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**THE RELATIONSHIP BETWEEN
DIET AND INTESTINAL MICROFLORA:
A BIBLICAL PERSPECTIVE**

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I. Introduction

The most essential lessons for teachers and students to learn are those, which point not to the world, but from the world to the cross of Christ.

Higher education is an experimental knowledge of the plan of salvation, and this knowledge is secured by earnest and diligent study of the Scriptures. Such an education will renew the mind and transform the character, restoring the image of God in the soul. There is no education to be gained higher than given to the early disciples, and which is revealed to us through the word of God. To gain the higher education means to follow this word implicit; it means to walk in the footsteps of Christ, to practice His virtues (1). To walk in the footsteps of Christ, we have to know who He is. The Bible says, “The fear of the LORD is the beginning of wisdom, and knowledge of the Holy One is understanding”(Proverbs 9:10 NIV). And “To God belong wisdom and power, counsel and understanding are his”(Job 12:13, NIV).

Since God is the source of all true knowledge, the first object of education is to direct our minds to His revelation of Himself. To direct our minds to His revelation of Himself, we should communicate with God in everyday life (2). So “Integration of Faith and Learning” is a very important work have to be settled in the field of education.

This is my 4th year as a faculty member of Sahmyook College. In my class, the proportion of Adventist students is about 5–10%. Because most of my students are non-Adventist students, they find it difficult to accept some rules such as no smoking and not drinking in the campus, and no meat in the university cafeteria etc. In my opinion, unacceptable rules have no effect on them. Before forcible demand, we have to persuade them to become Christians who can accept God as their Great Creator. This is our Christian teacher’s role in the classroom. But it is not easy to explain and

prove Creation with our limited scientific knowledge. So in my classroom (Food Microbiology), I will show that God's original principles (especially original diet) for humanity are the best and this is because He is our Creator and we are His created beings.

II. Biblical perspectives to diet

Korean traditional medicine says, "What we eat decides what we are". These are very meaningful words. Human bodies consist of what we eat and drink. There is a chemical reaction that we call metabolism: anabolism (build up) and catabolism (break down). Throughout this metabolism, we can get energy to survive (3). To get energy, appropriate supply of nutrients must occur.

It is important to choose the nutrients that best supplies the elements needed for metabolism. In order to know what are the best foods, we must research God's original principle for man's diet. According to E. G. White, (4) who created man and who understands his needs appointed Adam his food. "Then God said, I give you every seed-bearing plant on the face of the whole earth and every tree that has fruit with seed in it. They will be yours for food" (Genesis 1:29). Upon leaving Eden to gain his livelihood by tilling the earth under the curse of sin, man received permission to eat also "you will eat the herb of the field" (Genesis 3: 18). Grains, fruits, nuts, and vegetables constitute the diet chosen for us by our Creator. These foods, prepared in, as simple and natural manner as possible, are the most healthful and nourishing. They impart strength, a power of endurance, and vigor of intellect that are not afforded by a more complex and stimulating diet. After the Flood, God permitted the eating of animal food but with restriction. The use of swine's flesh was prohibited as also of other animals and of birds and fish whose flesh was pronounced unclean. Even though meat was permitted, the use of fat and blood was strictly prohibited. Today, we know that many diseases are transmitted through contaminated blood. Creutzfeldt-Jacob Disease (CJD), which cause the wasting of brain tissues, was initially identified among the cannibals of Papua New Guinea, is now increasingly present in our society. This disease is transmitted by an infective proteinaceous particle or a prion. In sheep it causes scrapie, and in cattle, bovine spongiform like

encephalopathy or BSE.

A discussion of diet and health would not be complete without the story of Daniel and his three friends. The Bible tells of the young prince taken into captivity who determined that the rich fare of the king, which he and his friends were to share, would diminish their physical health and their mental activity. Daniel and his three friends requested a diet composed of a plant-based diet. They made a contract with their guardian to feed them vegetables or plant foods for ten days, and then be tested them against those who had eaten the king's fare. The results were their mental and physical superiority. "At the end of ten days they looked healthier and better nourished than any of the young men who ate the royal food. So the guardian took away their choice food and the wine they were to drink and gave them vegetables instead"(Daniel 1: 11-20 NIV). As a result of his intellect, integrity and an ability to interpret dreams, Daniel was advanced to the rank of advisor to the king and was held in very high regard by the royalty of Babylon. Even when he eventually retired, memory of his ability still lingered, and on the night of the Med Persian conquest of Babylon in 539 B.C, he was called to interpret yet another vision that announced the doom of Babylonian Empire (5).

III. Currents research on the relationship between diet and health

With the progress of civilization, man's dining table became occupied by more meat, processed foods and fast foods (Junk Food). These kinds of food are suitable to the modern life style (more suited to the taste buds, convenient, easy and time saving). In spite of economic development and convenience, those who live this present time are less healthy than their parents. In the past, most of the diseases were caused by nutritional deficiency and bacterial infection. But now a day, most diseases are caused by the imbalance of nutritional consumption, over eating and contaminated (unhealthy) animal-based food (CJD).

With the change of the types of disease, scientists demand a change of diet. They recommended us to reduce the consumption of animal food and to eat a more plant-based diet. According to the USDA (United States Department of Agriculture) Food Pyramid the bottom half of

the food pyramid consist of original diet: 11 servings of grains, 5 servings of vegetables, 4 servings of fruit, and 3 servings of nuts (6).

This result shows the importance of the original diet. Today many studies support the theory that whole grains (The Original Diet) are protective against cancer, especially gastrointestinal cancer such as gastric and colon cancer, and cardiovascular disease. Elements included in whole grains that may be protective and affect the gut environment, such as dietary fiber, resistant polysaccharides, oligosaccharides. Whole grains are also rich in compounds that function as antioxidants (phenolic compounds) and phytoestrogens (with potential hormonal activity). Isoflavons, diadzein, genistein, coumesterol and lignins are included in phytoestrogen. These compounds are found in cereal, seed oil, nuts, legumes, vegetables and fruits (The Original Diet) (7,8).

New research and discoveries are taking us back to the Genesis diet of fruits, nuts and grains. Why did God recommend us the original diet to us? Is He a doctor or dietetic specialist? No, He is the Great Creator and we are His created beings. It is clear that the Creator knew what best promoted health and longevity. In this essay I'd like to deal with the intestinal bacteria. The diet we eat directly affects the distribution of intestinal microorganisms and their enzyme activities (that is involved in gastrointestinal cancer).

IV. Intestinal microorganisms, their role and diet

In the time fetus, man can only live aseptically. At that time the mother's immune system can defend the fetus against infectious agents. But after birth, bacteria start to adhere to the skin, bronchi and membrane of the digestive tract and then proliferate. Two to three days after birth, bacteria can be detected in feces in amount of 10^{11} /g of feces. Instantly after birth, intestinal microbial flora are formed and maintained (9) and we called it normal flora. The functions of normal flora are listed in Table I (10).

Intestinal microflora can roughly be classified into two groups beneficial and harmful in aspect of their function. The balance between these two groups is critical for health. Lactic bacteria group (beneficial

bacteria) metabolite plenty of carbohydrates and produce some organic acid (lactic acid, acetic acid)(11). They play a role as defense mechanisms in the digestive tract and vagina. *Streptococcus thermophilus*, *Lactobacillus sp.*, *Leuconostoc mesenteroides*, *Bifidobacterium sp.* are the lacticbacteria group. The physiological roles of these bacteria are the maintenance of normal intestinal flora, lowering the intestinal pH by the production of some organic acid, inhibiting the growth of harmful bacteria, anticancer activity, reduction of blood cholesterol level and synthesis of some vitamins (Table II)(12). In contrast to beneficial bacteria, harmful bacteria cause undergrowth, infection, diarrhea, immune suppression and cancer *etc.* This harmful bacterium includes *Bacteriodes sp.*, *Eubacterium sp.*, *Cl. perfringenes* and *Veionella sp.* Like the Great Controversy in the Christian life, these two groups of bacteria struggle for hegemony. The superiority mainly depends on what kinds of food are consumed by the host (man).

Table I. The Functions of Normal Micro Flora

Morphokinetic action
Regulation of gas composition of host cavities
Participation in metabolism of proteins, carbohydrates and lipids
Production of biologically active compounds (vitamins, hormones, toxins, antibiotics etc)
Participation in water-salt metabolism
Provision of colonization resistance
Immunogenic function
Participation in recirculation of bile acids, steroids and other macromolecules
Mutagenic/ antimutagenic function
Detoxication of exogenic and endogenic substrates and metabolites
Storage of microbial plasmid and chromosomal genes
Source of infection
Source of energy for host's cells

The diet, stress and hormones change the distribution of intestinal microflora. So the intestinal flora of an aged man is different from that of a child. For example, typical beneficial intestinal bacteria *Bifidobacterium sp.* maintains a superior position in childhood. But *Escheria coli*, *Enterococcus*

sp., *Lactobacillus sp.*, *Clostridium sp.* increases with age. The change of microflora results in the change of gut environment (the rise of intestinal pH, constipation and production of ammonia etc.).

Table II. The Effects of Beneficial Intestinal Microflora

Strains	Health effects in humans
<i>Lactobacillus acidophilus</i>	Lowering the fecal enzyme activities; decreasing fecal mutagenicity; prevention of radiotherapy-related diarrhea; improvement of constipation; high lactase activity; production of bacteriocins
<i>Lactobacillus casei</i>	Prevention of intestinal disturbances, balancing intestinal bacteria, lowering fecal enzyme activities, beneficial effects on superficial bladder cancer
<i>Lactobacillus johnsonii</i>	Adherence to human intestinal cells, balances intestinal microflora, immune enhancement, adjuvant in <i>Helicobacter pylori</i> treatment
<i>Lactobacillus rhamnosus</i>	Prevention of antibiotic associated diarrhea, treatment of relapsing <i>Clostridium difficile</i> diarrhea, stabilization of Crohn's disease
<i>Lactobacillus reuteri</i>	Colonizing the intestinal tract
<i>Bifidobacterium bifidum</i>	Treatment of viral diarrhea including rotavirus diarrhea
<i>Bifidobacterium animalis</i>	Treatment of viral diarrhea including rotavirus diarrhea
<i>Streptococcus thermophilus</i>	Alleviation of lactose intolerance
<i>Lactobacillus bulgaricus</i>	

The most important factor that affects the distributions of intestinal microflora is diet. Breast milk contains quite large amounts of bifidogenic factors (growth stimulants for *Bifidobacteria*). *Bifidobacteria* can maintain a superior position in a breast fed child. Also acetic acid, lactic acid produced by *Bifidobacteria* can inhibit the growth of harmful bacteria (*Cl. perfringenes*, *Bacteroides sp.*, *E. coli* etc.). The numbers of these kinds of harmful bacteria are increased with the intake of animal proteins (9,12). Then, how can we prevent or slow down the change of intestinal microflora in accordance with aging, diet and stress?. We can find out this answer in

a long-lived family. The intestinal microflora of long-lived family resemble that of a child. Their dietary patterns are unique. They live on fiber-plentiful whole grains, potatoes, vegetables and fruits. They eat less proteins and fats than normal family. This type of diet pattern might be the cause of their health and longevity (14,15).

According the results of many studies, diet patterns and the incidences of cancer are very closely related each other. In the East-Asia area, the common type of cancer is stomach cancer but in the U.S.-Euro area it is colon-rectal cancer. Today the incidence of colon cancer is increasing in an Asia region with the increased consumption of meat. So diet, intestinal bacteria and cancer (especially gastrointestinal cancer) are very closely related to each other (16). Armstrong and Doll (17) found that increased meat consumption increased the risk of cancers of the breast, the colon, rectum and kidney. Animal diet itself does increase the cancer risk when compared to a plant-based diet. It also interacts with harmful bacteria, and induces their enzyme activities (β -glucuronidase, azoreductase which is closely related to colon-rectal cancer). And the metabolites of these enzymes (nitrosoamines, indole, phenol, etc.) were identified as a carcinogen. But a plant-based-diet can promote the growth of beneficial bacteria and inhibit the growth of harmful bacteria. And nutrients found in many plant products itself appear to prevent cancer. One of the best Bifidogenic factor (stimulants for the growth of Bifidobacterium) is dietary fiber and which found in "The original diet" (Table III).

Table III. Some dietary fiber (Bifidogenic factor)

Dietary fiber	Sources	A Biblical expression
Cellulose	Chinese cabbage, Whole grains, Beans, Wheat flour	"Then God said, I give you every seed-bearing plant on
Hemicellulose	Whole grains, Beans, Wheat	the face of the whole earth
Pectin	Fruits, Chinese cabbage	and every tree that has fruit
Lignin	Cocoa, Wheat, Beans	with seed in it. They will be
Glucomannan	Brown seaweeds	yours for food" Genesis
Cereal Gum	Barley, Oat	1:29.NIV
Seaweed polysaccharides	Brown seaweeds, Agar	

V. Application for the classroom

1. Divide students in to several groups on the first day of class
2. Journal search
3. Feed mice with different kinds of diet (control group/ animal-based diet group/ plant-based diet group)
4. Collect the feces of mice (once a week) and store at -70°C
5. At the end of feeding
 - *Check some kinds of enzyme activities which is related to colon-rectal cancer (β -glucuronidase, tryptophanase, urease, azoreductase) with the frozen feces
 - *Check the distribution of microorganisms (*Bifidobacterium sp*, *Lactobacillus sp*, *Enterobacteria sp*, *Clostridium sp*, *Bacteriodes sp*) with the frozen feces.
6. After the experiments
 - * Each group present their results
 - *Discuss the results.
7. I will show some results that I have performed with my students in the class of Food Microbiology.

A. Comparison of bacterial population in the feces of mouse fed with plant-based diet and animal-based diet.

Discussion: Plant-based diet groups were found to contain about ten times higher numbers of *Lactobacillus* and *Bifidobacterium* than animal-based dietary groups. Animal-based diet groups were found to contain about 5 to 10 times higher numbers of anaerobic *Clostridia* and *Bacteriodes* than plant-based diet groups.

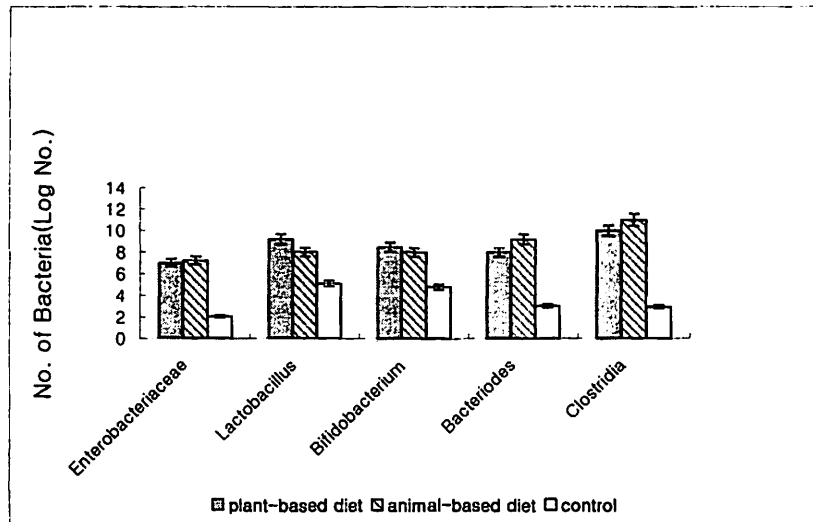


Fig. 1 Composition of bacterial population in the feces of mouse fed with plant-based diet and animal-based diet.

B. Comparison of enzyme activities in the feces of mouse fed with different diet.

Discussion: Fecal microbial enzyme activities (beta-glucosidase, beta-glucuronidase, tryptophanase and urease) in animal-based diet groups were shown to be 30–50% higher than those in the plant-based diet groups.

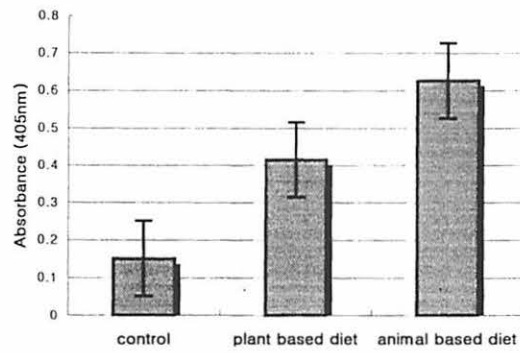


Fig. 2 Beta-glucosidase activities in the feces of mouse fed with different diets

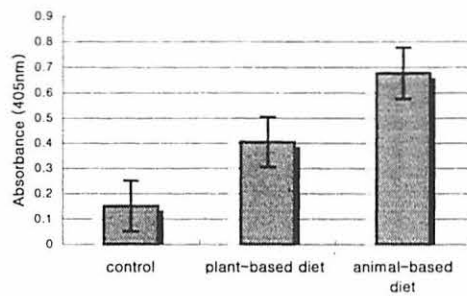


Fig. 3 Beta-glucuronidase activities in the feces of mouse fed with different diets

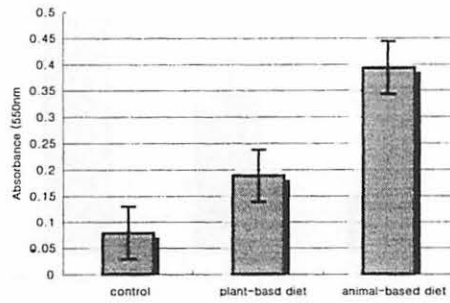


Fig.4 Tryptophanase activities in the feces of mouse fed with different c

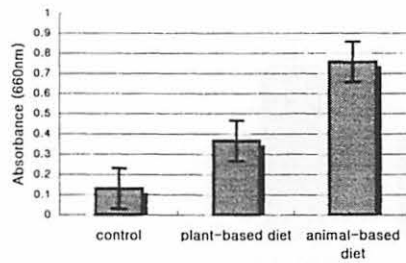


Fig.4 urease activities in the feces of mouse fed with different diets.

Throughout this experiment, my students may realize the importance of original diet empirically. They may know that the biblical original diet is the best food for man and God is our Creator.

VI. Conclusion and Implication for the Christian life–style.

In Proverbs 11: 30 “ The fruit of the righteous is the tree of life, and he who wins souls is wise”

Sacred history presents many illustrations of the results of true education. It presents many noble examples of men whose characters were formed under divine direction, men whose lives were a blessing to their fellow men and who stood in the world as a representatives of God.

Among those men, Joseph and Daniel were separated from their homes and carried as captives to heathen lands. But as a result of true education, they had rejected the temptation and they became witness for God. This is the practical example of divine education. In his childhood, Joseph had been taught the love and fear of God. A shepherd boy, tending his father’s flocks, Joseph’s pure and simple life had favored the development of physical mental power. By the communion with God through natural and the study of great truths handed down as a sacred trust from father to son. He had gained strength of mind and firmness of principle.

In the case of Daniel and his three friends, they had been faithfully instructed in the principles of the word of God. They had learned to sacrifice the earthly to the spiritual, to seek the highest good. And they reaped the reward. Their habits of temperance and their sense of responsibility as representatives of God called to noblest development the power of body, mind, and soul. At the end of their training, in their examination with other candidates for the honors of the kingdom, there was “found none like Danie, Hananiah, Mishael and Azariah.” Daniel 1:19. In physical strength and beauty, in mental vigor and literary attainment, they stood unrivaled. “ In all matters of wisdom and understanding, that the king inquired of them, he found them ten times better than all the

magicians and astrologers that were in all his realm” Daniel 1:20. This noble example of Joseph and Daniel is the result of biblical education (18).

Today, we can enjoy the marvelous benefits of modern conveniences. But many people suffer from disease, which is usually incurable and fatal. Modern developed medicine and medical techniques cannot treat the disease. Why those kinds of phenomenon happen these days? This is because of the ignorance of God’s original principle. God’s original principle is an explanatory note or operating manual for men. We are all created beings made by God’s hands. So we must obey His original principle. When we can keep this principle like Joseph or Daniel and his three friends, we can maintain our best condition (physical, mental and spiritual), we can be His witnesses, we can be His workers and we can prepare for heaven.

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