Based on the provided sources, several herbs and phytochemicals can change cell function through metabolic reprogramming. This involves altering gene expression, modulating signaling pathways (such as SIRT1, mTOR, and NF-κB), and shifting metabolic fluxes (such as the urea cycle or lipid metabolism).

Reprogramming Nitrogen and Urea Cycle Metabolism

These herbs and compounds directly alter the expression of enzymes responsible for converting toxic ammonia into urea, effectively reprogramming the liver's capacity for detoxification.

- **Naringin (Citrus Flavonoid):** This compound fundamentally alters liver metabolism by upregulating the expression of all five key urea cycle enzymes: carbamoyl phosphate synthase I (CPS I), ornithine transcarbamylase (OTC), argininosuccinate synthase (ASS), argininosuccinate lyase (ASL), and arginase I (ARG) 1, 2. It also modulates metabotropic glutamate receptors (mGluRs) and suppresses inflammatory markers like TNF-α and NF-κB 3.
- **Fisetin:** This flavonoid demonstrates chronotherapeutic potential (efficacy depending on the time of administration). It reprograms the liver to increase the expression of CPS-I, OTC, and ASS, as well as brain glutamine synthetase (GS), thereby enhancing ammonia detoxification 1, 4.
- **Yinchen Wuling Powder (YCWLP):** This traditional Chinese prescription treats hepatic fibrosis by reprogramming nitrogen, carbohydrate, and glycerophospholipid metabolism 1, 5. It specifically increases the expression of carbonic anhydrase 2 (CA2) and CPS1 to facilitate urea production 1, 6.
- **Xiaoyao San (XYS):** This formula exerts antidepressant and hepatoprotective effects by regulating the glutamine and glutamate metabolic pathways. It maintains the balance of ammonia and promotes energy metabolism, serving as a functional link between the liver and the brain 7, 8.
- **Defatted Walnut Powder Extract:** Identified metabolites from this extract (derived from gallic acid, ellagic acid, and glansreginin A) were shown to reprogram nitrogen metabolism by increasing the expressions of CA2 and CPS1 6, 9.

Reprogramming Signaling and Survival Pathways (SIRT1, mTOR, Apoptosis)

Certain herbs shift cell function by activating or inhibiting major signaling hubs that control cell survival, senescence, and inflammation.

- **Salvianolic Acid A (*Salvia miltiorrhiza*):** This compound prevents alcohol-induced liver injury by upregulating **SIRT1** (Sirtuin 1). SIRT1 deacetylates β-catenin, promoting its nuclear accumulation, which is essential for maintaining liver metabolic activity and regeneration 10, 11.
- **Resveratrol:** This polyphenol and its analogs ("resveralogues") protect hepatocytes against cellular senescence induced by hepatotoxins. They achieve this by activating **SIRT1**, allowing cells to maintain core functions like albumin synthesis and urea production even under toxic stress 12. Resveratrol also modulates the **Nrf2/HO-1**

pathway to prevent oxidative damage 13 and restores neuronal tight junction proteins by correcting ammonia levels 14.

- **Protocatechuic Acid (PCA):** This phenolic acid reprograms cell survival pathways by decreasing the level of **mTOR** (mammalian target of rapamycin) and inhibiting apoptosis. It downregulates caspase-3 and p53 expression while suppressing the IL-6/IL-17/IL-23 immunoinflammatory pathway 15, 16.
- **Ashwagandha (*Withania somnifera*):** The root extract of this plant acts as a neuroprotective agent by upregulating the **Nrf2/HO-1** antioxidant pathway and simultaneously downregulating the **NF-κB/MAPK** (p38/ERK) inflammatory signaling pathways 17, 18.
- **Naringenin:** Distinct from naringin, this compound mitigates hepatic encephalopathy by targeting the **JNK/Bax/caspase-8** apoptotic pathway. It reduces the levels of c-Jun N-terminal kinases (JNK) and decreases the expression of the pro-apoptotic protein Bax 19.

Reprogramming Immune and Inflammatory Responses

- **Barnebydendron riedelii:** Flavonoids extracted from this plant modulate the **NF-κB/IL-6** and **Nrf2/HO-1** signaling pathways. This reprogramming suppresses hepatic inflammation (reducing IL-6 and NF-κB) while enhancing antioxidant defenses 20, 21.
- **Chrysin:** This flavonoid exerts neuroprotective effects by inactivating the **TLR-4/NF-κB** pathway, thereby reducing the expression of inflammatory cytokines like TNF-α and IL-6 22.
- **Ixora parviflora:** Extracts from this plant inhibit the expression of **NADPH oxidase** subunits (gp91phox, p22phox, and p47phox), effectively reprogramming the cell's oxidative stress response 23.

Reprogramming Energy Metabolism

- **Quinoa (*Chenopodium quinoa*):** Functional ingredients from quinoa grains containing polyphenols and phytoecdysteroids can prevent excess ammonia formation and normalize urea excretion, effectively altering nitrogen metabolism under physical stress 24, 25.
- **Tea Seed Oil (*Camellia oleifera*):** Rich in monounsaturated fatty acids, this oil reprograms lipid metabolism to decrease the accumulation of liver lipid droplets and improve oral glucose tolerance 26, 27.

Toxic Reprogramming

It is noted that not all reprogramming is beneficial. For example, **Rhododendri Mollis Flos (RMF)** exerts toxicity by interfering with multiple metabolic pathways, including those for alanine, aspartate, glutamate, and steroid hormone biosynthesis, effectively "reprogramming" the liver toward dysfunction 28, 29.