days]

A MONO-DIET consists of restricting your intake to one food only; usually the choice is made from ***one*** of the following:

1 rice
2 grapes [best between mid–August and late October]
3 melon [best between late June and late October]
4 dried fruit
5 lemons

The restriction is only on the *type* of food; the amount is entirely unrestricted, as is the amount of plain water taken, but salt must be monitored, and flavourings entirely **excluded**. As an alternative to the MONO-DIET, elaborate protocols have been developed, especially for grapes, melons and what is known as The Lemon Cure. Details of these are available at my Practice, but they are not as simple and easy as the MONO-DIET.

Remember never to eat when exhausted, angry, anxious, upset or dehydrated

APPENDIX 4

The following chart shows calendar dates which are equivalent from the point of view of daylength. The midpoints are shown in bold.

June	21			March	21	September	21
June	20	June	22	March	20	September	22
June	19	June	23	March	19	September	23
June	18	June	24	March	18	September	24
June	17	June	25	March	17	September	25
June	16	June	26	March	16	September	26
June	15	June	27	March	15	September	27
June	14	June	28	March	14	September	28
June	13	June	29	March	13	September	29
June	12	June	30	March	12	September	30
June	11	July	1	March	11	October	1
June	10	July	2	March	10	October	2
June	9	July	3	March	9	October	3
June	8	July	4	March	8	October	4
June	7	July	5	March	7	October	5
June	6	July	6	March	6	October	6
June	5	July	7	March	5	October	7
June	4	July	8	March	4	October	8
June	3	July	9	March	3	October	9
June	2	July	10	March	2	October	10
June	1	July	11	March	1	October	11
May	31	July	12	February	28	October	12
May	30	July	13	February	27	October	13
May	29	July	14	February	26	October	14
May	28	July	15	February	25	October	15
May	27	July	16	February	24	October	16
May	26	July	17	February	23	October	17
May	25	July	18	February	22	October	18
May	24	July	19	February	21	October	19
May	23	July	20	February	20	October	20
May	22	July	21	February	19	October	21
May	21	July	22	February	18	October	22
May	20	July	23	February	17	October	23
May	19	July	24	February	16	October	24
May	18	July	25	February	15	October	25
May	17	July	26	February	14	October	26
May	16	July	27	February	13	October	27
May	15	July	28	February	12	October	28
May	14	July	29	February	11	October	29
May	13	July	30	February	10	October	30
May	12	July	31	February	9	October	31
May	11	August	1	February	8	November	1
May	10	August	2	February	7	November	2
May	9	August	3	**February**	**6**	November	3
May	8	August	4	February	5	November	4
May	7	August	5	February	4	November	5
May	**6**	**August**	**6**	February	3	**November**	**6**
May	5	August	7	February	2	November	7
May	4	August	8	February	1	November	8

May	3	August	9	January	31	November	9
May	2	August	10	January	30	November	10
May	1	August	11	January	29	November	11
April	30	August	12	January	28	November	12
April	29	August	13	January	27	November	13
April	28	August	14	January	26	November	14
April	27	August	15	January	25	November	15
April	26	August	16	January	24	November	16
April	25	August	17	January	23	November	17
April	24	August	18	January	22	November	18
April	23	August	19	January	21	November	19
April	22	August	20	January	20	November	20
April	21	August	21	January	19	November	21
April	20	August	22	January	18	November	22
April	19	August	23	January	17	November	23
April	18	August	24	January	16	November	24
April	17	August	25	January	15	November	25
April	16	August	26	January	14	November	26
April	15	August	27	January	13	November	27
April	14	August	28	January	12	November	28
April	13	August	29	January	11	November	29
April	12	August	30	January	10	November	30
April	11	August	31	January	9	December	1
April	10	September	1	January	8	December	2
April	9	September	2	January	7	December	3
April	8	September	3	January	6	December	4
April	7	September	4	January	5	December	5
April	6	September	5	January	4	December	6
April	5	September	6	January	3	December	7
April	4	September	7	January	2	December	8
April	3	September	8	January	1	December	9
April	2	September	9	December	31	December	10
April	1	September	10	December	30	December	11
March	31	September	11	December	29	December	12
March	30	September	12	December	28	December	13
March	29	September	13	December	27	December	14
March	28	September	14	December	26	December	15
March	27	September	15	December	25	December	16
March	26	September	16	December	24	December	17
March	25	September	17	December	23	December	18
March	24	September	18	December	22	December	19
March	23	September	19	December	21	December	20
March	22	September	20				