MITOCHONDRIA IN CHINESE MEDICINE
Part 3: Adaptogens

Steve Woodley

The adaptogenic concept has been both popular and controversial in herbal medicine since its invention almost a century ago. Adaptogens modulate stress responses to exert beneficial effects against many modern diseases including chronic inflammation, atherosclerosis, neurodegenerative cognitive impairment, metabolic disorders, cancer, and other age-related conditions, yet their mechanisms lack specificity (Panossian, 2025; Panossian & Efferth, 2022; Gerontakos et al., 2020). This has led to criticisms that their marketing outstrips the evidence of their efficacy (Jarry, 2022). It has also become apparent that mitochondria are critical for our adaptive responses to cellular stresses and influence longevity, whose dysfunction is connected to inflammatory, neurodegenerative, metabolic and cardiovascular disorders, as well as cancer and resistance to its treatment (Chen, Zhao & Li, 2023; Trinchese et al., 2024). This article seeks to clarify the relationship between adaptogens and mitochondria, discuss how they function in terms of Chinese medicine, and prepare the reader for the final part in this series, on the results of my PhD research at the University of Westminster.

What is an Adaptogen?

The adaptogenic concept has evolved over the last 80 years. It was first coined by Russian toxicologist Lasarev in 1947 to describe substances that "increase 'non-specific' resistance to adverse influences to [the] organism and stress" (Lasarev, cited by the Committee on Herbal Medicinal Products, 2008). Stress was considered in terms of Selye's (1936) General Adaptation Syndrome, where the physiological response to a homeostatic threat initially enables the organism to cope but the energy required to maintain this equilibrium eventually leads to exhaustion. Since then, it has undergone several evolutions (Panossian et al., 2021), including that:

- It should be innocuous, non-toxic and cause minimal physiological disturbances;
- It should have non-specific or polyvalent mechanisms of action;
- Those actions should be normalising, reducing the effects of damaging stressors, irrespective of the direction that the pathology has taken;
- This regulatory effect becomes more pronounced as the pathology becomes deeper.

To be a genuinely useful category, they must be differentiated from other similar substances with which they have overlapping characteristics, including stimulants, tonics and hormetins.

Stimulants are "substances or agents that produce a temporary increase in the functional activity or efficiency of an organism or any of its parts" (Stohs & Badmaev, 2016). They are also usually followed by a rebound period of reduced functioning, and the potential for tolerance leading to abuse and addiction (Panossian & Wagner, 2005). Adaptogens are not typically associated with side effects and it is precisely through their repeated administration that they exert their resilience building effects, comparable to repeated physical exercise.

Many sources equate adaptogens with tonics in traditional herbal medicine (e.g. Panossian et al., 2021). Tonics are defined as "an agent that has the capability to restore and/or maintain the physiological functioning of an organ system, leading to the subjective feeling of well-being of the patient treated with it" (Götti, Melzer & Saller, 2014). Tonifying properties are an essential aspect

of an adaptogen's function, but there are many tonifying substances that are not adaptogens. Most foods have qi or blood tonifying properties, including rice and sugar (Chen & Chen, 2008) but they do not exhibit adaptogenic properties and regular consumption may even cause disease (Ludwig et al., 2018). Therefore adaptogens are a subset of tonics, but not equivalent.

Hormetins are substances that induce hormesis, a biphasic dose-response where a low dose stimulates beneficial adaptive changes and a high dose elicits inhibitory or harmful effects (Bhakta-Guha & Efferth, 2015). Adaptogens are certainly a class of hormetins, but they are recognised to have a wide therapeutic window, often greater than 1000-fold between their lowest dose exerting a beneficial effect and the zero sum point, beyond which toxic effects are reported (Panossian et al., 2010). Many hormetins may have therapeutic windows less than 20-fold, with the reactive oxygen species (ROS) produced as a byproduct of respiration that trigger adaptive changes from exercise and fasting, having a hormesis zone between 20 µM and 120 µM, after which they cause oxidative stress, only a 6-fold window of tolerance (Mao & Franke, 2013).

Adaptogens often comprise three main groups of chemicals (Panossian et al., 2021):

- Compounds with a tetracyclic skeleton similar to steroid hormones like cortisol, oestrogen and testosterone;
- Structural analogues of catecholamines like dopamine, adrenaline and noradrenaline, or their precursor tyrosine;
- Structural analogues of resolvins, lipid mediators of inflammatory responses.

This suggests that they work on the endocrine, neurological and immune systems, with only occasional reference to their effects on metabolism (Panossian, Wikman & Wagner, 1999; Panossian, 2017).

Mitochondria as the Biological Target for Adaptogens

Despite the overlap in disorders caused by mitochondrial dysfunction and the conditions which adaptogens treat or prevent, reviews rarely focus on their effects on mitochondria. This is due to the complexity of adaptogenic activity, often simultaneously influencing several systems and pathways, making it challenging to identify clear mechanisms (Panossian, 2025; Panossian & Efferth, 2022; Gerontakos et al., 2020) but their end result is almost always an improvement in mitochondrial function. Many individual studies on specific adaptogens have reported mitochondrial outcomes:

***Ren Shen* (*Panax Ginseng*)**
Image courtesy of Phoenix Medical

Ginsenosides, found among true ginsengs (*Panax spp.*), including *ren shen* (*P. ginseng*), *san qi* (*P. notoginseng*) and *xi yang shen* (*P. quinquefolium*), are suggested to have a common mechanism in the modulation of mitochondria (Huang et al., 2021; Wang & Roh, 2020). They enhance ATP production, reduce ROS, encourage mitochondrial integrity through increased fission and mitophagy, stimulate biosynthesis of new mitochondria, maintain membrane potential stability, prevent apoptosis in healthy cells while activating it in cancerous ones, and alter the expression of genes and proteins related to mitochondrial activity. Ginseng was among the first plants to attract an interest in the adaptogenic concept (Brekhman & Dardymov, 1969) and has loaned its name to adaptogens from all species and countries.

Ci wu jia (*Eleutherococcus senticosus*), commonly known as Siberian ginseng, was also among the first adaptogens investigated by Soviet scientists. It modifies signaling pathways and enzymes related to enhancing mitochondrial numbers and promotes fat breakdown in fat and muscle cells (Hashimoto et al., 2020). It also adjusts markers of senescence and apoptosis pathways in cell and animal models of dementia which are understood to be dependent on the mitochondrial health of neurons (Fu et al., 2023; Liu et al., 2018).

Hong jing tian (*Rhodiola rosea seu crenulata*), contains salidroside which demonstrates several actions on mitochondrial function, including protection from

hypoxia which may explain its traditional use against altitude sickness. It achieves this by maintaining the integrity of the blood brain barrier and activating several mitochondrial homeostasis mechanisms (Hou et al., 2024; Hou et al., 2023; Yan et al., 2021). It has demonstrated neuroprotective and cardioprotective effects by preventing mitochondrially induced apoptosis and ferroptosis (Wang et al., 2017; Chen, Zhu et al., 2022; Yang et al., 2024), stimulating mitochondrial biogenesis and protecting against oxidative stress induced endothelial dysfunction (Xing et al., 2014). *R. rosea* also contains rosavins which provide additional effects on mitochondria, prolonging endurance and enhancing ATP synthesis (Abidov et al., 2003), further benefitting management of chronic diseases, although future research is required (Bernatoniene, Jakstas & Kopustinskiene, 2023) and adulteration with *R. crenulata* is common (Booker et al., 2016).

Wu wei zi (*Schisandra chinensis*) is also one of the original adaptogens studied by the Soviets that is commonly used in Chinese medicine. It demonstrates an ability to preserve the structural integrity of the mitochondrial respiratory chain and ATP synthase from oxidative damage and stress induced apoptosis, restoring function in multiple tissues compromised by various experimental conditions (Guo et al., 2026; Kopustinskiene & Bernatoniene, 2021).

Huang qi (Astragalus membranaceus)
Image courtesy of Phoenix Medical.

Huang qi (*Astragalus membranaceus*) rose to fame in longevity research for preventing telomere loss from DNA strands, used as a marker of age-related decline. A proprietary extract, TA-65, produced impressive molecular outcomes, but functional measurements are less convincing (Su et al., 2025). Mitochondrial mechanisms of longevity enhancement have also been suggested with evidence that it may protect mitochondria from oxidative damage (Li et al., 2012), sun damage (Li et al., 2020), hypoxia from chronic heart failure (Li, Shang et al., 2025), muscle wasting in cancer and heart failure (Tian et al., 2025; Ma et al., 2023), and chemically induced heart and kidney toxicity (Li, Zhou et al., 2025; Luo et al., 2009). It also restores normal mitochondrial function in a model of endothelial inflammation (Zhang, Li, Cui et al., 2025) and induces apoptosis in gastric carcinoma cells through mitochondrial pathways (Yu et al., 2019).

Ling zhi (*Ganoderma lucidum*) has five dedicated entries in the *Shen Nong Ben Cao Jing* which claim it "lightens the body, staves off ageing, extends the years and [makes you] a spirit immortal" (Wilms, 2017). Modern studies support this ability to extend lifespan through inducing autophagy, enhancing stress resistance (Peng et al., 2021), and reducing skin ageing by alleviating the mitochondrial dysfunction associated with senescence (Wang et al., 2025). It has also shown protective effects against brain ageing through enhancing the activities of mitochondrial respiratory complexes and antioxidant enzymes (Sudheesh et al., 2010; Ajith et al., 2009). This results in more efficient ATP production, lower levels of oxidative stress and the reduction of low grade inflammation that occurs with age.

There are too many adaptogens to individually present in this article, but this selection reveals that they result in improved mitochondrial function. The principle proposed for this is that they act as mild stress mimetics or "stress vaccines" that cause slight perturbations in homeostasis in order to teach the body how to withstand the stressor when encountered again (Wróbel-Biedrawa & Podolak, 2024). This makes them the opposite of traditional antioxidants. Instead of scavenging excess ROS, adaptogens trigger its release, exploiting the dynamic nature of mitochondria to initiate adaptive changes that result in enhanced mitochondrial functionality, including innate antioxidant defences. The advantage is that these defences are dynamic too, only acting to remove excess ROS, instead of providing blanket antioxidant activity that may inhibit physiological processes that rely upon ROS for their optimal functioning.

Adaptogens in Chinese Medicine

Adaptogens are very prevalent in Chinese medicine, a fact which is evident in the number of herbs colloquially named "ginsengs" to designate their adaptogenic

properties. These include:

- Ginseng (*ren shen, Panax ginseng*)
- Pseudoginseng (*san qi, Panax notoginseng*)
- American ginseng (*xi yang shen, Panax quinquefolium)*
- Siberian ginseng (*ci wu jia, Eleutherococcus senticosus*)
- Thorny ginseng (*wu jia pi, Eleutherococcus gracilistylus*)
- Highland ginseng (*hong jing tian, Rhodiola crenulata seu rosea*)
- Poor man's ginseng (*dang shen, Codonopsis pilosula*)
- Female ginseng (*dang gui, Angelica sinensis*; also refers to *shatavari*, *Asparagus racemosus*)
- Desert ginseng (*rou cong rong, Cistanches deserticola seu tubulosa*)
- Five-leaf ginseng (*jiao gu lan, Gynostemma pentaphyllum*)

Such is the influence of ginseng on the adaptogenic story that many adaptogens outside of Chinese medicine are also referred to as the ginseng of their country, including:

- Indian ginseng (*ashwagandha, Withania somnifera*)
- Malaysian ginseng (*tongkat ali, Eurycoma longifolia*)
- Thai ginseng (*krachai dum, Kaempferia parviflora*)
- Peruvian ginseng (*maca, Lepidium meyenii*)
- Brazilian Ginseng (*suma, Pfaffia paniculata*)
- Alaskan Ginseng (*Devil's club, Oplopanax horridus*)

This is not unique to the English language either, with many common herbs with special properties using the character for ginseng, 參 *shen*. For example:

- *Dan shen* ("cinnabar ginseng," *Salvia miltiorrhiza*)
- *Dang shen* ("ginseng from Shangdang," *Codonopsis pilosula*)
- *Tai zi shen* ("prince's ginseng," *Pseudostellaria heterophylla*)
- *Ku shen* ("bitter ginseng," *Sophorae flavescentis*)
- *Sha shen* ("sand ginseng," *Glehnia littoralis seu Adenophora tetraphylla*)
- *Xuan shen* ("dark/mysterious/profound ginseng," *Scrophularia ningpoensis*)
- *Shou zhang shen* ("hand-palm ginseng," *Gymnadenia conopsea*)
- *Hai shen* ("sea ginseng," *Stichopus*)

However, names are given after its adaptogenic properties are decided, making it too self-referential to be of use for anything more than developing a list of recognised adaptogens. Besides, many adaptogens are not referred to as ginsengs at all. For example, *wu wei zi* and *huang qi* bear no reference to ginseng in their Chinese or English names (schisandra and astragalus), nor do the many mushrooms which are becoming popular commercial adaptogens due to recent research (Chugh et al., 2022), including:

- Reishi (*ling zhi, Ganoderma lucidum*)
- Cordyceps (*dong chong xia cao, Ophiocordyceps sinensis*)
- Turkey tail / coriolus (*yun zhi, Trametes versicolor*)
- Lion's mane (*hou tou gu, Hericium erinaceus*)
- Maitake / hen-of-the-woods (*hui shu hua, Grifola frondosa*)
- Chaga (*hua jie kong jun, Inonotus obliquus*)

***Ling zhi* (*Ganoderma lucidum*).**
Image courtesy of Phoenix Medical.

Therefore, to find a method of determining if a herb has adaptogenic properties in terms of Chinese medicine, it is better to examine this for patterns in their actions that differentiates them from other herbs.

San qi (Panax notoginseng)
Image courtesy of Phoenix Medical.

It was stated earlier that adaptogens are always tonics but there is more to adaptogens than tonification. Their activities often contain a paradoxical blend of actions in contrast to simple tonics. For example, tonification is normally contraindicated in exterior conditions, but *ren shen* and *dang shen* are specifically indicated for tonifying qi in deficient patients with exterior conditions (Chen & Chen, 2008). *San qi* is said to possess the abilities of "stopping bleeding without causing stasis and promoting blood circulation without harming the blood" (Zhang, Li, Wang et al., 2025). *Dan shen* and *dang gui* also have simultaneous actions of invigorating and tonifying the blood, transcending the simple paradigm of "do not replenish a repletion or deplete a depletion," (*Nan Jing* 81, trans. Unschuld, 1986). This corresponds with the western definition of an adaptogen by implying that these herbs have a balanced activity making them non-toxic and altering their effects depending on the pathology, but this is also not the whole picture.

Wu wei zi emerges once again as an exception. It tonifies qi but does not have any clearing or invigorating activities. Instead it stabilises and binds, preventing leakage while generating fluids and quieting the *shen* (Bensky et al., 2004). The key lies in the endpoint of adaptogenic activity being improved mitochondrial function, reducing the susceptibility to oxidative stress. Referring to the previous part of this series, oxidative stress has several stages:

- It starts as an excess qi pattern: qi stagnation, blood stasis or wind obstruction stasis or wind obstruction
- Stagnation generates heat
- Heat damages the yin
- Yin can no can longer embrace yang
- *Jing* can no longer be contained and leaks, shortening lifespan

Herbs high in antioxidant potential will have actions of invigorating qi and blood, clearing wind or heat, protecting yin (sometimes described as moistening the bowel or generating fluids), warming yang or securing *jing*. Since mitochondria are both the primary generators of ATP and the first line of antioxidant defence, then herbs which improve their functioning will give rise to both improved energy reserves, reflected in their tonifying actions, and improved antioxidant defences, with actions that that may be regulatory, clearing or protective of resources like yin, yang and *jing*.

***Wu wei zi* (*Schisandra chinensis*)**
Image courtesy of Phoenix Medical.

Wu wei zi now fits into this modified adaptogen paradigm. Despite not having regulatory or expelling properties, its ability to prevent the leakage of *jing* is still an indication that it has a net antioxidant effect, but one that suggests that it is applicable in the end stages of oxidative stress when the damage from a stressor can no longer be avoided and normal functioning must be restored to prevent the loss of *jing*. This corresponds with the research presented earlier (Guo et al., 2026; Kopustinskiene & Bernatoniene, 2021).

This also means that yin and yang tonics fit the definition of adaptogens since their tonifying properties are antioxidant too: yang tonics often unblock the channels to regulate qi or stabilise and secure the *jing* as a direct result of their warm, raising properties, while tonics generate fluids and clear heat due to their moist, cooling nature. Research supports this too with spices reported to have antioxidant and metabolic enhancing properties that reduce biological ageing (Zhang, Hong et al., 2025). This occurs through uncoupling where electrons are diverted from the respiratory chain causing their energy to be released as heat. This raises body temperature (thermogenesis) and triggers an adaptive response in the mitochondria to compensate for the decreased ATP output, resulting in increased mitochondrial numbers, browning of adipose tissue and improved metabolic health (Yang et al., 2026). Yin tonics have less effect on ATP but display stronger antioxidant and immunomodulatory activities (Ko & Leung, 2007). Mitochondria also play a central role in mounting and regulating appropriate immune responses (Trinchese et al., 2024), suggesting that yin tonics also act through mitochondria, but activating their downregulatory functions.

Differentiating Adaptogens by Channels and Vital Substances

Some of the most popular adaptogens focus on enhancing the qi of the Lungs and Spleen. Those that enter the Lungs exert an effect on physical endurance and *wei qi*, improving breathlessness, modifying immunity and treating coughs, while those that enter the Spleen enhance energy to treat fatigue. Many of those most associated with longevity such as *ren shen*, *huang qi* and *ling zhi* enter both of these channels, enhancing both routes of acquiring qi. It may seem surprising that the herbs most associated with longevity do not enter the Kidneys or nourish the *jing*, but *Su Wen* 2 outlines the superior strategy is to treat disease before it manifests. By boosting acquired qi and expelling pathogens, these prevent the loss of pre-natal energies before they are even threatened.

Adaptogenic herbs that enter the Liver and Kidneys tonify and secure the more inherent energies of yin, yang and *jing*. While pre-natal *jing* cannot be recovered once lost, the body is always extracting *jing* from food which it consumes first, so supplementing the pre-natal *jing* with post-natal sources can be a tactic to slow its decrease (Gardner, 2024). Those with astringent properties like *wu wei zi* also prevent its leakage. This makes these kinds of adaptogens best suited when we are experiencing a stressor that the qi of our Lungs and Spleen alone cannot resist.

Many adaptogens act across these categories making them particularly versatile and prized herbs. *Dong chong xia cao* enters the Lungs and Kidneys, tonifying yin and yang, boosting immunity, while also nourishing deeply

***Dong chong xia cao* (*Ophiocordyceps sinensis*)**
Image courtesy of Phoenix Medical.

(Bensky et al., 2004). This has placed it in such high demand that it has become known as the most expensive mushroom in the world (Das et al., 2021) and necessitated the development of cheaper alternatives. *Cordyceps militaris* can be cultivated artificially without the use of animal hosts and demonstrates a far higher cordycepin content than *O. sinensis* (Krishna et al., 2025). This compound is the most researched single constituent isolated from cordyceps species, with its synthetic analogue, NUC-7738, entering clinical trials for the treatment of cancer (Serpi et al., 2022). However, the diversity of compounds within wild-harvested *O. sinensis* and their many potential activities still make it more prized as an adaptogen (Chen et al., 2018). Recent Food Standards Agency guidance has classified all cordyceps as a novel food, restricting its sale in shops and online, but it is still available to herbalists to prescribe (Register of Chinese Herbal Medicine, 2025).

Some adaptogens enter the Heart and quiet the *shen* which reflects a capacity to protect the brain from stress. These are known as nootropics, meaning that they enhance cognitive function, a category that overlaps with both adaptogens and stimulants (Malík & Tlustoš, 2022). They are particularly popular today due to the prevalence of psychological stress in our society and help by reducing anxiety, promoting sleep, and in the prevention and treatment of neurodegenerative disorders (Du et al., 2023). Sleep disturbances are known to be both a symptom and contributing factor of neurodegenerative disorders (Rábago-Monzón et al., 2025), and anxiety also has a bidirectional relationship with sleep (Xue et al., 2025), forming a self-reinforcing triangle with mitochondrial dysfunction at its centre. Adaptogenic nootropic herbs act on all points of this triangle to reduce their influence while also aiming to improve cognitive function. Adaptogenic nootropic Chinese herbs include *ren shen*, *ling zhi*, *ci wu jia*, *hong jing tian* and *wu wei zi*, as well as *ashwagandha* and *maca* from other traditions.

It can be observed that adaptogens can act on any of the vital substances, but have a particular affinity for the three treasures (*san bao*): *jing*, *qi* and *shen*, whose preservation is the main object of their activity. Yin and yang tonics aid this by nourishing these two aspects of *jing* (Gardner, 2024). Blood also has a close relationship to all the three treasures, so appears in the actions of many adaptogens like *san qi*, *dang gui* and *dan shen*. Lastly, fluids are mentioned frequently too, in herbs like *ren shen*, *tai zi shen* and *wu wei zi* which do not directly tonify yin but protect its consumption from heat and dryness. The more of these activities a herb has, and the more paradoxical their actions are, the better they can

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return us to an equilibrium and preserve our lifespan, making it a better candidate as an adaptogen.

Liquorice

***Gan cao* (*Glycyrrhiza uralensis seu glabra*)**
Image courtesy of Phoenix Medical.

Gan cao (*Glycyrrhiza uralensis seu glabra*) fits firmly in the definition of an adaptogen presented here, with its ability to tonify Spleen qi, clear heat and resolve fire toxicity, as well as generate fluids to moisten the Lungs (Bensky et al., 2004). However, it stands out among all the herbs in the Chinese pharmacopoeia as being an exceptional example due to it being "the king of herbs with regard to the neutral earth element" (Liu, 2020). Its very sweet taste, neutral temperate and yellow colour give it the ability to return all extremes to the centre, treating both hot and cold patterns, and reducing the toxic properties of other herbs, regardless of their taste or temperature. It also has the unique ability to enter all of the twelve channels, but with a particular affinity for the Heart, Lungs, Spleen and Stomach, and a wide therapeutic window with dosages ranging from 1.5 - 30 g (Bensky et al., 2004). The *Shen Nong Ben Cao Jing* places it in the superior class of herbs, saying that, "consumed over a long time, it lightens the body and extends the years" (Wilms, 2017), suggesting an effect on metabolism and longevity.

Liquorice has been described as an adaptogen in the western literature too, both directly (Panossian, 2020) and through its experimental effects on improving resilience to stress (Adamyan et al., 2005). It has shown a range of pharmacological properties with its main constituent, glycyrrhizin, possessing strong antioxidant activities, albeit with debated mechanisms and contradictory results from different assays (Ageeva et al., 2022). The aglycone metabolite of glycyrrhizin, glycyrrhetinic acid, has a similar structure to corticosteroids, enabling it to raise cortisol by binding to the enzyme that converts it to its inactive form, cortisone (Shinu et al., 2023). Cortisol is an important and necessary stress hormone but its chronic accumulation can result in dysregulation of multiple systems (Russell & Lightman, 2019). This means that liquorice is best used in either situations of acute stress when raised cortisol may be adaptive, or when chronic stress has resulted in low or exhausted cortisol with inadequate stress responses, such as adrenal fatigue or burnout. Overconsumption can lead to raised cortisol, low potassium and raised blood pressure with potentially fatal consequences (Smedegaard & Svart, 2019).

Glycyrrhizin and glycyrrhetinic acid also demonstrate some impressive activities with regard to their modulation of how cells interact with other substances. Glycyrrhizin enhances resistance to toxic substances through altering the expression of efflux transporters that pump toxins out of the cell (He et al., 2019). Conversely, glycyrrhetinic acid has shown an ability to increase the permeability of membranes, including those on the mitochondria which are generally considered impermeable (Selyutina & Polyakov, 2019). It seems possible that the resistance to toxic drugs may apply mostly to healthy cells, while the increased permeability may apply mostly to cancerous cells. Cancer cells favour glycolysis, improving their survival in the hypoxic tumour microenvironment, and repurpose their mitochondria for biosynthesis to aid proliferation (Du et al., 2025) while the efflux pumps are dependent on mitochondrial ATP for optimal performance (Giddings et al., 2021). Meanwhile, the increase in mitochondrial permeability to drugs depends upon the generation of ROS, which is naturally higher in cancer cells making them more prone to this effect. This has led to an interest in the use of glycyrrhetinic acid as a scaffold to deliver cytotoxic drugs directly into the mitochondria of tumour cells (Chen, Fang et al., 2022).

It was partly due to this range of possible mitochondrial activities that liquorice was chosen as the first herb to be studied. However, the primary reason was that liquorice is used in so many formulas, it is necessary to understand its effects to ensure that observations of later formulas could be distinguished from their liquorice content. The results were so surprising that the remainder of my laboratory work was dedicated entirely to the study of this herb.

Conclusion

This article has looked at the concept of adaptogens, and how it evolved from its early understanding of enhancing resistance to homeostatic stress, to a modern theory that places mitochondria at the nexus of the various modes of adaptogenic activity. Within Chinese medicine, it was identified that adaptogens have tonifying properties but their actions on mitochondria also give them the antioxidant properties discussed in the previous article. These include regulating qi or blood; clearing heat or wind; tonifying yin or yang; or securing *jing*, often in paradoxical combinations that enable a return to the centre from a pathological change in either direction. Finally, *gan cao* was identified as an exemplar of an adaptogen using Chinese medical terminology and modern research, and the reasons why this herb was chosen for initial research were presented. The final part in this series will look at the results of my research and how mitochondrial function could be used as a measure of quality and potency, to detect adulteration with a deliberately reduced potency sample that was difficult to see with the industry's standard chromatography tests.

Steve Woodley is a Chinese medicine practitioner, researcher, teacher and editor of the RCHM Journal. He began studying traditional medicine with an anthropology degree at UCL over 25 years ago before training in acupuncture, tui na, herbs and taiji. He recently completed a PhD in the use of mitochondrial functional analysis to evaluate the quality and adulteration of herbal teas. He is most interested in areas where his different studies converge, finding insights into how historical practices may have affected metabolic pathways.

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