



RESEARCH ARTICLE

AN INTRICATE MECHANISM OF INTERACTION BETWEEN HUMAN GUT-MICROBIOTA, HISTO-BLOOD GROUP ANTIGENS AND DIETARY PATTERN, DETERMINING COMPLEX HEALTH STATUS OF AN INDIVIDUAL: A REVIEW

¹Niraj Kumar, ¹Agrawal, B. P., ^{1,2}Chauhan, D. K., ^{1,2}Singh, K. P., ^{1,2}Abhay P. Pandey, ¹ Rizvi, A. F., and ^{1,3}Divya Bartaria

¹Institute of Applied Sciences, 644/508 Tripathi Crossing, Mumfordganj, Prayagraj-211002, India; ²Science Faculty, Central University of Allahabad, Prayagraj – 211002, India; ³UNITED Group of Institutions, Naini Industrial Area, Prayagraj, U. P., India

ARTICLE INFO

Article History:

Received 15th December, 2025
Received in revised form
25th January, 2026
Accepted 18th February, 2026
Published online 29th March, 2026

Keywords:

Gut-Microbiome, Histo-Blood Group,
Diet, Yoga, Autoimmune Diseases.

*Corresponding author:

Niraj Kumar, B. P.,

Copyright©2026, Niraj Kumar et al. 2026. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Niraj Kumar, B. P., Agrawal, D. K., Chauhan, K. P., Singh, Abhay P. Pandey, Rizvi, A. F., and Divya Bartaria. 2026. "An intricate mechanism of interaction between Human Gut-Microbiota, Histo-Blood Group Antigens and Dietary pattern, determining complex health status of an individual: A review". *International Journal of Current Research*, 18, (03), 36499-36504.

INTRODUCTION

Increasing rates of autoimmune, inflammatory and cardiovascular diseases, as well as rapid upsurge in obesity and diabetes in last few decades are believed to be explained, in part, by the dogma of 'Biogeogens' (1), and/or unintended effects on the human-microbiota from vaccinations, poor diets, environmental chemicals, indiscriminate antibiotic use, etc. Researchers have claimed on the basis of extensive research into the genome and the microbiome that the human body and the microbiota have a long-established symbiotic relationship; homeostatic balance between them regulates body functions (2). Discovery and exploration of the brain-gut-microbiota axis have provided new insights into functional diseases of the gut, autoimmune and stress-related disorders, and the role of probiotics in treating certain affective disorders (3,4). Further, researches into dietary pattern and its effects on the human gut microbiota, classified these into three proposed enterotypes (5); it also revealed the surprising role of blood group antigens in shaping those populations. Blood group antigens have previously been associated with disease risks; their subsequent association with the microbiota reveals the mechanisms that lead to development of nutritional

interventions and improved treatment modalities in many disorders (6). A pilot study conducted by the Institute of Applied Sciences, Allahabad (IASc), also found a correlation between the blood group and nutritional adaptability in its preliminary findings (7); although an elaborate study is required for which a Google Questionnaire has already been floated (<https://docs.google.com/forms/d/e/1FAIpQLSe9KqS4TENgxU08JDA8t3xYdAtSDweI7knx9rvgnULJVjY4EA/viewform?pli=1>) in collaboration with the UNITED Group of Institutions, Naini, Prayagraj. Further, role of Yoga in managing different disorders/diseases has also been proved by many, including the scientists of the IASc (8). Therefore, it is high time to correlate and collate all these researches in the light of other research findings to extrapolate and establish the interaction mechanism between Human Gut-Microbiota, Histo-Blood Group Antigens and Nutrition & Dietary pattern, with further futuristic approach of Yoga-intervention, for determining and ensuring holistic health of an individual.

NUTRITION AND DIETARY PATTERN

Some Bizarre Facts: In the 2023 Global Hunger Index, India ranks 111th out of the 125 countries with sufficient data to calculate 2023 GHI scores. With a score of 28.7 in the 2023

Global Hunger Index, India has a level of hunger that is serious (9). Further, India topped the list of countries with the highest child-wasting rate in the world, at 18.7 per cent, reflecting acute undernutrition (10). Therefore, 'believe it or not', the nutritional status of Indian populace is very poor (not at all normal). On the other hand, ironically one in nine school children suffering from over nutrition is a concern as India suffers a dual burden of undernutrition and excess/over nutrition (11), representing the inequitable distribution of health/wealth. Obesity continues to be a significant public health concern in India. As half of overweight adults were also overweight during their childhood, estimates of the burden of overweight or obesity among Indian school children would help to forecast the obesity epidemic among adults. This has put India off-track regarding the progress needed to achieve the Sustainable Development Goal of "Zero Hunger" (Goal 2) by 2030. Several recent changes in food environment and food culture have detrimental health effects. The National Nutrition Monitoring Bureau (NNMB) surveys highlighted that overweight/obesity was specifically increased in men and women consuming energy above 1587 cal/day, protein above 41 to 57 g/day and fat above 19 to 32 g/day (12). Per-capita per day consumption of milk/milk products, fats and oils (including meat and meat products), sugars and jaggery (including condiments, biscuits etc.) and salts/sodium (savory snacks) showed a significant dose-response relationship with overweight/obesity prevalence. This review highlights that several determinants of obesogenic environment in India have linkages with non-health sectors. It is essential to devise mechanisms to grade obesogenic environment that correlates with the prevalence of overweight/obesity in corresponding locations.

The impact of cultural behaviour, environmental factors in correlation with human nutrition and health was earlier discussed in detail by the researchers of the Institute of Applied Sciences, Allahabad (IASc), while explaining the 'Dogma of Biogeogens' (13). We know that Nutrition is a major process taking place in a human body giving rise to several free radicals, anti-oxidants, etc., all these could be considered as biogens (the proceeds of the processes taking place in a biotic component), which interact with the geogens (radiations, pesticide and other chemicals etc., i.e. the proceeds of the processes taking place in an abiotic component), determining finally the status of human health. Extensive research in this direction led to establishing a close link between the intake calorific value of the food and actual energy requirement needed to sustain the activity level (14); in further studies, while discussing the energy value of food a focus was also given to analyse different types of the food (Table 1), preferred by different individuals/populations, and their blood group type (7). This was an attempt to check the theory of 'Blood group type diet' propounded by D'Adamo. The blood type diet (BTD), also known as the blood group diet, was popularized in 1996 by Dr. Peter D'Adamo in his book "Eat Right 4 Your Type" (15). D'Adamo claims that the antigens found in our blood that decide whether we are type O, A, B, or AB, are also present in other parts of our body, including our digestive tract. That's what causes the foods we eat to react chemically with our blood type, he says. There are many views supporting/rejecting his theory; the details have been studied, and discussed in later part of this article. Before that, if we look into the intricacies of nutritional requirements of an individual, several other factors are worth considering in the light of rapid evolving research domains.

ROLE OF HUMAN GUT MICROBIOTA

The structural, functional and diversity details of the microbiome in healthy adults were thoroughly investigated under the Human Microbiome Project (HMP) in 2011 (16). Substantial taxonomic variations in the composition of the microbial community at different anatomical locations in the same person (intra-individual) were reported; also substantial variations at the same anatomical site of different persons (inter-individual) were also recorded (17). Out of the eight anatomical sites chosen (e.g. hair, skin, nostrils, oral cavity, esophagus, stomach, colon and vagina), the intestinal microbiome is the most complex. Researchers, using 16S ribosomal RNA and DNA, could detect, identify, and classify most of the microbes found in the healthy human gut (18).

The presence of beneficial bacteria in the gut is very important to prevent excessive colonization by pathogenic organisms, which occurs through competition for mucosal attachment sites, depletion of essential nutrients and/or oxygen, and by secretion of peroxides, antimicrobials, or bacteriocidins to inhibit other bacteria (19-21). This protective effect is known as 'colonization resistance' (19). The Diet-Microbial Axis extensively studied and analysed reveals that the synergistic interaction between the microbiota, the epithelial barrier, and the immune system is complicated by the fact that all three respond to and are affected by dietary influences (22). Metabolites from epithelial cells directly regulate the functions of antigen-presenting cells (APCs) and lymphocytes; metabolites in the diet indirectly influence the function of the mucosal barrier (23) and the intestinal microbiota produce most of the metabolites found in blood plasma (24). Metabolic activities of the microbiota are monitored by the immune system, which is in turn modified by microbial signaling and mucosal absorption of metabolites and other dietary compounds (22). Further, it appears from the preliminary studies that each human being has a virtually unique microbiome (25), but despite individual variances in its taxonomy and microbial composition, the metabolic capabilities and functions carried out by the microbiota are fairly constant and remarkably stable (26). The intestinal microbiota has coevolved with its human host, and although within the lumen, it actually exists outside of the human body and functions independently from it but in close cooperation with it (16). However, the intestinal microbiota could be considered an organ within an organ (27), because it mediates various metabolic effects, directly influences epithelial cell proliferation, induces IgA production, stimulates lymphoid tissue development and strongly influences the host's metabolic response to environmental factors, drugs, and disease (28). Therefore, it is fairly well understood that the microbiota plays important role in metabolism of the host and have evolved with the host itself; although alterations are found due to effect of the 'Biogeogens'. The coexistence is how related with the blood group is now the matter of investigation.

HISTO-BLOOD GROUP ANTIGENS

Now for better understanding of microbiome and its interaction with the human, it is necessary to consider the blood type antigens we were born with; and its influence on the microbiota. Histo-blood group antigens (HBGAs) are specific surface-associated structures, classified into more than 30 blood group systems (29).

Table 1.

Nutritional Assessment Questionnaire

Date: _____

1. Name of the student:
2. Name of school/ College:
3. Gender:
4. Date of Birth:
5. Height:
6. Weight:
7. Blood group:
8. Dietary information:

Place a check in the column that describes how often you usually eat each food –

| Food items | Daily | Serving size & times | 3 or more times per week | 1 or 2 times per week | 2-3 times per month | Less than 2 times per month | Never or less than 1 time per month |
|----------------------------|-------|----------------------|--------------------------|-----------------------|---------------------|-----------------------------|-------------------------------------|
| Milk | | | | | | | |
| Tea | | | | | | | |
| Green tea | | | | | | | |
| Black tea | | | | | | | |
| Coffee | | | | | | | |
| Cold drink | | | | | | | |
| Fruit juice | | | | | | | |
| Whole egg | | | | | | | |
| Yogurt | | | | | | | |
| Cheese | | | | | | | |
| Cream | | | | | | | |
| Ice cream | | | | | | | |
| Butter | | | | | | | |
| Chickpea | | | | | | | |
| Black gram | | | | | | | |
| Green gram | | | | | | | |
| Arhar dal | | | | | | | |
| Kidney beans(Rajma) | | | | | | | |
| Out meal | | | | | | | |
| Lentils | | | | | | | |
| Sprouts | | | | | | | |
| Corn | | | | | | | |
| Whole wheat bread(Chapati) | | | | | | | |
| White bread | | | | | | | |
| Pasta | | | | | | | |

9. My Appetite:

(A) Classify your appetite

- (a) Excellent (b) Good (c) Fair (d) Poor

(B) Have you noticed any change in your appetite for certain foods? Yes..... No.....

If yes, Please explain –

(C) Food allergies:

Foods that disagree with you-

| | | |
|-------------|--------------|-------------|
| Raw veges | Cabbage | Nuts |
| Milk/ Dairy | Beans | Fried foods |
| Spicy foods | Fats | Eggs |
| Breads | Greasy foods | Meat |
| Raw fruits | Fish | Onions |

Other:

- Do you have any food allergies? Yes..... No.....

| To what | Symptoms |
|---------|----------|
| | |

- Foods you avoid for religious, personal or cultural reasons:
- Food your doctor told you to avoid:

(D) Do you take supplements (vitamins, minerals, herbs etc.)? Yes... No... If yes, list it:

| Supplement | Dosage | Frequency |
|------------|--------|-----------|
| | | |

18. Fill out a 3 day food chart (including types of food eaten, amounts and times):

Day 1:

| Meals | Food Items | Amount |
|-----------|------------|--------|
| Breakfast | | |
| Lunch | | |
| Brunch | | |
| Snacks | | |
| Dinner | | |
| Drinks | | |

Day 2:

| Meals | Food Items | Amount |
|-----------|------------|--------|
| Breakfast | | |
| Lunch | | |
| Brunch | | |

| | | | | | | | |
|------------------------|--|--|--|--|--|--|--|
| Noodles | | | | | | | |
| Rice | | | | | | | |
| Chips and fried snacks | | | | | | | |
| Peanuts | | | | | | | |
| Walnuts | | | | | | | |
| Cashews | | | | | | | |
| Pistachio | | | | | | | |
| Olive oil | | | | | | | |
| Coconut oil | | | | | | | |
| Mustard oil | | | | | | | |
| Leafy vegetables | | | | | | | |
| Other vegetables | | | | | | | |
| Banana | | | | | | | |
| Orange | | | | | | | |
| Apple | | | | | | | |
| Grape fruit | | | | | | | |
| Berries | | | | | | | |
| Grapes | | | | | | | |
| Papaya | | | | | | | |
| Pomegranate | | | | | | | |
| Melon | | | | | | | |
| Other fruits | | | | | | | |
| Ketchup | | | | | | | |
| Mayonnaise | | | | | | | |
| Chocolate and candies | | | | | | | |
| Pickles | | | | | | | |
| Burger | | | | | | | |
| Pizza | | | | | | | |
| Red meat | | | | | | | |
| Chicken | | | | | | | |
| Beef | | | | | | | |
| Pork product | | | | | | | |
| Fish | | | | | | | |
| Pastries & cakes | | | | | | | |
| Donuts | | | | | | | |
| Alcohol | | | | | | | |
| Sugar | | | | | | | |
| Honey | | | | | | | |
| Salad | | | | | | | |

(E) Digestion:

| I get heart burn | Before eating | After eating | When I lie down | Upon rising |
|---|---------------|----------------|---------------------------------|-------------|
| I get | Indigestion | Intestinal gas | Bloating | Belching |
| How soon after eating | Immediately | 1-2 hours | 3-5 hours | 6+ hours |
| These symptoms occur | Daily | Sometimes | Only after eating certain foods | |
| These symptoms are | Mild | Moderate | Severe | |
| Do you take antacid regularly | Yes | No | | |
| Do you regularly experience Nausea/ vomiting/ diarrhea/constipation | Yes | No | | |

10. Do you smoke? Yes..... No.....

11. I drink mostly water from: Tap..... Filtered..... Well..... Spring..... Bottled.....

12. How would you rate your life style?

- Not active..... Active.....
Moderate active..... Very active.....

13. List any major illness or problem you have, not mentioned in questionnaire:

14. List any medications you are presently taking:

15. Which food affects your activity index/ factor:

16. What do you do to shun those effects:

17. Which type of common diseases you normally/ generally developed (especially during your childhood):

| | | |
|--------|--|--|
| Snacks | | |
| Dinner | | |
| Drinks | | |

Day 3:

| Meals | Food Items | Amount |
|-----------|------------|--------|
| Breakfast | | |
| Lunch | | |
| Brunch | | |
| Snacks | | |
| Dinner | | |
| Drinks | | |

ABO and Rh “blood type” antigens found on red blood cells (RBCs) and platelets, are the most well-known HBGAs, which are found on the surface of most endothelial and epithelial cells, and in the body fluids and secretions (30-31). Because blood group antigens are found throughout the body, they are considered histocompatibility antigens. These surface-associated markers not only serve as antigens, they also are a food source for intestinal bacteria (32-33). A small but intriguing study in Finland found a statistically significant correlation between the composition of the intestinal mucosal microbiota and the ABO blood type of the host (34). The overall mucosal microbial profile as well as the relative proportion of major bacterial groups in the mucosal layer were significantly different in the presence of the B antigen (from B and AB blood types). Similarly, long term diet has been found associated with particular microbiota composition. In a human study that assessed the effect of long-term diet on microbiota composition (35), enterotype 1 (Prevotella) was strongly associated with a high-carbohydrate and low animal protein diet, such as that found in agrarian populations.

However, enterotype 3 (Bacteroides) was strongly associated with a diet high in animal fat and animal proteins, typical of the Western diet. While short-term dietary changes had a significant effect within 24 hours on microbiome composition of the subjects, the effect was not strong enough to change their enterotype classification. In another postulate (further reviewed by Megan Soliman, MD, 36) claimed by D’Adamo, the antigens found in our blood are also present in other parts of our body, including our digestive tract; and people with different blood types also have different gut bacteria, which D’Adamo traces back to our early ancestors. As blood group A is supposed to be the oldest evolved, when human was mainly depending on vegetarian diet, therefore, it seems that Vegan diet is better for them. Phylogenetic networks of human and non-human ABO alleles also show that the A gene was the first to evolve (37). In our findings (result of a pilot study, 7), some close association was found in tolerance of different diets and the blood group type; but there were many other factors which might have played role. It is therefore, a matter of further investigation keeping the variables constant with a target group. But on the basis of aforesaid theories/findings, it may be claimed that a correlation could be established between blood group, diet and microbiota; which was emphasized during an Invited talk by one of the researchers recently (38).

FUTURE PLANS

As ABO (H) blood group antigens result in negative selection and deletion of self-reactive T-cells, the adaptive immune system does not produce antibodies to pathogenic bacteria that exhibit blood group antigens; and the innate immune system contains various glycan-binding proteins, such as C-type lectins and galectins, which recognize a variety of cell-surface carbohydrate moieties and participate in innate immune responses to pathogens bearing blood group antigens (also claimed by D’Adamo). Further, microbial ability to rapidly adjust to dietary changes gave selective advantage to ancestral populations whose diet depended on success in foraging and hunting, and was further affected by season, climate, and temperature (39). A short-term dietary intervention in humans found that significant changes in the structure of the gut microbiota were observed within 24 hours of introducing an animal-based diet, which reverted to the baseline profile within 2 days of the end of the intervention. As the Institute has

already developed certain types of Nutraceuticals/functional foods, based on animal protein and phyto-protein contents under the projects of the DST/DBT, GoI, already tested and verified by the agencies, as well as reported and published by the Institute (40), therefore, these would be tried on different groups to assess the cumulative effect of MBD. Further, in our earlier study (8), it was successfully established that there exists a definite pattern/regime of the set practices of yoga. The patients were divided into different groups; and their blood type and dietary pattern were also taken into account. The different groups/persons responded differently to the type of Yoga regime, which included Dhyana, Pranayama and Asanas. Regular analysis of their Anthropometric, haematological and nutritional status were done; and now we are trying to find out a definite correlation between the type of different regime and their blood group with nutritional interventions. Hopefully, after thorough investigation, it would be possible to establish a correlation between the microbiota, blood group, diet and yoga pattern (MBDY).

CONCLUSION

A vast study has already been done in the aforesaid field (MBDY), now it needs to be tested and verified on targeted population so that the results could be analysed to exactly define the pattern of correlation between MBDY. On the basis of the Google Questionnaire (as mentioned in the Introduction) further studies are being done; and part of the results were presented as the Key-note Address in an International Conference held at the ‘Dr.HarisinghGourVishwavidyalaya (A Central University), Sagar, M. P., India on Feb. 4-6, 2026, by the first author (details available on the web: <https://iasc-alld.org/wp-content/uploads/2026/03/Silver-Jubilee-Year-First-Quarter-Report-IASc.pdf>).

ACKNOWLEDGEMENT

Authors are grateful to the Institute, United Group of Institutions and University of Allahabad, for providing the necessary help and infrastructural facilities for carrying out the necessary review work, as well as for getting this work reviewed by other experts.

CLINICAL TRIAL NUMBER: NOT APPLICABLE

As it is a Review Article, based on the earlier studies done by several authors/scientists, the references include their names and other details.

FUNDING DECLARATION: As it is a Review Article, therefore, no funding was required from any external sources.

CONFLICT OF INTEREST: The authors declare unanimously that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this review paper.

REFERENCES

1. Kumar Niraj, Biogeogens and Human Health; Springer, 2013; <https://link.springer.com/book/10.1007/978-81-322-1084-9>

2. Ewald DR, Sumner SCJ. Human microbiota, blood group antigens, and disease. *Wiley Interdiscip Rev Syst Biol Med*. 2018 May;10(3):e1413. doi: 10.1002/wsbm.1413.
3. Konturek PC, Brzozowski T, Konturek SJ. Stress and the gut: pathophysiology, clinical consequences, diagnostic approach and treatment options. *J Physiol Pharmacol*. 2011; 62:591–599. Available at: www.jpp.krakow.pl/journal/archive/12_11/pdf/591_12_1_1
4. Forsythe P, Kunze W, Bienenstock J. Moody microbes or fecal phrenology: what do we know about the microbiota-gut-brain axis? *BMC Medicine*. 2016; 14doi: 10.1186/s12916-016-0604-8
5. Arumugam M, Raes J, Pelletier E, Le Paslier D, Yamada T, Mende DR, Fernandes GR, Tap J, Bruls T, Batto JM, et al. Enterotypes of the human gut microbiome. *Nature*. 2011; 473:174–180. DOI: 10.1038/nature09944
6. Makivuokko H, Lahtinen SJ, Wacklin P, Tuovinen E, Tenkanen H, Nikkila J, Bjorklund M, Aranko K, Ouwehand AC, Matto J. Association between the ABO blood group and the human intestinal microbiota composition. *BMC Microbiol*. 2012; 12:94–105. DOI: 10.1186/1471-2180-12-94
7. KumarNiraj, Specific dietary pattern and its correlation with different types of blood group, in context of Geography of Health [Vindhya Research Journal: Vol. 3 (Dec. 2021): 72 (ISSN: 2395 3993)].
8. Agrawal B. P., Chauhan D. K., Agrawal Sangeeta, PandeyAbhay P., Singh K. P. Singh, Singh Virendra, RizviAnees F.and KumarNiraj, Rody study (reversal of diabetes by yoga study): a scientific study evolving a set pattern of yoga and life style modification in diabetic patients, *International Journal of Current Research*, Vol. 16, Issue, 03, pp. 27653-27661, March, 2024; DOI: <https://doi.org/10.24941/ijcr.46930.03.2024>
9. Global Hunger Index - <https://www.globalhungerindex.org/india.html>
10. Down to Earth - <https://www.downtoearth.org.in/health/global-hunger-index-2023-india-reports-highest-child-wasting-rate-slips-4-notches-on-ranking-92282>
11. Pratap Jena, Baliyeri P Jeena, Overnutrition among schoolchildren in India: a review and meta-analysis, March 2018, *The Lancet Global Health* 6(S2):S25; DOI: 10.1016/S2214-109X(18)30154-2
12. Prashant Mathur and Rakesh Pillai, Overnutrition: Current scenario & combat strategies, *Indian J Med Res*. 2019 Jun; 149(6): 695–705. doi: 10.4103/ijmr.IJMR_1703_18
13. Kumar Niraj, Dogma of Biogeogens (Book Chapter), 2013; https://link.springer.com/chapter/10.1007/978-81-322-1084-9_2
14. Kumar Niraj, Biogeogens: Affecting and Controlling the Human Health - Accepted research paper for oral presentation at the 14th World Conference on Bioethics, Medical Ethics and Health Law, was to be held on May 11-14, 2020 at Porto, Portugal (later on organised in virtual mode on 7-10 March 2022).
15. Dr. Peter D'Adamo, Eat Right for Your Type - 2016 (revised and updated 20th anniversary edition); <https://www.4yourtype.com/eat-right-for-your-type-book/>
16. Proctor LitaM. The Human Microbiome Project in 2011 and beyond. *Cell Host Microbe*. 2011; 10:287–291. DOI: 10.1016/j.chom.2011.10.001
17. Huttenhower C, Gevers D, Knight R, Abubucker S, Badger JH, Chinwalla AT, Creasy HH, Earl AM, FitzGerald MG, Fulton RS, et al. Structure, function and diversity of the healthy human microbiome. *Nature*. 2012; 486:207–214. DOI: 10.1038/nature11234
18. Methé BA, Nelson KE, Pop M, Creasy HH, Giglio MG, Huttenhower C, Gevers D, Petrosino JF, Abubucker S, Badger JH, et al. A framework for human microbiome research. *Nature*. 2012; 486:215–221. DOI: 10.1038/nature11209
19. Jarchum I, Pamer EG. Regulation of innate and adaptive immunity by the commensal microbiota. *Curr Opin Immunol*. 2011; 23:353–360. DOI: 10.1016/j.coi.2011.03.001
20. Ouwerkerk JP, de Vos WM, Belzer C. The Gut M. Glycobiome: Bacteria and mucus at the epithelial interface. *Best Pract Res Clin Gastroenterol*. 2013; 27:25–38. DOI: 10.1016/j.bpg.2013.03.001
21. Alonso, C., Vicario, M., Pigrau, M., Lobo, B., Santos, J. Intestinal barrier function and the brain-gut axis. In: Lyte, M., Cryan, JF., editors. *Microbial Endocrinology: The Microbiota-Gut-Brain Axis in Health and Disease*. New York: Springer; 2014. p. 73-113.
22. Kau AL, Ahern PP, Griffin NW, Goodman AL, Gordon JI. Human nutrition, the gut microbiome and the immune system. *Nature*. 2011; 474:327–336. DOI: 10.1038/nature10213
23. Guzman JR, Conlin VS, Jobin C. Diet, microbiome, and the intestinal epithelium: an essential triumvirate? *Biomed Res Int*. 2013; 2013:1–12. DOI: 10.1155/2013/425146
24. Yatsunencko T, Rey FE, Manary MJ, Trehan I, Dominguez-Bello MG, Contreras M, Magris M, Hidalgo G, Baldassano RN, Anokhin AP, et al. Human gut microbiome viewed across age and geography. *Nature*. 2012; 486:222–227. DOI: 10.1038/nature11053
25. Blaser MJ, Falkow S. What are the consequences of the disappearing human microbiota? *Nat Rev Micro*. 2009; 7:887–894. DOI: 10.1038/nrmicro2245
26. Cho I, Blaser MJ. The human microbiome: at the interface of health and disease. *Nat Rev Genet*. 2012; 13:260–270. DOI: 10.1038/nrg3182
27. Biedermann L, Rogler G. The intestinal microbiota: its role in health and disease. *Eur J Pediatr*. 2015; 174:151–167. DOI: 10.1007/s00431-014-2476-2
28. Kinross JM, Darzi AW, Nicholson JK. Gut microbiome-host interactions in health and disease. *Genome Med*. 2011; 3:14.doi: 10.1186/gm228
29. Daniels, G. Human blood groups. 3rd. Somerset, NJ: John Wiley and Sons; 2013.
30. Lloyd KO. Blood Group Antigens as Markers for Normal Differentiation and Malignant Change in Human Tissues. *Am J Clin Pathol*. 1987; 87:129–139. DOI: 10.1093/ajcp/87.1.129
31. Ravn V, Dabelsteen E. Tissue Distribution of Histo-Blood Group Antigens. *APMIS*. 2000; 108:1–28. DOI: 10.1034/j.1600-0463.2000.d01-1.x
32. Stowell SR, Arthur CM, Dias-baruffi M, Rodrigues LC, GouridineJp, Heimburg-molinario J, Ju T, Molinaro RJ, Rivera-marrero C, Xia B, et al. Innate Immune Lectins Kill Bacteria Expressing Blood Group Antigen. *Nat Med*. 2010; 16:295–301. DOI: 10.1038/nm.2103
33. Weng M, Walker WA. The role of gut microbiota in programming the immune phenotype. *J Dev OrigHlth*

- Dis. 2013; 4:203–214. DOI: 10.1017/S2040174412000712
34. Makivuokko H, Lahtinen SJ, Wacklin P, Tuovinen E, Tenkanen H, Nikkila J, Bjorklund M, Aranko K, Ouwehand AC, Matto J. Association between the ABO blood group and the human intestinal microbiota composition. *BMC Microbiol.* 2012; 12:94–105. DOI: 10.1186/1471-2180-12-94
35. Wu GD, Chen J, Hoffmann C, Bittinger K, Ying-Yu C, Keilbaugh SA, Bewtra M, Knights D, Walters WA, Knight R, et al. Linking long-term dietary patterns with gut microbial enterotypes. *Science.* 2011; 334:105–108. DOI: 10.1126/science.1208344
36. Joe Leech, MS (reviewed by Megan Soliman, MD), The Blood Type Diet: An Evidence-Based Review; <https://www.healthline.com/nutrition/the-blood-type-diet-review>
37. Saitou N, Yamamoto F. Evolution of primate ABO blood group genes and their homologous genes. *MolBiolEvol* 1997; 4(4):399-411.
38. Kumar Niraj, Biogeogens – A Dogma for better health management, Award Lecture (Oration) presented in the Annual Conference of Environment & Child Health Group of Indian Academy of Pediatrics, held at United Medicity, Allahabad on 22nd Jan. 2023
39. David LA, Maurice CF, Carmody RN, Gootenberg DB, Button JE, Wolfe BE, Ling AV, Devlin AS, Varma Y, Fischbach MA, et al. Diet rapidly and reproducibly alters the human gut microbiome. *Nature.* 2014; 505:559–563. DOI: 10.1038/nature12820
40. PavitraTandon, Rizvi, A. F., Prasanna K. Ghosh, Singh, K. P., Chauhan, D. K., Agrawal, B. P. and Niraj Kumar, An integrative and novel approach to combat SARS-COV-2: application of far infrared radiation, alternative system of medicines and nutraceuticals; DOI: <https://doi.org/10.24941/ijcr.38491.04.2020>
