Enterohepatic Recirculation
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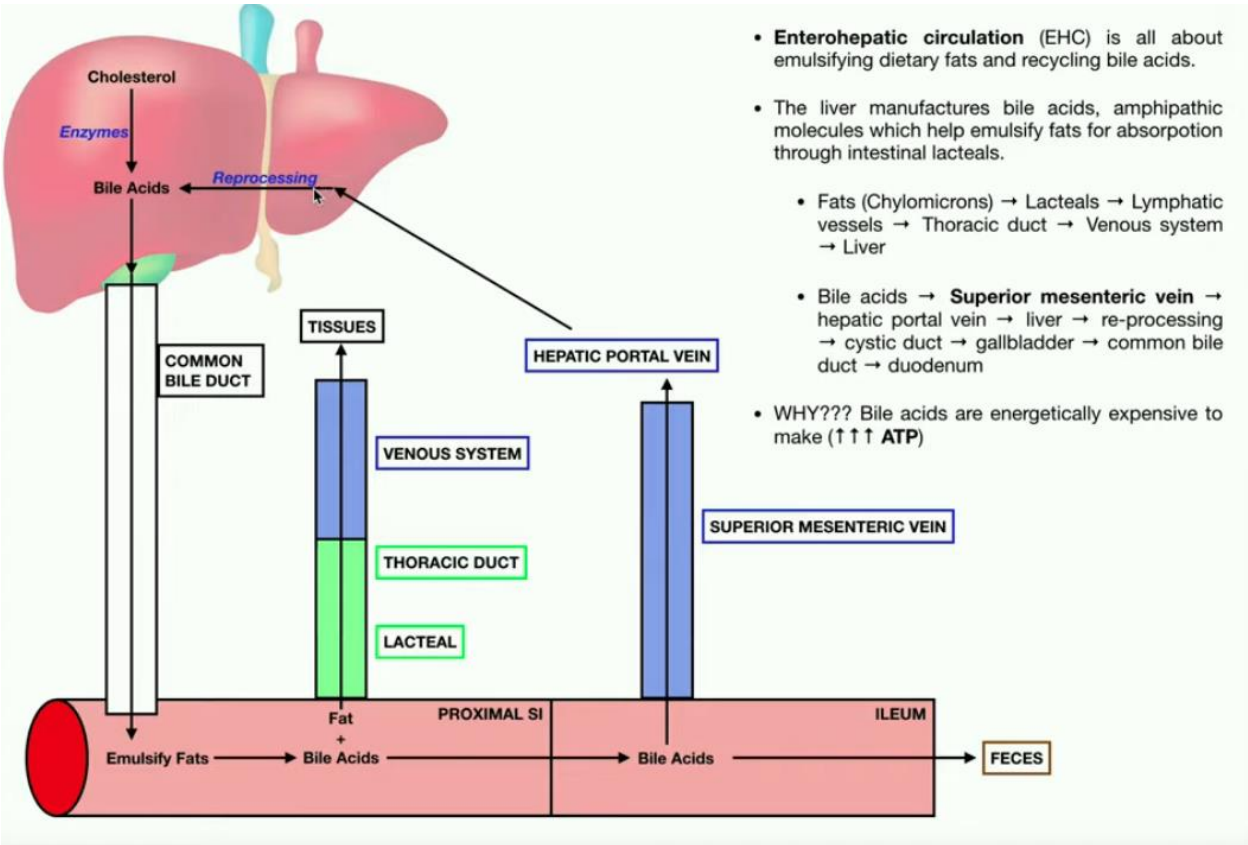

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Introduction

The liver is the largest gland in the human body and performs 500-5,000 functions. It is one of the most important detoxification organs next to the kidneys. In our modern industrialized world, we are exposed to over 80,000 manufactured chemicals in household products and in our food supply and the liver is responsible for eradicating this waste. The following information explores a physiological process for detoxification called enterohepatic recirculation. The liver is designed to dump toxins into bile, store it in the gallbladder and eventually eliminate the bile carrying toxins through the digestive system. When the diet lacks a source of soluble fiber to bind to the bile and eliminate it from the body, 95% of the bile including harmful toxins will absorb through the intestinal wall and recirculate back to the liver. This process is referred to as enterohepatic recirculation.

In the following pages, a general description of enterohepatic recirculation is revealed along with an introduction to Karen Hurd's bean protocol, which saved her daughter from liver failure due to organophosphate poisoning. Endocrine disrupting chemicals such as xenoestrogens, the three phases of liver detoxification and the role of enterohepatic recirculation is investigated in detail. The effects of soluble fiber and prebiotics on the microbiome with special attention to the estrobolome, which is the part of the microbiome that regulates hormones, will be considered along with scientific research on the intestinal enzyme, beta-glucuronidase and its role in perpetuating estrogen imbalance.

Cultural comparisons are studied in the following research correlating intake of soluble fiber with the presence of certain bacterial stands in the intestinal tract and an increase in toxin and bile acid excretion. Regularly consuming prebiotic foods such as

beans have the ability to increase the diversity of beneficial bacteria needed to heal digestive disorders and support a strong immune system.

Additional bile binders outside of the bean family are contemplated and their effects on eliminating toxicity and reducing enterohepatic recirculation is explored. Modified citrus pectin found in citrus fruits and apples gains special notoriety in cancer research. With herbicide and pesticide use at astronomical levels, it is suggested that fulvic and humic acid may be one of the most critical toxin binders of the 21st century.

The final section uncovers a connection between soluble fiber, enterohepatic recirculation and hormone-driven cancers. Other symptoms of hormonal imbalance such as acne, PMS and estrogen dominance are investigated in relation to soluble fiber. The interesting concept of seed cycling and lignin soluble fiber consumption to balance hormones provides a simple solution and hope for healing common endocrine diseases and chronic inflammatory disorders.

General Description of Enterohepatic Recirculation

In order for the digestive system to break down or emulsify fat, the liver produces a digestive liquid called bile. Bile contains bile salts and acids that are made from enzymes and cholesterol. The liver produces approximately 500-600 milliliters of bile daily, which is primarily composed of electrolytes, water, bile salts, cholesterol, phospholipids, bilirubin and protein (Ruggeri, 2018). Bile salts and acids are stored in the gallbladder until fatty acids in the intestines signal the release of the hormone cholecystokinin causing the gallbladder to contract. Bile is then released from the gallbladder into the duodenum to help break down fat and support the absorption of nutrients through the brush border cells of the small intestine into the blood stream. Bile salts and acids are also critical for the

absorption of fat-soluble vitamins including vitamin A, D,E and K. Without bile, these important nutrients would be passed out of the body through the feces.

Bile production requires a sizeable amount of ATP (energy) to produce so the body has a built in mechanism for recycling them called enterohepatic recirculation. First, the liver filters metabolic waste into the gallbladder via bile. In the distal portion of the ileum, enterohepatic recirculation occurs when 95% of the bile is reabsorbed into the portal vein and returned to the liver for recycling. Bile salts go through this cycle about 10-12 times a day and small amounts of bile salts (the remaining 5% that does not enter enterohepatic recirculation) are reabsorbed in the large intestine and broken down by bacteria or excreted in the stool (Lindenmeyer, 2019). If bile acids are not properly absorbed during enterohepatic recirculation, a large amount of bile travels into the large intestine and triggers the release of excess fluid into the colon causing diarrhea.

The effects of enterohepatic recirculation unintentionally recycling toxic waste and other compounds into the liver and bloodstream may pose significant adverse health reactions. Enterohepatic recirculation allows for recycling of metabolized and non-metabolized compounds, and is of critical importance in toxicologic processes involving the gastrointestinal tract (Watkins and Klaassen, 2010). Some of these compounds are excreted in the urine or feces before being absorbed into the bloodstream or returned to the liver. However, exposure to synthetic toxic chemicals, referred to as endocrine disruptors, has increased exponentially over the last 70 years. More than 80,000 chemicals are used commercially in the United States, found in products ranging from toys and detergents to pesticides and food packaging (Trubo, 2005). The enterohepatic circulatory pathway can also be utilized by dermally absorbed or inhaled materials that are excreted in

the bile (Watkins and Klaassen, 2010). In fact, the average American woman uses 12 products containing 168 unique chemicals every day (Chow, 2015). This level of exposure heavily burdens the liver and its ability to clear toxins effectively. The recycling of toxins that occurs during enterohepatic recirculation allows these harmful waste products to enter the bloodstream and bioaccumulate in various organs. The liver is the main detoxification organ the body employs to clear fat-soluble waste such as chemicals, pesticides, heavy metals etc. Essentially, fat-soluble waste will bind to a fat-soluble carrier and bile is the ideal fat to transport this waste into the gastrointestinal tract and ultimately out of the body (Hurd, 2019).

Organophosphate Poisoning and Enterohepatic Recirculation

The following story depicts the importance of understanding enterohepatic recirculation and chemical poisoning. Organophosphates are a common insecticide used to kill carpet beetles and other indoor pests. Renowned nutritionist and biochemist, Karen Hurd, saved her 18-month-old daughter from liver failure and death after unintended exposure to high amounts of carpet beetle insecticide. The entire family was exposed after the organophosphate was incorrectly concentrated at high levels prior to application. Karen, who was pregnant at the time, suffered a miscarriage and the whole family became ill, particularly her young daughter Ruth who began to experience grand mal seizures. When they arrived at the hospital, they were told that Ruth was in liver failure and specialists around the country concluded that she would have approximately six weeks to live.

Fortunately, Karen previously worked for the army in Biological Warfare and knew that her daughter had been poisoned. In order to save her daughter's life, she researched

for days in a local library and created a protocol using soluble fiber in legumes to help clear the liver and restore Ruth's health. Karen's theory was based on enterohepatic recirculation and that the introduction of fat soluble fiber in the digestive system would bind strongly with the bile containing the fat-soluble insecticide and carry it from the small intestine to the colon and finally excrete it through the feces. Essentially, fat-soluble waste needs a fat carrier like bile and the addition of soluble fiber interrupts the absorption cycle in the small intestine and carries the bile and waste into the toilet, circumventing enterohepatic recirculation (Hurd, 2019). This inhibits the recirculation of the insecticide compound into the liver causing damage and liver failure. By the time Karen created the protocol, Ruth had elevated liver enzymes, jaundice, warts all over her body, suppressed immune system and allergies to most foods and other substances including grass. Ruth was syringe fed a blend of legumes (2 tablespoons, six times a day) and within a week, the symptoms of liver failure began to abate. In six weeks, her daughter fully recovered. Today, Ruth is a highly functioning adult with no signs of liver or neurological damage. The organophosphate that poisoned Ruth and the Hurd family has since been recalled from the market.

Karen Hurd received a Master's Degree in Biochemistry from the University of Wisconsin-Eau Claire in 2010. She is currently the leading Toxicology expert in her county and holds a client base of over 30,000 people. Karen developed the "bean protocol" and for the last 30 years has administered nutritional counseling to those with debilitating diseases. Adult clients consume up to a half-cup of beans six times a day along with consuming healthy fats. Her clients have had a high rate of success using this protocol. Karen's work is the inspiration for the following research.

Estrogen and Enterohepatic Recirculation

It is a well-known fact that humans today are living in an "estrogen sea." We are exposed daily to endocrine disrupting chemicals that mimic estrogen and cause numerous adverse health effects. Bisphenol A (BPA) is one of the principal chemicals that can mimic estrogen hormones and is found in plastics, food packaging such as linings of canned food, baby bottles, receipts, cosmetics, personal care products such as shampoo and conventional household cleaners. BPA is currently unregulated by the EPA (Environmental Protection Agency) and the FDA (Food and Drug Administration). What is widely agreed upon is that exposure to BPA is nearly ubiquitous. It has been found in more than 90 percent of the Americans tested (Grossman, 2013). Studies conducted by the National Institute of Environmental Health Sciences reported health effects in lab animals at very low levels of BPA exposure that they say are comparable to amounts people encounter through consumer products (Grossman, 2013).

The liver is designed to filter out harmful toxins and chemicals from the blood and detoxify the body but the amount of chemical exposure in modern industrialized lifestyles leaves this vital organ overtaxed and sluggish. It is also a major regulator of hormonal balance, responsible for filtering hormones from the bloodstream. BPA is just one of the 85,000 – plus manufactured chemicals in use in the United States today (Zerbe, 2019). When these chemicals are not excreted through the bowels, they undergo enterohepatic recirculation and the liver is required to filter them again. This is specifically concerning for chemical substances that mimic estrogen because if the liver is overtaxed and sluggish, the synthetic estrogens are not properly excreted and end up in the bloodstream causing hormonal imbalance and estrogen dominance linked to acute and chronic diseases. The

resultant excess estrogen is inducing an overexpression of estrogen receptors (ERα and ERβ), harming tissues, leading to autoimmune diseases, and neoplasms (Patel et al, 2018).

It is extremely difficult to achieve hormonal balance when synthetic estrogens are continually recycled through enterohepatic recirculation. One study correlated higher urinary BPA concentrations with medical disorders, noting that higher BPA concentrations were associated with clinically abnormal concentrations of liver enzymes (Lang et al, 2008). Elevated liver enzymes are most commonly associated with fatty liver disease and indicate that the body is not eliminating toxins properly. When the liver is in a diseased state, chemicals including estrogen mimics like BPA are unable to undergo the three phases of liver detoxification. This could be a proposed explanation to correlating higher exposure to BPA with increased BPA concentrations in the urine. Since the liver is not able to process the amount of toxic exposure, the alternative route for detoxification is through the urinary system. When detoxification phases in the liver are disrupted, various health complications ensue.

Another study in the late 1990's discovered that endogenous (internally-derived) estrogens and exogenous (externally-derived) estrogens are treated the same by the enterohepatic recirculation (Hurd, 2010). Eighteen healthy postmenopausal women were administered oral doses of synthetic estrogen hormones and oral contraceptives. They found that the synthetic estrogen followed the same pathway as naturally produced estrogen, evoking concern over hormone replacement therapy allowing for excess synthetic estrogens to reenter the bloodstream through enterohepatic recirculation.

When toxic chemicals enter the body, they process through Phase One of liver detoxification, which involves breaking down the substance into a less harmful substance

using enzymes and oxygen. This process is called oxidation as it makes the toxins more soluble in water so they can be more easily excreted from the body by the kidneys and the liver (Wszelaki, 2019). In general, environmental toxins are fat-soluble making them difficult to excrete and Phase One oxidation converts these substances into extractable water-soluble materials. However, oxidation creates free radicals causing stress on the tissues and cellular damage. The liver naturally produces a powerful antioxidant called glutathione that helps to prevent cellular free radical damage. If the liver is not functioning properly due to poor nutrition, toxic exposure, prescription medications, etc. harmful free radicals proliferate and glutathione production is restricted.

Phase Two of liver detoxification involves conjugating or combining Phase One water-soluble, oxidized chemicals with specific amino acids and minerals in order to excrete them through the bile, urine and stool. This phase is comprised of six different pathways responsible for converting specific substances. For example, the methylation pathway converts estrogen and the sulphation pathway converts steroids. When the toxic overload on the liver is exacerbated and the correct nutrients are unavailable for conjugation, Phase Two does not function efficiently. This allows the toxic Phase One byproducts to accumulate in tissues, triggering various diseases. It may also cause excess hormones to circulate through the bloodstream instead of being excreted and this can lead to hormonal imbalances, which may affect the thyroid gland or our estrogen levels (Wszelaki, 2019).

Phase Three mainly refers to the transportation of Phase Two conjugates out of the body via bile, stool and urine elimination. Bacteria in the gastrointestinal tract directly affect this phase determining if conjugates are excreted in the stool or enter enterohepatic

recirculation. In 2010, approximately 60-70 million people in the United States were reported to have a digestive disease.[1] Imbalances in gut bacteria, or gut dysbiosis, inhibit the proper excretion of conjugated toxins out of the body through the stool and allow for reabsorption into the enterohepatic pathway leading back to the liver. Conclusively, the health of the gastrointestinal tract has a direct impact on the liver and the body's ability to excrete harmful environmental toxins.

Microbiome and Estrobolome Imbalances

The microbiome consists of 10-100 trillion microbial cells in the gastrointestinal tract and is undoubtedly the second genome of the human body, with over 3.3 million genes, which have diverse roles in health and disease (Parida, 2019). Research indicates a direct correlation between estrogen dominance and imbalanced gut bacteria. The balance of bacteria in the gastrointestinal tract is crucial for normalizing estrogen levels. The part of the microbiome that regulates hormones is known as the estrobolome. The estrobolome is a collection of enteric bacterial genes that have the ability to metabolize estrogen. Gut dysbiosis or an imbalance and overgrowth of inflammatory microbes or flora in the intestines, affects the delicate balance of the bacteria that compose the estrobolome. The Standard American Diet (SAD) with highly processed foods, alcohol, sugar, hydrogenated oils, chemical additives etc., along with various prescription medications and antibiotics all contribute to dysbiosis in the microbiome and estrobolome. The result is intestinal inflammation, hormone dysfunction and digestive diseases.

Bacteria in the estrobolome work to prevent or promote estrogen excretion from the body. When estrogen excretion is prevented, the hormone enters the enterohepatic

[1] https://www.niddk.nih.gov/health-information/health-statistics/digestive-diseases

recirculation cycle and must go through Phase One and Phase Two detoxification in the liver. As explored earlier, an overtaxed and sluggish liver will not be able to process the amount of estrogen needing to be recycled. This is especially concerning for estrogen mimics such as harmful BPA chemicals that end up in the bloodstream and numerous tissues resulting in disease and hormone-driven cancers.

During Phase Two detoxification in the liver, estrogen is conjugated or "packaged up" and delivered to the bile for safe elimination in Phase Three. The process for conjugating estrogen in the liver is called glucoronidation, which attaches glucuronic acid to estrogen making it chemically water-soluble and easy to excrete in the intestines. However, upon leaving the liver, conjugated estrogens in the bile are released into the intestines and can be deconjugated by beta-glucuronidase producing bacteria. Deconjugation refers to removing an acid (glucuronic acid) or mineral group from an oxidized compound that was added during Phase Two liver metabolism. This deconjugation unbinds the estrogen making them active and preventing their excretion (Schoenfeld, 2018). Bacteria in the estrobolome produce the enzyme beta-glucuronidase that is responsible for deconjugating estrogen. Beta-glucuronidase is also responsible for breaking down complex carbohydrates and reabsorbing bilirubin and flavonoids. Therefore, this enzyme is needed in the intestinal tract in a useful amount. In an unhealthy and imbalanced estrobolome, the amount of beta-glucuronidase is hyper-expressed causing deconjugation of estrogen at excessive levels. When estrogen is deconjugated or extracted from its inactive elimination state, it becomes active and available to absorb through the intestinal wall into the bloodstream and enter enterohepatic recirculation. In other words, intestinal microbes encode enzymes capable of deconjugating conjugated

estrogen metabolites marked for excretion, pushing them back into the enterohepatic circulation in a biologically active form (Parida, 2019). This cycle is very concerning when chemicals and toxins that mimic estrogen enter the bloodstream and return to the liver for processing. Enterohepatic circulation will increase the toxicity of a compound to organs in the enterohepatic circuit if the compound remains active during circulation (Watkins and Klaassen, 2010). The unprecedented escalation in the polycystic ovary syndrome, infertility, breast cancer, ovary cancer, and gynecomastia cases are indicating that this sensitive hormone is getting exacerbated (Patel et al, 2018).

The two primary forms of estrogen in the body are estrone and estradiol. In 2016, an important study showed that women injected with radioactively labeled estrogens (estradiol, estrone and estriol) recovered 65% of the injected estrogens (specifically estradiol) in bile released into the intestines for excretion (Kwa et al, 2016). Alarmingly, only 10-15% of injected radiolabeled estrogens were found conjugated in the feces. This study supports that estrogens are indeed undergoing deconjugation in the intestinal tract due to a plethora of beta-glucuronidase made by an imbalanced and unhealthy estrobolome. Consequently, these harmful estrogens are reabsorbed back into the bloodstream.

A recent study explored estrogenic compounds exposed to beta-glucuronidase enzymes that could, in theory, cleave the sugar moiety, reactivating the parent compound and allowing the unconjugated estrogen to be reabsorbed in the blood stream and undergo iterative rounds of enterohepatic recirculation (Ervin et al, 2019). Experts agree that unbound estrogens are much higher in plasma and tissues of women with hormone driver cancers.

It is common knowledge that the top contributor to gut dysbiosis is the Standard American Diet (SAD) filled with highly processed foods containing excessive amounts of sugar, minimal fiber and harmful food additives. Researchers in the late 1980's compared the urinary and fecal excretion of estrogen and plasma levels of estrogen in pre and post-menopausal American and Asian women consuming different diets. American women consuming a "Western" diet of high-fat and low-fiber contents had 30% higher levels of plasma estrogen compared to their Asian counterparts. This means that estrogens were deconjugated in the estrobolome, re-circulated in the bloodstream and underwent enterohepatic recirculation. The Asian group of women excreted three times the amount of estrogen in their feces compared to the American women. The Asian diet is typically high fiber and low fat. In conclusion, correlation analysis of dietary components and plasma estrogen showed that plasma estrogen was positively associated with fat and was negatively associated with fiber. The results indicate that diet can alter the route of excretion of estrogen by influencing the enterohepatic circulation and that this, in turn, influences plasma estrogen levels (Gorbach and Goldin, 1987). Over the past thirty years, the Western food industry has incorporated genetically modified foods, increased the amount of pesticides used on commercial crops and has introduced countless chemical food additives into the market, many are unregulated, mislabeled and unknown to the consumer. All of these factors contribute to gut dysbiosis by eradicating beneficial gut bacteria imperative to a healthy immune system. The amount of hormone disrupting chemicals in the food chain and in the environment has increased exponentially over the years, exposing the average American to imbalances in the glandular, digestive and nervous systems, irrefutably resulting in disease. If plasma estrogen is negatively associated with

fiber as the above study purports, an exploration into high-fiber diets and other binder materials to support Phase Three elimination of estrogen and other toxins released into bile is pertinent.

Beneficial Effects of Dietary Fiber and Microbiome Balance

Dietary fiber and its positive effects on human health, specifically colon health, has been extensively studied over the last two decades. Unfortunately, limited research exists on the role dietary fiber plays in limiting enterohepatic recirculation. Many studies allude to the beneficial effects of increased dietary fiber and decreased circulation of toxins but the link between decreased enterohepatic recirculation and increased dietary fiber has yet to be extensively explored. According to Karen Hurd, soluble fiber found in beans saved her daughter from liver failure after exposure to organophosphate poison (Hurd, 2019). In this tragic but miraculous story, the soluble fiber attached to bile that carried the poison from the liver. The fiber interrupted the absorption and recirculation of the bile with harmful toxins back into the bloodstream and liver and carried it out of the body in the feces. Dietary fibers are considered binders, meaning that they can bind onto materials in the gastrointestinal tract and clear waste from the body. Many toxin binders exist that will perform a similar function but the unique chemistry of beans makes them an optimal binder selection.

Beans are considered a soluble fiber meaning that they dissolve in water and form a viscous gel. Soluble fiber can bypass the hydrochloric acid in the stomach and digestion in the small intestine and enter a fermentation process with the bacteria of the colon or large intestine. On the other hand, insoluble fibers are not water-soluble and pass through the GI tract with little to no fermentation. A large amount of research has reported an inverse

relationship between fiber consumption and the risk for coronary heart disease and several types of cancer. For this reason, the FDA has adopted and published the claim that increased consumption of dietary fiber can reduce the prevalence of coronary heart diseases and cancer (Lattimer and Haub, 2010). This claim embraces the correlation between increased fiber intake and increased bile acid excretion, binding of carcinogens and the benefits of antioxidants, minerals and vitamins inherent in the composition of many fibrous food sources. In the early 1990's, experiments were piloted on rats to examine the difference between soluble and insoluble fiber. This study showed that concentrations of circulating bile acid in soluble fiber fed rats was significantly lower than the insoluble fiber fed rats and the fecal bile output was much higher in soluble fiber fed rats (Hurd, 2010). This study proves that soluble fiber interrupts enterohepatic recirculation.

A 2017 study examined dietary fiber intake across industrialized and unindustrialized parts of the world, focusing on Western style diets in the United States, United Kingdom and Europe compared to rural communities in Africa. This study established a direct correlation with intake of dietary fiber and diversity of bacteria in the microbiome. They found that unindustrialized rural communities in Africa such as Tanzania and Burkina Faso consumed seven times more fiber than their Western counterparts. Researchers based this strongly on their plant-focused diet. It was also found that rural community participants had more diversity overall in intestinal bacteria. Those consuming a Western diet high in saturated fat, sugar, animal protein and refined carbohydrates had depleted microbiota diversity and "subsequent increases in chronic non-communicable diseases, such as obesity, cardiovascular disease, type 2 diabetes and

colon cancer" (Holscher, 2017). Cross-sectional studies of human populations across the globe revealed association between increased dietary fiber intake with increased diversity of gut bacteria. Initially, the same study was conducted on mice prior to human trails and researchers found that low-fiber diets negatively impacted the diversity of the microbiome and this depletion continued over several generations.

Another benefit of beans, aside from the soluble fiber content and their ability to bind with bile and excrete harmful toxins from the intestinal tract, is that they are a well known prebiotic. Prebiotics were originally defined in 1995 by Gibson and Roberfroid as, "a non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health" (Holscher, 2017). In 2010, the definition was updated to expand the language of "limited number of bacteria in the colon" to "a large number of bacteria in the entire intestinal tract." Prebiotics are the food or fertilizer for the bacterial probiotics in the gastrointestinal tract and assist in making the environment more diverse. Diversity in the microbiome is correlated with health and helps to mitigate disease, as the earlier study on Western and African fiber consumption pointed out. Prebiotics are unique because they can survive the acidity of stomach and reach the intestinal tract where most probiotics taken supplementally to increase the diversity of the microbiome risk eradication by hydrochloric acid in the stomach. In particular, beans contain fibers called oligosaccharides, which are non-digestible: allowing them to bypass stomach and duodenum digestion and travel to the colon for fermentation by beneficial microflora.

Studies comparing the gut microbiota of rats fed high fat-diets and prebiotics showed that certain bacteria stains were restored with prebiotic consumption. Reduced

body weight was also a reported side effect of prebiotic intake. It was clear that rodents with nutritional or genetic-induced obesity and type 2 diabetes displayed gut barrier dysfunctions leading to the leakage and dysbiosis in the microbiome (Petschow et al, 2013). Common prebiotic foods aside from beans include but are not limited to bananas, garlic, leeks, onions, sweet potatoes, dandelion greens, flaxseeds, wheat bran, oats, barley, apples, Jerusalem artichokes, carrots, seaweed and asparagus. As noted earlier, the Standard American Diet (SAD) is low-fiber and contains marginal amounts of the above mentioned prebiotic food sources. Digestive diseases are currently an epidemic and as a result, the number of published studies on microbiome-related research has increased four-fold between 2005 and 2012 (Petschow et al, 2013). The microbiome is commonly referred to as the "second immune system" and it is reasonable to correlate the lack of diversity in the SAD diet to the lack of diversity in gut bacteria. To compound matters, environmental exposure to toxic chemicals including heavy metals, pesticides, plastics and prescription medications such as antibiotics, which are designed to eliminate harmful and helpful bacteria, are drastically reducing the diversity of the microbiome, allowing harmful pathogens and toxins to bioaccumulate in intestinal tissue and circulate in the bloodstream, inevitably residing in major organs. The brilliance of Karen Hurd's bean protocol is that it offers a cost effective, nutrient dense prebiotic that is an easily accessible solution for not only detoxifying the body of harmful toxins and reducing enterohepatic recirculation of chemicals, endocrine disruptors and disease producing substances but also helps to restore the diversity in the microbiome by nourishing and producing gut bacteria essential to health.

Dr. Deanna Minich, internationally recognized teacher, author and nutritional scientist states that "diversity on the plate, leads to diversity in the gut." (Minich, 2018). She examines several studies on microbiomes across cultures and found that variations in diversity of bacteria in the gut is based more on specific foods as opposed to the overall diet per se. This is an interesting discovery when considering various types of prebiotics interacting with microflora in the large intestine. Consuming specific prebiotic foods could lead to greater diversity in the microbiome. One study compared the microbiomes of the sub-Saharan African Hadza hunter-gathers with Italian people. Certain strains of gut bacteria were present in Hadza people that rarely presented in the Italians and vice versa. The Hadza people are primarily secluded with no exposure to factors negatively affecting gut diversity such as antibiotics, plastics, heavy metals, pesticides and herbicides. Longevity in the Hadza people rivals the Okinawans of Japan were many live well and healthily past 100 years of age. Both cultures are very connected to the land and their diets change throughout the seasons based on what is available for consumption. The exposure to toxic environmental and food chemicals is minimal to non-existent. Researchers also discovered that certain strands of bacteria were present when the diet seasonally shifted and the transformation was rapid. For example, comparisons between plant-based diet microbiomes (high fibers and low fats and proteins) with animal-based diet microbiomes (low fibers and high fats and proteins) demonstrated that a shift toward an animal-based diet increases the abundance of bile-tolerant microorganisms (Alistipes, Bilophila, and Bacteroides) and decreases the levels of Firmicutes bacteria that metabolize dietary plant polysaccharides (Roseburia, Eubacterium rectale, and Ruminococcus bromii) (Rinninella, 2019). Bile-tolerant microorganisms in the animal-based diet are able to survive the

stomach acid and are potentially harmful. The microbes in the intestinal tract alternate between carbohydrate and protein fermentation to mimic the diet changes. Remarkably, the microflora can adapt and change within one day of the diet change. Since probiotic gut bacteria feed on prebiotics, an efficient and rapid way to increase microflora diversity would be to diversify prebiotic intake. Although, Karen Hurd's protocol specifically focuses on beans as the primary prebiotic, it would be reasonable to conclude that consuming the other prebiotic sources mentioned earlier would have a synergistic effect of removing harmful toxins and pathogens while increasing microbiome diversity and improving immune function and overall wellness. The above study supports Karen's initial findings on the rapid change in her daughter's condition. Her child transformed from a terminally ill liver-failure patient to a functioning toddler after one week of a syringe-administered legume diet. This evidence has the capacity to instill hope in a culture that desperately requires a dietary revolution. The fact that the microbiome is so adaptable to positive changes in food consumption, such as prebiotics, is indeed encouraging for those dedicated to improving their health and those whose lives depend on rapid results.

Supplemental Binders, Enterohepatic Recirculation and Detoxification

Beans are the primary food binder focused on in this research but it is worthwhile to explore additional supplemental binders that work to eradicate specific toxins. Most of these binders are used in the initial stages of gastrointestinal toxicity and are not recommended for long-term use. This is why beans and other soluble fiber food sources can be a superior option for long-term detoxification and rebalancing the microbiome and estrobolome. Binders work as magnets for toxins, attracting and grabbing them from the intestines and pulling them out (Donaldson, 2018). Common examples of binders are

zeolite, modified citrus pectin, chlorella, activated charcoal, carbonized bamboo, humic and fulvic acid, silica and seeds. All of these substances reduce enterohepatic recirculation of toxins and other harmful pathogens.

Zeolite is a type of volcanic clay from the silica family that binds easily to mold, mycotoxins (toxic chemicals produced by fungi) and mercury. Clay is typically negatively charged and mold, fungi and other toxins such as BPA, pesticides and heavy metals carry a positive charge. Based on the laws of physics, positive and negative charges are attracted to one another and form very strong ionic bonds. This reaction is specifically advantageous in heavy metal detox as it stabilizes or neutralizes the dangerous toxin for safe removal through the digestive system. Zeolite and other positively charged binders are able to chelate heavy metals, which simply describes the action of binding to heavy metals, neutralizing them, removing them from the blood and tissues and finally transporting them out of the body. Aside from its powerful detox capabilities, zeolite can also improve digestive health. In a 12-week, double-blinded, placebo controlled study conducted in 2015, researchers measured the effects of zeolite supplementation on the digestive systems of 52 aerobically trained athletes to see if it could improve their performance and health. They found a positive correlation between zeolite supplementation and reduced inflammation and significantly increased zonulin concentrations in the stool (Lamprecht et al, 2015). Zonulin is an intestinal molecule that reduces the tight junction between brush border cells in the gastrointestinal tract leading to increased intestinal wall permeability or a common digestive condition called “leaky gut.” In conclusion, zeolite has beneficial effects on gut health, assisting in remediating leaky gut conditions by binding to hyper-expressed substances like zonulin and other harmful toxins and pathogens.

Modified citrus pectin (MCP) binds efficiently to lead and other heavy metals and has been extensively studied in cancer research. MCP has been a successful chelator of lead in children hospitalized with toxic levels. An interesting and unique study was conducted on a family of six from Phoenix, Arizona with exposure to uranium in their drinking water. Within 6 days of consuming MCP capsule supplements, significant amounts of uranium were measured in the feces. This is the first report of a supplement promoting uranium excretion, suggesting it may reduce negative health effects in regions where chronic uranium exposure is known (Eliaz et al, 2019). Miraculously, this substance was successful in binding to uranium, foregoing enterohepatic recirculation (protecting the liver and kidneys from heavy metal damage) and safely eliminating it from the body. Modified citrus pectin is available in supplemental form for extreme cases afore mentioned but is readily obtainable in nature, found as a polysaccharide in the pulp and skin of citrus fruits and in apples. Studies utilizing MCP in cancer research is a burgeoning topic. An abnormal excess of a naturally produced protein in the body called galectin-3 has been correlated to heart failure, kidney disease and various cancers (it is a biomarker in breast, ovarian and prostate cancer). MCP has been shown to inactivate and bind to galectin-3, reducing the excess levels in the body and blocking its ability to send destructive molecular signals throughout the body that stimulate cancer growth (Benson, 2020). Interestingly, pharmaceutical companies are currently trying to patent and produce a galectin-3 blocking medication with minimal success. Fortunately, MCP is already available in convenient supplemental forms, naturally occurs in nature and is free from negative side effects, which inevitably exist with every patented pharmaceutical drug.

According to the National Integrated Health Association (NIHA), chlorella is one of the most widely used binders and health foods worldwide and is the most studied nutrient (2,000 pier reviewed articles mostly Asian) (McClure). Chlorella is an ancient algae that binds to most heavy metals and offers a gentle detox pathway that does not overburden the liver or kidneys. Aside from being an excellent metal chelator, chlorella is rich in vitamins, minerals, amino acids, essential fatty acids and B-12. A double-blind, placebo controlled study was conducted in 2018, investigating what combination of 14 natural substances could effectively and safely detox metals from 347 Russian metal foundry workers. The trials took place over a three-year period with homeopathic remedies and vitamins administered with various combinations of chlorella and cilantro substances. Researchers found that participants had an increase between 150% to 400% heavy metal excretion in the feces and up to 1,200% increase of metal excretion in the urine. The most effective combination that operated as a "gentle chelator" and did not adversely affect liver and kidney function tests and is tolerable by most adults was homeopathic chlorella combined with CFG (Chlorella Growth Factor, an extract from chlorella) and cilantro (Georgiou, 2018). The study confirmed that these effective binders detoxed all hazardous heavy metals in participants and decreased the possibility of re-absorption through enterohepatic recirculation.

Activated charcoal and carbonized bamboo are both carbon-based compounds from decomposed shells or vegetable matter that have extremely high binding capacity to chemical and metal toxins. Activated charcoal has been used for years in the medical community to reverse drug overdose and poisoning. It is also a well-known component of water filtration systems. Activated charcoal is not intended for long-term use because it can

bind to vitamins and interfere with the absorption of beneficial nutrients (Axe, 2019). Many low-quality products exist that can cause constipation and even blockage in the intestinal tract. Carbonized bamboo has been used for years in Japan but is not as well known in the Western medical or holistic community. As a result, studies are limited on its effects as a binder for detoxification and restoring digestive health. However, it makes sense that the popularity in Asian countries is increasing due to its affinity for binding to radiation.

Humic and fulvic acids are potent binders for one of the most destructive and pervasive herbicide/pesticide: glyphosate. Glyphosate is a biotoxin that acts as a powerful antibiotic in the human gastrointestinal tract causing gut dysbiosis and increased permeability of the intestinal wall (leaky gut). It is widely known that glyphosate is sprayed on conventional crops and is even found in organic crops due to blow over from non-organic farm fields. The indestructible nature of this chemical allows it to exist in the soil for several decades, risking contamination of future crops. In 1996, the American Chemical Society published a study stating that, "humic extracts from soil adsorbed glyphosate even more than clay minerals, thereby indicating that the interactions with humic substances, in either a solid or dissolved form, are far more important than previously believed" (Piccolo et al, 1996). Essentially, humic and fulvic compounds are derived from decomposing plant and animal materials in the soil. The very substance (soil) that major agricultural companies are poisoning is the substance that can bind and detox glyphosate from human beings. Many practitioners in the natural health arena believe that the "soil" of our gut is only as healthy as the "soil" of the earth, and that all diseases begin in the gut. Ingesting fulvic and humic acid from the soil is critical for eradicating glyphosate from the digestive

tract and healing gut dysbiosis, leaky gut and an array of other diseases. What is even more disturbing is that glyphosate can chelate aluminum, allowing it to bypass the gut barrier, enter enterohepatic recirculation and circulate in the bloodstream. Eventually, this biotoxin can permeate the blood-brain barrier with aluminum attached to it and provoke neurological diseases. One study points out that aluminum and glyphosate synergistically induce autism, depression (impairs serotonin synthesis in the gut), dementia, Alzheimer's, anxiety disorders and Parkinson's disease, and is associated with abnormal sleep patterns, which are directly linked to pineal gland dysfunction (Seneff, 2015). Since human beings across the world are exposed to glyphosate on a daily basis through the food they consume, there is strong evidence that fulvic and humic acid is the most critical binder of the 21st century.

In combination with fulvic and humic acid, silica is the principal binder for aluminum. Silica is naturally occurring in the earth's crust and found in the skins of fruits and vegetables. Aluminum has a special attraction to brain and nervous tissue and is found in cookware, baking products, personal care products such as makeup, drinking water, medications, vaccines and antiperspirants. Fortunately, aluminum is a fairly easy toxin to detox from the body using the mineral silica as a binder. In 2017, research funded in part by the Children's Medical Safety Research Institute and conducted by a team at Keele University in Staffordshire, England found dangerous levels of aluminum in brain tissue of children with autism. This was the first time that professor and chemist Christopher Exley and his team of scientists had the opportunity to examine the brain tissue of deceased autistic children. Exley is one of the leading experts in aluminum toxicity and a vocal advocate for the eradication of vaccines that use aluminum as an adjuvant (substance used

to enhance the immune response of the vaccine). His findings concluded that consuming silicon-rich mineral water daily binds to aluminum and removes it safely from the body. He goes on to report, "What we have found in clinical trials, involving both healthy individuals and individuals with disease, is that drinking around a litre of silicon-rich mineral water (containing soluble silicon or silicic acid) every day can speed up the removal of toxic aluminum from the body via the kidneys and ultimately urine" (Adi-Tabatabaj, 2017).

The final binders to explore are seeds that contain soluble and insoluble fiber such as chia, hemp, flax, pumpkin, sesame, sunflower etc. The chemical properties of seeds work synergistically with healthy bacteria in the gut and have the ability to bind to hormone disrupting chemicals. For example, lignans are a phytonutrient that contains soluble and insoluble fiber and are found in sesame and flax seeds. Lignans assist with hormone balance by binding to excess estrogen, therefore interrupting enterohepatic recirculation of estrogen mimicking chemicals and excess endrogenous (internally-derived) estrogens. The next section will investigate the relationship between soluble fiber and hormonal imbalance, including estrogen-driven cancers and acne.

Soluble Fiber and Hormonal Imbalance

Hormones are chemical messengers that are involved in every physiological process inside the human body. Hormones are made from proteins, lipids or amino acids and are produced by various glands in the body such as the pituitary and pineal glands, hypothalamus, thyroid, pancreas, adrenals, thymus, ovaries and testes. These powerful chemical messengers circulate throughout the body, work synergistically with the nervous system and bind to cell receptor sites; activating physiological processes. The physiological processes that are regulated by hormones include metabolism, sleeping and waking cycles,

physical growth and development, body temperature, sexual function, reproduction and appetite. The human body strives to maintain a delicate balance of hormone production and utilization and the endocrine disrupting chemicals and toxins mentioned throughout this paper pose serious hazards to hormonal health. For example, 50-100th millionth of a gram of thyroid hormone is produced each day and even the slightest excess or deficiency in this microscopic amount has serious affects on health. Hormones utilize a "lock and key" system when binding onto cellular receptor sites and hormone mimic chemicals and toxins inhibit this system by deceptively congesting the receptor, prohibiting necessary hormonal chemical reactions and physiological balance.

The list of symptoms of hormonal imbalance is quite extensive but according to the Women's Health Network, the most common symptoms include: weight gain, fatigue, irregular menstrual cycles, low libido, infertility, hair loss or hair growth in unwanted places, skin issues such as acne, irritability and depression (James, 2020).
Numerous studies have purported a direct correlation between excess estrogen hormones and the development of breast cancer. As explored earlier in the **Estrogen and Enterohepatic Recirculation** section, synthetic estrogens found in plastics, birth control pills, cosmetics, detergents, commercial animal products, pesticides and herbicides etc. are treated the same in the body as naturally occurring estrogens. This is extremely concerning when considering hormone-sensitive cancers such as breast, ovarian, uterine and prostate cancer. In the case of hormone-sensitive cancers, the cancer cells contain receptors and a "lock and key" format for estrogen (Johnson, 2019). As the body is flooded daily with synthetic estrogen exposure; the unnatural hormone will lock into cancer cell receptors and proliferate growth. Since synthetic estrogens are able to undergo enterohepatic

recirculation, soluble fiber should be at the forefront as a powerful binder for preventing and treating estrogen dominance and hormone-sensitive cancer progression. Soluble fiber studies are increasing as more than one million women will be diagnosed with breast cancer and over 460,000 of them will die from the disease each year worldwide (Li et al, 2012).

A long-term study conducted by researchers at Harvard T.H. Chan School of Public Health showed that higher fiber intake in adolescence reduced breast cancer risk in adulthood. Over 90,000 premenopausal women between the ages of 25 to 42 participated in a 20-year study from 1991 to 2011. Researchers collected data of food items, focusing specifically on fiber intake consumed from 1960-1980, when these women would have been in high school. Average fiber intake was also recorded and analyzed in follow-up data collection in 1995, 1999, 2003, 2007, 2011 or until cancer diagnosis, death or menopause. Conclusively among all the women, early adulthood total dietary fiber intake was associated with significantly lower breast cancer risk. The study suggests that, "sex steroid hormone levels are strongly related to breast cancer development and a diet high in fiber has been hypothesized to reduce breast cancer incidence by inhibiting reabsorption of estrogen, thus decreasing circulating levels (Farvid et al, 2016). This study directly supports Karen Hurd's protocol of employing soluble fiber to interrupt enterohepatic recirculation and to prevent the engagement of dangerous and synthetic cancer-causing estrogens at a cellular and physiological level.

In 2012, a smaller case controlled study was conducted in Connecticut on dietary fiber and breast cancer. Researchers studied the diets of 557 breast cancer cases and focused on premenopausal and post-menopausal women with estrogen receptor tumors.

Their findings correlated with the above study concluding that dietary soluble fiber intake was associated with decreased risk of estrogen receptor breast cancer in premenopausal women. Interestingly, among post-menopausal women, no reduced risk of breast cancer was observed for either soluble or insoluble fiber intakes or among estrogen receptor tumor groups (Li et al, 2012). An earlier study in 2009 followed over 5,000 breast cancer cases over a 7-year period. This study also found an inverse relationship between dietary fiber intake and breast cancer risk in premenopausal women and an inconclusive relationship in postmenopausal women. It suggests that the type of fiber consumed had a direct effect in postmenopausal breast cancer cases. Dietary fiber from grains, beans and vegetables showed minimal correlation for postmenopausal women but fiber from fruit was positively correlated with reduced risk. They report that, "It is possible that fiber type makes a difference in pathophysiologic processes related to breast cancer. Soluble fiber has been shown to be more effective in controlling blood glucose, insulin, and insulin-like growth factors, which have been positively related to risk of breast cancer." (Park et al, 2009). Pectin, a soluble fiber found in fruit, had an inhibitory effect on tumor growth and metastasis. Further studies are necessary to examine fiber type and the effects on women at various hormonal life stages.

Based on the Institute of Medicine report on US intakes of fiber, dietary fiber is found in plant foods: vegetables, fruits, and legumes. Common sources of soluble fiber include oats, lentils, apples, oranges, pears, bran, strawberries, nuts, flaxseeds, beans, dried peas, blueberries, psyllium, cucumbers, celery, and carrots (Li et al, 2012). When considering soluble fiber sources, debate has ensued over fiber supplements versus plant foods. The studies presented in this section examined dietary soluble fiber from whole

foods as opposed to fiber supplements. While fiber supplements are helpful for those with digestive issues and elimination difficulty, the isolated extracts do not contain the vitamins and minerals present in whole food form. Hurd explains that supplements do not have all the co-factors found in whole foods and this is why consuming soluble fiber in her bean protocol is so beneficial for digestive and hormonal health (Hurd, 2019). Co-factors are naturally occurring chemicals that unite with vitamins and minerals and assist them in functioning properly within the body. For example, the tomato is theorized to have 10,000 co-factors for vitamin C but scientists have only identified ten of them. A 2015 study supports Hurd's claims by reporting, "fiber supplements cannot be presumed to have the same health benefits that are associated with dietary fiber that is intact and intrinsic in whole foods. The clinically proven health benefits for fiber supplements are associated with specific characteristics (eg, viscous gel), and only a minority of marketed fiber products provide health benefits" (McRorie, 2015). Historically, humans have endeavored to mimic the intelligence of nature by extracting and isolating naturally occurring chemicals and compounds. This process has manifested into the pharmaceutical industry leaving physiological systems stressed and symptoms suppressed. It is common knowledge that all pharmaceutical drugs have side effects and are ineffective at addressing and balancing the core of the issue. This is yet another powerful example that organically produced food eaten in whole form is the medicine of the past, present and future.

One of the most visible and embarrassing signs of hormonal imbalance is acne. Karen Hurd describes acne as strictly a soluble fiber issue and touts that it will subside within a week of dietary fiber introduction (Hurd, 2019). According to a 2016 study, the link between diet and acne is extremely controversial but can no longer be overlooked.

Patients with acne vulgaris consumed daily 30g of high fiber breakfast cereal (13 g fiber/serving), and a significant improvement in the skin condition was shown (Kucharska et al, 2016). Once again, excess estrogens linked to hormonal imbalance and acne were bound to fiber in the gastrointestinal tract and transported out of the body. It is well documented and understood that on-going stress causes the adrenal glands to release the hormone cortisol. One of the symptoms of excess cortisol is acne. The pervasive production of cortisol can deplete the hormone progesterone, which attempts to maintain a healthy balance with estrogen. When progesterone is depleted, the ratio between the two hormones is exacerbated, causing symptoms of estrogen dominance. Both estrogen dominance and cortisol excess are linked to acne vulgaris. A 2014 study supports Hurd's claim by exploring the effects of prebiotics (a form of soluble fiber prevalent her bean protocol) on cortisol levels. After three weeks of daily consumption of various prebiotics, salivary cortisol levels in 45 participants significantly decreased (Schmidt et al, 2014). Decreased levels of cortisol in the salvia indicate that the hormone did not recycle during enterohepatic recirculation and was carried out of the body by soluble fiber.

Another simple and effective way to address hormone imbalance is a method called seed cycling. In the past several years, this old naturopathic protocol has gained tremendous popularity. The protocol entails ingesting certain seeds during specific times of the month. Flax and pumpkin seeds are ground and consumed during the first 14 days of a women's cycle called the follicular phase. Ground sesame and sunflower seeds are consumed from day 15 to the first day of the menstrual cycle called the luteal phase. One tablespoon of each seed is consumed and they must be raw and preferably organic to receive the hormone balancing benefits. The idea is that this rotation can bring hormones

back into balance naturally and reduce symptoms of hormonal imbalance including PMS, infertility, hot flashes, missed cycles, acne, bloating, fatigue etc.

To date, there are no peer-reviewed scientific studies that explore the protocol's effectiveness. A plethora of successful testimonials and positive experiences reported online have encouraged many desperate women with hormonal imbalances to experiment. The descriptions and articles available explain that the properties in the raw seeds are able to detox the body of excess estrogens. It is well established that flax and sesame seeds contain lignans. As mentioned earlier, lignans are a phytonutrient that contains soluble and insoluble fiber. Flaxseed contains 800 times more lignans than other plant food. They were cultivated in Babylon as early as 3,000 B.C. and in the 8th century, Charlemagne passed laws requiring people to consume it (Magee, 2009). The first report on the effects of flaxseed consumption on the common endocrine disorder, PCOS (Polycystic Ovarian Syndrome) occurred in 2009. Researchers discovered a significant decrease in PCOS symptoms correlated with a decrease in androgen (steroid hormone such as testosterone) levels when consuming flaxseeds over a four-month period (Nowak et al, 2009). Earlier research conducted in 1993, uncovered astounding effects of flaxseed consumption on ovulation. Eighteen participants consumed their regular diet for three cycles and added in flaxseeds for an additional three cycles. Three anovulatory cycles occurred during the 36 control cycles, compared to none during the 36 flax seed cycles (Phipps et al, 1993).

Further research is required to fully understand the properties of the seeds and exactly how they balance hormone levels. The research presented on flax and lignans is an excellent foundation to support the necessity for soluble fiber's critical role in addressing hormonal imbalance. Interestingly, many studies and articles allude to the process of

interrupting enterohepatic recirculation by explaining that lignans/soluble fiber detox excess estrogen in the digestive system. The work of Karen Hurd identifies the significance of understanding soluble fiber, enterohepatic recirculation and its role in the burgeoning field of addressing and healing endocrine disorders and chronic diseases holistically.

Conclusion

Ongoing research is required to solidify the importance of dietary fiber and its array of healing benefits. Karen Hurd's bean protocol proposes a simple and cost effective avenue for eliminating harmful toxins from the body and restoring liver, hormonal and digestive health. Research suggests that this delightful protein can prevent and remedy many disorders ranging from hormonal imbalance to cancer. It is critical for all holistic, naturopathic and allopathic practitioners to understand the process of enterohepatic recirculation and the importance of soluble fiber in order to support the healing of disorders exacerbated by the recirculation of harmful toxins and chemicals.

Diets high in soluble fiber are woven into the cultural fabric of families across the globe for innate reasons. The intrinsic healing qualities of soluble fiber are undeniable and should become an integral part of the current food revolution. Until we as a human race take control of our food system by consuming whole, non-toxic food high in fiber and essential vitamins and minerals, disease will continue to manifest at epidemic proportions in Western culture and throughout the world.

Works Cited

Adl-Tabatabai, Sean. "UK Study: Brains Of Children With Autism Are Loaded With Aluminum." News Punch, 10 Dec. 2017, newspunch.com/brains-children-autism-aluminium/

Axe, Josh DC. "Top 10 Activated Charcoal Uses, Plus Potential Side Effects." 5 Jul. 2019, draxe.com/nutrition/activated-charcoal-uses/

Chow, Lorraine. "Women Apply an Average of 168 Chemicals on Their Bodies Every Day." EcoWatch, 15 May 2015, www.ecowatch.com/women-apply-an-average-of-168-chemicals-on-their-bodies-every-day-1882041568.html

De Berg, Steven. "Why Does Your Body Need Citrus Fruits." Life Extension, May 2020, www.lifeextension.com/magazine/2014/10/why-some-people-need-modified-citrus-pectin

Donaldson, Julie. "Toxin Binders: A Modern Necessity." True Nature Health Consulting, 26 Apr. 2018, www.truenaturehealthconsulting.com/blog/2018/4/20/toxin-binders-a-modern-necessity

Eliaz et al. "Modified Citrus Pectin/Alginate Dietary Supplement Increased Fecal Excretion of Uranium: A Famly." National Library of Medicine, Jul. 2019, www.ncbi.nlm.nih.gov/pubmed/31202207

Ervin et al. "Gut microbiome-derived B-glucurondases are components of the estrobolome that reactivate estrogens." Journal of Biological Chemistry, Oct. 2019, DOI:10.1074/jbc.RA119.010950

Farvid et al. “Dietary Fiber Intake in Young Adults and Breast Cancer Risk.” Official Journal of the American Academy of Pediatrics, Feb. 2016, DOI:https://doi.org/10.1542/peds.2015-1226

Georgiou, Georgiou PhD. “Scientific research on natural heavy metal chelators: testing what works.” International Journal of Complementary & Alternative Medicine, vol. 11, issue 5, 18 Sept. 2018, medcraveonline.com/IJCAM/IJCAM-11-00409.pdf

Gorbach and Goldin. “Diet and the Excretion and Enterohepatic Cycling of Estrogens.” National Library of Medicine, Jul. 1987, DOI:10.1016/0091-7435(87)90067-3

Grossman, Elizabeth. “Do Low Doses of BPA Harm People?” Scientific American, 20 Feb. 2013, www.scientificamerican.com/article/do-low-doses-of-bpa-harm/

Holscher, Hannah. “Dietary fiber and prebiotics and the gastrointestinal microbiota.” US National Library of Medicine National Institutes of Health, 6 Feb. 2017, DOI: 10.1080/19490976.2017.1290756

Hurd, Karen. “Clearing of Metabolic Waste Via Enterohepatic Recirculation.” University of Wisconsin-Eau Claire, Fall 2010, artofdetox.com/wp-content/uploads/2018/09/EnterohepatieReCirculation.pdf

Hurd, Karen, narrator. “Healing Through Food with Nutritionist Karen Hurd.” Expanded Podcast with Lacy Phillips, episode 75, tobemagnetic.com/expanded-podcast/2019/75

James, Mary ND. “Symptoms of Hormonal Imbalance.” 2020, www.womenshealthnetwork.com/hormonalimbalance/major-symptoms-of-hormonal-imbalance.aspx

Johnson, Tracy MD. “What are Hormone-Sensitive Cancers?” WebMD, 12 Oct. 2019, www.webmd.com/breast-cancer/hormone-sensitive-cancers

Kucharska et al. “Significance of diet in treated and untreated acne vulgaris.” US National Library of Medicine National Institutes of Health, 16 May 2016, DOI:10.5114/ada.2016.59146

Lamprecht et al. “Effects of zeolite supplementation on parameters of intestinal barrier integrity, redoxbiology and performance in aerobically trained subjects.” US National Library of Medicine National Institutes of Health, 20 Oct. 2015, DOI: 10.1186/s12970-015-0101-z

Lang et al. “ Association of Urinary Bisphenol A Concentration With Medical Disorders and Laboratory Abnormalities in Adults.” National Library of Medicine, 17 Sept. 2008, DOI: 10.1001/jama.300.11.1303

Lattimer and Haub. “Effects of Dietary Fiber and Its Components on Metabolic Health.” US National Library of Medicine National Institutes of Health, 15 Dec. 2010, DOI:10.3390/nu2121266

Li et al. “Dietary fiber intake and risk of breast cancer by menopausal and estrogen receptor status.” US National Library of Medicine National Institutes of Health, 16 Feb. 2012, DOI:10.1007/s00394-012-0305-9

Lindenmeyer, Christina MD. “Gallbladder and Billiary Tract.” Merck Manual Consumer Version, Oct. 2019, www.merckmanuals.com/home/liver-and-gallbladder-disorders/biology-of-the-liver-and-gallbladder/gallbladder-and-biliary-tract

Magee, Elaine. “The Benefits of Flaxseed.” WebMD, 2009, www.webmd.com/diet/features/benefits-of-flaxseed#1

McClure, Mark DDS. “Dosing With Chlorella/Cilantro for Neurotoxin Elimination.” NIHA, www.nihadc.com/library/detox-for-life-class-2-addit-resources/54-4-dosing-with-chlorella/file.html?accept_license=1

McRorie, Johnson PhD. “Evidence-Based Approach to Fiber Supplements and Clinically Meaningful Health Benefits, Part 1.” US National Library of Medicine National Institutes of Health, 26 Mar. 2015, DOI:10.1097/NT.0000000000000082

Minich, Deanna. “6 Reasons Why You Need Food Diversity.” 18 Sept. 2018, www.deannaminich.com/food-diversity/

Nowak et al. “The Effects of Flaxseed Supplementation on Hormonal Levels Associated with Polycystic Ovarian Syndrome: A Case Study.” US National Library of Medicine National Institutes of Health, 28 Sept. 2009, www.ncbi.nlm.nih.gov/pmc/articles/PMC2752973/

Parida and Sharma. “The Microbiome-Estrogen Connection and Breast Cancer Risk.” National Library of Medicine, 15 Dec. 2019, DOI:10.3390/cells8121642

Park et al. “Dietary fiber intake and risk of breast cancer in postmenopausal women: the National Institutes of Health–AARP Diet and Health Study.” US National Library of Medicine National Institutes of Health, 22 Jul. 2009, DOI:10.3945/ajcn.2009.27758

Patel et al. “Estrogen: The Necessary Evil for Human Health, and Ways to Tame It.” National Library of Medicine, Jun. 2018, DOI: 10.1016/j.biopha.2018.03.078

Petschow et al. “Probiotics, prebiotics, and the host microbiome: the science of translation.” US National Library of Medicine National Institutes of Health, 22 Nov. 2013, DOI:10.1111/nyas.12303

Phipps et al. “Effect of Flax Seed Ingestion on the Menstrual Cycle.” National Library of Medicine, Nov. 1993, pubmed.ncbi.nlm.nih.gov/8077314/

Piccolo et al. “Adsorption of Glyphosate by Humic Substances.” American Chemical Society Publications, 15 Aug. 1996, doi.org/10.1021/jf950620x

Rinninella et al. “What is the Healthy Gut Microbiota Composition? A Changing Ecosystem across Age, Environment, Diet and Diseases.” US National Library of Medicine National Institutes of Health, 10 Jan. 2019, DOI: 10.3390/microorganisms7010014

Ruggeri, Christine. “Bile Salts: How They Work and Nine Reasons You Need Them.” 2 Sept. 2018, draxe.com/nutrition/bile-salts/

Schmidt et al. “Prebiotic intake reduces the waking cortisol response and alters emotional bias in healthy volunteers.” US National Library of Medicine National Institutes of Health, 3 Dec. 2014, DOI:10.1007/s00213-014-3810-0

Schoenfeld, Laura. “Is An Unhealthy Gut Causing Your Estrogen Dominance?” 20 Aug. 2018, lauraschoenfeldrd.com/unhealthy-gut-estrogen-dominance/

Seneff et al. “Aluminum and Glyphosate Can Synergistically Induce Pineal Pathology: Connection to Gut Dysbiosis and Neurological Disease.” Vol. 6, no. 1, Jan. 2015, DOI:10.4236/as.2015.61005

Trubo, Richard. “Endocrine-Disrupting Chemicals Probed as Potential Pathways to Illness.” JAMA Network, 20 July 2005, DOI:10.1001/jama.294.3.291

Watkins and Klaassen. “Gastrointestinal Toxicology.” Science Direct, 2010, www.sciencedirect.com/topics/medicine-and-dentistry/enterohepatic-circulation

Wszelaki, Magdalena. “How to Optimize Liver Function to Rebalance Hormones in Women.” Hormones & Balance, 27 Mar. 2019, hormonesbalance.com/articles/the-role-of-the-liver-in-female-hormone-balance/

Zerbe, Leah. “How Endocrine Disruptors Destroy Your Body and The Dirty Dozen to Avoid.” 10 Nov. 2019, draxe.com/health/endocrine-disruptors-how-to-avoid-excess-estrogen/