

Probiotics and Disease: A Comprehensive Summary—Part 4, Infectious Diseases

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Abstract

This article series provides a literature review of the disease-specific probiotic strains studied in published clinical trials in humans and animals. The goal of the series is to provide clinically useful tools. The table design allows for quick access to supportive data and will be helpful as a guide for both researchers and clinicians. The first article (part 1) focused on mental health and neurological conditions and the second article (part 2) explored cultured and fermented foods that are commonly available in the United States. The third article (part 3) explored the relationship between

bacterial strains and 2 of the most prevalent diseases we have in modern society, cardiometabolic disease and fatigue syndromes. This fourth article (part 4) elucidates the role of the microbiome in infectious diseases. Future articles will review conditions related to infections of the upper respiratory system and ear, nose, and throat; autoimmunity and dermatological conditions; cancer; and gastrointestinal and genitourinary, followed by an article focused on probiotic supplements. This literature review is specific to disease condition, probiotic classification, and individual strain.

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The purpose of this review is to investigate disease-specific probiotic strains associated with infectious diseases such as influenza, hepatitis, and human immunodeficiency virus (HIV). This is not an exhaustive review. Considerable research exists on the gut microbiome and role of probiotics; however, this research has not been clearly connected with clinical practice. The authors undertook a review of current literature to explore which specific probiotics and probiotic strains have been used in clinical and laboratory studies. To make this clinically valuable, product names of probiotics and fermented foods have been included. Finished products

may vary between manufacturers; therefore, the researchers included brand listings to provide transparency and to facilitate a functional probiotics guide for clinicians. Exclusions of products meeting our criteria do not imply that these products are not effective—we simply were not aware of them.

Methodology

This literature review originated from a group project that was part of the requirements for a course in the doctoral program in functional and clinical nutrition at Maryland University of Integrative Health (Laurel, MD, USA). The student researchers had approximately 2 months to review the literature and synthesize the paper. The authors agreed on format, templates, and execution. Each author researched and wrote sections reviewing probiotics in relation to various health conditions with literature searches conducted in PubMed, Biomed Central, EBSCO Research Premier, PloS One, Cochrane reviews, and topic-specific open-source journals.

The review of specific probiotic products in the professional marketplace and specific probiotics products was performed using Internet searches, primarily Shop Google, in addition to topic-specific databases to search for specific probiotic species including the strains listed in the research. Novel strains were cross-referenced to

determine whether the strain was available only for research purposes. If a probiotic combination was used in the research, formulas that closely matched the combination were included. Formulas that contain all or most of the specific probiotics and strains were also included. The food survey focused on bacterial strains in food and includes foods that are commercially produced and commonly available in the refrigerated sections of grocery stores in the United States. Information was gleaned from commercial Web sites and by visiting grocery stores (primarily in California).

Infectious Disease

Infectious diseases infiltrate down to the genomic level. These infections alter the microbiome even in countries that have abundant resources for antiviral medication and adjuvants. This review of infectious disease-associated probiotic strains elucidates the influence of probiotics on the infected individual.

HIV type 1 (HIV-1) infection and the resultant condition of acquired immunodeficiency syndrome (AIDS) affects millions of people, particularly women and children in poor countries such as Africa. The vertical transmission rates from mother to child have increased the epidemic, while finding novel ways to alter the microbiome of both the gastrointestinal system and vagina have proven to reduce these rates.¹ Furthermore, supplementation with probiotic strains has demonstrated that alteration of the microbiome can increase CD4⁺ cells, increase hemoglobin levels, and decrease drug-induced diarrhea.²⁻⁵ Infants and children who are infected, and labeled as failure to thrive, regain weight and normalize their body mass index (BMI) when supplemented with either a probiotic-fortified yogurt or infant formula.^{5,6} Conventional yogurt fermented with additional probiotic supplementation has given promise to alternate therapies for women who do not have access to antiretrovirals.³

Influenza is one of the deadliest respiratory diseases on the planet.⁷ All efforts should be attempted to increase host

immunity and to prophylactically prevent the transmission of influenza. Predetermining the next influenza strain is a moderate process and is flawed with inaccuracies.⁷ Thus, novel therapies are paramount for those who (1) chose not to be vaccinated, (2) cannot afford to be vaccinated, and (3) are already immunocompromised. Probiotic supplementation has shown great promise in modulating inflammatory cytokines, acting as a direct antiviral as well as a prophylactic therapy against influenza.⁸⁻¹¹ The dysbiosis patterns have yet to be fully elucidated for each probiotic strain or “ecosystem” of disease. It is known that bifidobacteria are sensitive to antibiotics and the Enterobacteriaceae family is known for its drug resistance.¹² The implications of such sensitivities include a decrease in healthy bifidobacteria species and an overgrowth of pathogens such as *Escherichia coli*. Although it is atypical to treat influenza with antibiotics initially, these sensitivities within the microbiome become salient when looking at at-risk populations such as older adults or those who are immunocompromised, who often have multiple coinfections.

Hepatitis induced cirrhosis increases bacterial translocation, endotoxemia, and tumor necrosis factor α (TNF-α) production from the diseased liver. Urease-producing bacteria and cognitive dysfunction are positively correlated in cirrhotic patients¹³ while also increasing the dysbiotic flora found within the gastrointestinal tract. Supplementation with probiotic species has resulted in the normalization of liver function markers (alanine aminotransferase [ALT], aspartate aminotransferase [AST], gamma-glutamyltransferase [GGT], lactate dehydrogenase [LDH], and total bilirubin) as well as lowering ammonia levels and improving cognitive performance.^{13,14}

Probiotic supplementation and consumption has also been positively correlated with other infectious diseases such as Epstein-Barr virus (EBV); hand, foot, and mouth disease (HFMDV); and Lyme disease. Research into these areas is in its infancy; however, there is promise in the current supporting literature.

Table 1. Infectious Disease

Infectious Disease	Strains	Overview	Professional and Commercial Products	Foods
HIV/AIDS				
Hummelen et al ¹ (2010)	<i>L rhamnosus</i> GR-1, <i>L reuteri</i> RC-14	Randomized, double-blind, placebo-controlled trial that indicates these 2 strains may act as a prophylactic for bacterial vaginosis among women with HIV. Probiotics tended to increase the probability of a normal vaginal flora (OR, 2.4; <i>P</i> = .10) and significantly increased the probability of a beneficial vaginal pH (OR, 3.8; <i>P</i> = .02) at follow-up.	<i>L rhamnosus</i> GR-1 and <i>L reuteri</i> RC-14: Pro-B (Rephresh) Women's Fem Dophilus (Jarrow Formulas) UltraFlora Women's (Metagenics) Clinicians Flora Restore (Douglas Pharmaceuticals)	None
Anukam et al ³ (2008)	Conventional yogurt fermented with <i>L delbrueckii</i> subsp <i>bulgaricus</i> ; <i>S thermophilus</i> was supplemented with probiotic <i>L rhamnosus</i> GR-1, <i>L reuteri</i> RC-14	In the absence of antiretrovirals, Nigerian adult females with HIV could benefit from yogurt supplemented with <i>L rhamnosus</i> GR-1 and <i>L reuteri</i> RC-14: “The mean CD4 cell count remained the same or increased at 15 and 30 days in 11/12 probiotic-treated subjects compared to 3/12 in the control. Diarrhea, flatulence, and nausea resolved in 12/12 probiotic-treated subjects within 2 days.”	<i>L rhamnosus</i> GR-1 and <i>L reuteri</i> RC-14: Pro-B (Rephresh) Women's Fem Dophilus (Jarrow Formulas) UltraFlora Women's (Renew Life) Clinician's Flora Restore (Douglas Pharmaceuticals)	<i>S thermophilus</i> and <i>L delbrueckii</i> subsp <i>bulgaricus</i> produce yogurt

Table 1. (continued)

Infectious Disease	Strains	Overview	Professional and Commercial Products	Foods
Hummelen et al ² (2011)	Micronutrient fortified yogurt with additional probiotic <i>L rhamnosus</i> GR-1	Randomized, double blind, controlled trial that shows in the absence of antiretrovirals, women with HIV can have improved hemoglobin levels ($P = .02$) and improved CD4 activity: "An average decline in CD4 count of -70 cells/ μ L (95% CI: -154 to -15) was observed in the micronutrient, probiotic group versus a decrease of -63 cells/ μ L (95% CI: -157 to -30) in the micronutrient control group ($P = .9$)" for the first month and not thereafter. There was no effect on diarrhea frequency.	<i>L rhamnosus</i> GR-1: Pro-B (Rephresh) Women's Fem Dophilus (Jarrow Formulas) UltraFlora Women's (Renew Life) Clinicians Flora Restore (Douglas Pharmaceuticals) Women's Fem Dophilus (Jarrow Formulas)	Yogurt specified in Hummelen et al ² (2011)
Cunningham-Rundles et al ⁵ (2011) Gori et al ⁶ (2011)	Infant formula supplemented with <i>B lactis</i> (with glutamine or without)	Glutamine treatment reduced malabsorption while those infants who received the <i>B lactis</i> formula gained significantly more weight than controls: "Dietary supplementation with a prebiotic oligosaccharide mixture improved the gut microbiota composition, reducing biomarkers of microbial translocation and T-cell activation."	Now Berrydophilus (kids) One-A-Day TruBiotics (Bayer)	Infant formula specified in Cunningham-Rundle et al ⁵ (2011)
Chiba et al ¹⁵ (2010) Cunningham-Rundles et al ⁵ (2011)	<i>L casei</i>	" <i>L casei</i> induced interleukin (IL)-12 production by CD11b ⁺ cells more strongly than pathogenic Gram-positive and Gram-negative bacteria and promoted the development of T helper type 1 (Th-1) cells leading to high levels of secretion of IFN- γ in vitro while slightly decreasing the IL-17 response to ovalbumin in cells from Peyer's patches."	<i>L casei:</i> Widely available in supplement formulas Mega Flora (Mega Foods)	<i>L casei:</i> Kefir, kvass, lassi, yogurt (Yakult)
Smits et al ¹⁶ (2005) Cunningham-Rundles et al ⁵ (2011)	<i>L reuteri</i> , <i>L casei</i> , Not <i>L plantarum</i>	"Treg cells express toll-like receptor 4 (TLR-4) and are activated by LPS." Stimulates functionally activated Treg cells via dendritic C-type lectin DC-specific intercellular adhesion molecule 3-grabbing nonintegrin (DC-SIGN).	<i>L reuteri</i> with <i>L rhamnosus</i>, <i>L acidophilus</i>, & FOS: <i>L Reuteri</i> Plus (Swanson) <i>L Reuteri:</i> Primadophilus Reuteri (Nature's Way) <i>L casei</i> Mega Flora (Mega Foods)	<i>L reuteri:</i> None <i>L casei:</i> Kefir, kvass, lassi, yogurt (Yakult) <i>L plantarum:</i> Fermented vegetables, KeVita probiotic drinks, olives (green), pickled vegetables, fermented salsa (not indicated for HIV/AIDS)
Anukam et al ¹ (2008)	Intravaginal probiotic treatment with <i>L reuteri</i> combined with <i>L rhamnosus</i> GR-1	Intravaginal probiotic therapy was more effective than metronidazole gel. Vertical transmission of HIV is 3-fold higher when there is bacterial vaginosis. Must be intravaginal: "Oral <i>L rhamnosus</i> GR-1 and <i>L reuteri</i> RC-1 given in a randomized, double-masked placebo-controlled trial did not enhance response to metronidazole."	<i>L rhamnosus</i> GR-1 and <i>L reuteri</i> RC-14: Pro-B (Rephresh) Women's Fem Dophilus (Jarrow Formulas) UltraFlora Women's (Renew Life) Clinicians Flora Restore (Douglas Pharmaceuticals)	None
Anukam et al ⁴ (2006)	Yogurt containing <i>L delbrueckii</i> subsp <i>bulgaricus</i> , <i>S thermophilus</i> , supplemented with <i>L rhamnosus</i> GR-1, <i>L reuteri</i> RC-14	Reduced diarrhea, increased CD4 counts, and stabilized T cells in HIV/AIDS-positive subjects. Fortified yogurt reduced diarrhea, flatulence, and nausea.	<i>L rhamnosus</i> GR-1 and <i>L reuteri</i> RC-14: Pro-B (Rephresh) Women's Fem Dophilus (Jarrow Formulas) UltraFlora Women's (Renew Life) Clinicians Flora Restore (Douglas Pharmaceuticals)	Yogurt containing <i>L delbrueckii</i> subsp <i>bulgaricus</i> and <i>S thermophilus</i> (commercial yogurt)
Cunningham-Rundles et al ⁵ (2011) Resta-Lenert et al ¹⁷ (2009)	Combination of <i>S thermophilus</i> , <i>L acidophilus</i>	Improved malabsorption, which is vital for HIV stabilization: "... ameliorated epithelial dysfunction due to inflammatory cytokines in vitro and in a mouse model of colitis in vivo."	<i>S thermophilus</i>, <i>L acidophilus:</i> Mega Flora (Mega Foods) <i>S thermophilus</i>, <i>L acidophilus:</i> Innate Flora 5-14 (Complete Care)	<i>S thermophilus:</i> Nancy's Organic Cultured Soy; cultured coconut and almond yogurts; lassi; kefir <i>L acidophilus:</i> Nancy's Organic Yogurts; lassi, kefir
Salminen et al ¹⁸ (2004) Cunningham-Rundles et al ⁵ (2011)	<i>L rhamnosus</i> GG, LGG (ATCC 53103)	Shortens the duration of rotavirus diarrhea; enhances humoral immune responses. Does not work against drug-induced diarrhea: "No benefits were found against protease inhibitor-induced diarrhea induced by inhibitors in this small placebo-controlled, crossover study."	LGG: Probiotic LGG (Walgreens) Advanced Multi-Billion (Dophilus-Solgar)	Yogurt and dairy products such as fermented and unpasteurized milk and semihard cheese Almond Dream Non-dairy Yogurt Amande Cultured Almond Milk Trader Joe's Cultured Coconut Milk Nancy's Organic Cultured Soy Nancy's Organic Yogurts Green Valley Organics Lactose-Free Kefir Nancy's Organic Lowfat Plain Kefir Redwood Hill Farm Goat Milk Kefir KeVita Kombucha Masterbrew KeVita Kombucha Sparkling Probiotic Drink
Trois et al ¹⁹ (2008)	Probiotic formula containing <i>B bifidum</i> , <i>S thermophilus</i>	In children who received the probiotic, the mean CD4 ⁺ T-cell count increased in the probiotic group. Controls observed a decrease in CD4 ⁺ cells during the same period. There was a concurrent decrease in diarrhea in both groups.	<i>B bifidum</i> and <i>S thermophilus:</i> Mega Foods (Mega Flora) BIODOPH-7 PLUS (Biotics) Innate Flora 5-14 (Complete Care)	All yogurts containing "live and active bacteria" <i>S thermophilus:</i> Nancy's Organic Cultured Soy; cultured coconut and almond yogurts

Table 1. (continued)

Infectious Disease	Strains	Overview	Professional and Commercial Products	Foods
Steenhout et al ²⁰ (2009)	<i>B lactis</i> (CNCM I-3446)–supplemented infant formula	“Weight gain of those taking <i>B lactis</i> was significantly higher than of those not taking <i>B lactis</i> by 3.1 g/day.” BMI was significantly increased in the probiotic group.	Isolated for research purposes only.	Infant formula <i>B lactis</i> : Nancy’s Organic Lowfat yogurt, nondairy yogurts, cow’s milk lassi, goat milk yogurt, and kefir
Cunningham-Rundles et al ² (2011)	Active LP 299V (<i>L plantarum</i>)	5% or greater improvement in height for 5/9 children with congenital HIV labeled failure to thrive. Height ratio was compared to readings (–3, –2, –1 mo, and day 0) before and 5 mo post therapy.	<i>L plantarum</i> 299V : Ideal Bowel Support (Jarow Formulas) Probiotic Supplement (GoodBelly) Probiotic GX (Nature’s Bounty) Probiata Digestion Support and Critical Care (Kyolic) Probiotic Balance (Sundown Naturals) Heart Healthy Probiotic Solutions (Dr Sinatra) Digestive Health Probiotic (Nature Made)	GoodBelly probiotic products <i>L plantarum</i> : Fermented vegetables, KeVita probiotic drinks, olives (green), pickled vegetables, salsa
Hu et al ²¹ (2013)	<i>Bifidobacterium</i> and <i>Lactobacillus</i> found in DanActive/YoPlus yogurts	Pilot study showing that <i>Candida</i> /fungal colonization of the vagina was reduced when consuming DanActive ($P = .03$): “54 % of the women had vaginal fungal colonization during the nonprobiotic yogurt consumption period, 29% during the DanActive period, and 38% during YoPlus yogurt consumption period.”	DanActive Yogurt	DanActive OR YoPlus
D’Eitorre et al ²² (2015)	Dietary supplement with probiotics (1 g packet containing <i>S salivarius</i> subsp <i>thermophilus</i> [at least 204 billion CFU], <i>Bifidobacterium</i> –represented by <i>B breve</i> , <i>B infantis</i> and <i>B longum</i> [at least 93 billion CFU], <i>L acidophilus</i> [at least 2 billion CFU], <i>L plantarum</i> [at least 220 million CFU], <i>L casei</i> [220 million CFU], <i>L delbrueckii</i> subsp <i>bulgaricus</i> [at least 300 million CFU], <i>S faecium</i> [at least 30 million CFU])	cART does not modulate inflammatory markers alone. When combined with probiotic therapy, CD4 ⁺ CD38 ⁺ HLA-DR ⁺ T and CD8 ⁺ CD38 ⁺ HLA-DR ⁺ T cells were significantly lower; CD4 and CD8 surface at T1 normalized and were similar to healthy controls; CD4 ⁺ were increased; reduction of acute diarrheal episodes or constipation; reduction of allergic episodes and less fatigue; LBP and CRP were reduced.	<i>B breve</i>, <i>B infantis</i>, and <i>B longum</i>, <i>L acidophilus</i>, <i>L plantarum</i>, <i>L casei</i> , Mega Foods (Mega Flora) <i>B breve</i>, <i>B infantis</i>, and <i>B longum</i>, <i>L acidophilus</i>, <i>L plantarum</i>, <i>L casei</i>, <i>S salivarius</i> subsp <i>thermophilus</i> : Innate Flora 5-14 (Complete Care)	<i>B breve</i> : None <i>B infantis</i> : None <i>B longum</i> : None <i>L acidophilus</i> : Lassi, kefir, yogurt <i>L plantarum</i> : Fermented vegetables, KeVita probiotic drinks, olives (green), pickled vegetables, salsa <i>L casei</i> : Kefir, kvass, lassi, yogurt, (Yakult) <i>L delbrueckii</i> subsp <i>bulgaricus</i> : Redwood Hill Farm Goat Milk Kefir <i>S faecium</i> : Found in conventional yogurt
Martinez et al ²³ (2009)	<i>L rhamnosus</i> GR-1 and <i>L reuteri</i> RC-14	Attenuated the cure rate of yeast vaginitis when combined with fluconazole.	<i>Lactobacillus rhamnosus</i> GR-1 and <i>L reuteri</i> RC-14 : Pro-B (Rephresh) Women’s Fem Dophilus (Jarow Formulas) UltraFlora Women’s (Renew Life) Clinicians Flora Restore (Douglas Pharmaceuticals)	None
Nagy et al ²⁴ (2013)	May need to avoid <i>L plantarum</i> WCFS1, <i>L gasseri</i> 1SL4, <i>L casei</i> BL-23	Chronic HIV infection enhances the responsiveness of antigen presenting cells to commensal lactobacilli. The chronic activation of the immune system may result in decreased immunity. Can cause an upregulation of IL-6, IL-12/IL-23p40, and TNF- α . Precaution: Lactic acid producing bacteria can result in lactic acidosis. Certain probiotics can result in upregulation of proinflammatory cytokines.	<i>L plantarum</i> WCFS1, <i>L casei</i> BL23, and <i>L gasseri</i> 1SL4 (isolated for research purposes only).	<i>L plantarum</i> : Fermented vegetables, KeVita probiotic drinks, olives (green), pickled vegetables, salsa Other strains : None
EBV				
Clancy et al ²⁵ (2006)	<i>Lacidophilus</i> (LAFTIL10)	Fatigued athletes often have sore throats and fatigue after intense training, which is consistent with EBV reactivation. They have significantly ($P = .02$) less secretion of interferon γ from blood CD4 ⁺ T cells. LAFTIL10 resulted in secretion of IFN- γ from T cells ($P = .01$) to levels found in healthy control athletes.	LAFTIL10 (DSM Food Specialties, Moorebank, NSW, Australia). NA on commercial supplements.	None
Influenza				
Hu et al ²⁶ (2016)	<i>B subtilis</i> , <i>E faecium</i>	Reduced/ameliorate secondary infection in 1 patient. H7N9 infection might decrease intestinal microbial diversity.	<i>B subtilis</i> and <i>E faecium</i> : GHT Threelac Probiotic, Natural Lemon Flavor <i>E faecium</i> : Enterogenic Concentrate (Integrative Therapeutics) Ultimate Probiotic (4 billion; Nature’s Secret) Health-Bac 100 grams (North American Herb & Spice)	None
Park et al ⁸ (2013)	<i>L plantarum</i> DK119	Antiviral; potentially modulates host innate immunity of dendritic and macrophage cells, and cytokine production pattern.	Dr Formulated Probiotics, Urinary Tract+ (Garden of Life)	Isolated from the fermented Korean cabbage food

Table 1. (continued)

Infectious Disease	Strains	Overview	Professional and Commercial Products	Foods
Wang et al ²⁷ (2013)	<i>E faecium</i> NCIMB10415	Effective against replication of swine flu, H1N1 and H3N2 strains; decreased TNF- α , TLR-3, and IL-6, and increased IL-10. <i>E faecium</i> directly adsorbed both strains and increased host immunity.	Only available in veterinary supplementation.	None
Waki et al ⁹ (2014)	<i>L brevis</i> KB290	Prophylactic in school children against influenza ($P < .001$). Results were the most robust in unvaccinated children.	Dr Formulated Probiotics Mood + (Garden of Life) Raw Probiotics Colon Health (Garden of Life)	Probiotic drink containing <i>L brevis</i> KB290 (KB290), isolated from a traditional Japanese pickle <i>suguki</i> .
Nakayama et al ¹⁰ (2014)	<i>L gasseri</i> SBT2055	Effective for preventing influenza virus A/PR8 in mice; probiotic decreased virus titer, IL-6, and bronchoalveolar lavage fluid. The <i>Mx1</i> and <i>Oas1a</i> genes, increased with pretreatment with LG2055 (critical for the viral clearance in the lung tissues).	Isolated for research purposes only.	None
Lu et al ¹² (2014)	<i>C butyricum</i> , <i>B subtilis</i> , <i>E faecium</i>	Effective against H7N9 in older adults who did not also have coinfections such as <i>Candida</i> species and multidrug-resistant <i>A baumannii</i> and <i>K pneumoniae</i> . CBM588 was ineffective. Fecal microbiota were balanced and immunity restored after antibiotic therapy.	<i>C butyricum</i>: AOR Probiotic-3 MIYARISAN 630 Tablets (Miyarisan) <i>B subtilis</i>: Probiotic Formula (Vitaweb) <i>E faecium</i>: Enterogenic Concentrate (Integrative Therapeutics Ultimate Probiotic (4 billion; Nature's Secret) Health-Bac 100 grams (North American Herb & Spice)	None
Mortaz et al ¹¹ (2013)	LGG, <i>L casei</i> strains Shirota and DN114001	Antiviral against influenza and other bacterial/viral infections of the gastrointestinal system. Useful for the prevention and/or treatment of infections.	<i>L rhamnosus</i> GG: Probiotic LGG (Walgreens) Advanced Multi-Billion (Dophilus-Solgar)	LGG: None <i>L casei</i> subsp Shirota: Yakult <i>L casei</i> DN114001: None
HFMD				
Fu et al ²⁸ (2015)	<i>S pastonianus</i> and <i>A xylinum</i> . The experimental kombucha was prepared by mixing 50 g of sugar, 1 g of (NH ₄) ₂ SO ₄ , 1 g of KH ₂ PO ₄ , 5 g of licorice (<i>Glycyrrhizae Radix</i>), 2 g of <i>Momordica Grosvenori</i> , 2 g of chrysanthemum (<i>D morifolium</i>), 2 g of green tea (<i>C sinensis</i>) in 1 L of distilled water	Kombucha fortified with Chinese antiviral herbs. Inhibits HFMD replication in vitro and vivo and may be useful in preventing HFMD outbreaks.	Isolated for research purposes.	Kombucha
Lyme Disease				
Recombinant	Recombinant <i>L plantarum</i>	Recombinant <i>L plantarum</i> protects mice from tick-transmitted <i>B burgdorferi</i> infection. Potential vaccine product.	NA	None
Del Rio et al ²⁹ (2008)				
<i>Lyme inflammation</i>	2 <i>L rhamnosus</i> strains, LGG and LC705	Stimulates levels of IL-1 β in macrophages, which are essential for caspase-1 activity. LC705 showed antiviral activity by inducing type 1 interferon-gene activation.	<i>L rhamnosus</i> GG: Probiotic LGG (Walgreens) Advanced Multi-Billion (Dophilus- Solgar)	<i>L rhamnosus</i> lc705 originates from milk
Howarth et al ³⁰ (2013)				
Hepatitis				
Galland ¹³ (2014)	<i>B longum</i> , FOS	Reduced serum ammonia and improved cognitive performance; alleviates cognitive dysfunction in patients with cirrhosis.	<i>B longum</i> and FOS: Jarro-Dophilus FOS (Jarro Formulas) <i>B longum</i>: Mega Flora (Mega Foods) 5-14 Complete Care (Innate Flora)	None
Galland ¹³ (2014)	Cocktail of 4 freeze-dried, nonurease producing bacteria (<i>P pentosaceus</i> , <i>L mesenteroides</i> , <i>L paracasei</i> subsp <i>paracasei</i> , <i>L plantarum</i>) mixed with beta glucan, inulin, pectin, and resistant starch	Alleviates cognitive dysfunction in patients with cirrhosis; reduced serum ammonia and improved cognitive performance.	<i>L paracasei</i>, and <i>L plantarum</i>: Nexabiotic <i>P pentosaceus</i> blend: Sour Weapon <i>L plantarum</i>: Ideal Bowel Support, 10 Billion Organisms V-Capsules (Jarro Formulas) Probiotic Supplement (GoodBelly) Probiotic GX (Nature's Bounty) Probiata Digestion Support and Critical Care (Kyolic) Probiotic Balance (Sundown Naturals) Heart Healthy Probiotic Solutions (Dr Sinatra) Digestive Health Probiotic (Nature Made)	<i>L paracasei</i> in KeVita probiotic drinks <i>L plantarum</i>: Fermented vegetables, KeVita probiotic drinks, olives (green), pickled vegetables, salsa <i>P pentosaceus</i> found in beer

Table 1. (continued)

Infectious Disease	Strains	Overview	Professional and Commercial Products	Foods
Kirpich et al ¹⁴ (2008)	<i>B bifidum</i> , <i>L plantarum</i> 8RA	5-d treatment resulted in lower levels of ALT and AST and significantly increased numbers of both bifidobacteria and lactobacilli in alcoholic patients. A subgroup of mild alcoholic hepatitis patients also had decreased levels of ALT, AST, GGT, LDH, and total bilirubin along with restoration of appropriate commensal species.	“Algibif” and “Algilac”, Microgen/Imbio Moscow-N (Nowgorod, Russian Federation) 8PA3- of 0.9×10^8 CFUs <i>B bifidum</i>: Mega Flora (Mega Foods) <i>L plantarum</i> 8RA: NA	FOS have been shown to stimulate the growth of <i>Bifidobacterium</i> spp <i>L plantarum</i>: Fermented vegetables, KeVita probiotic drinks, olives (green), pickled vegetables, salsa
Lam et al ²¹ (2009)	LGG	Increases basal mucosal prostaglandin E ₂ production in alcohol fed rats. LGG reduces alcohol induced gut permeability and steatohepatitis.	Probiotic LGG (Walgreens) Advanced Multi-Billion (Dophilus-Solgar)	None
Ewaschuk et al ²² (2007)	VSL#3	Prevented a breakdown in colonic barrier function, reduced bacterial translocation, reduced tissue TNF- α levels, and significantly attenuated liver injury.	VSL#3 – <i>B longum</i> , <i>B infantis</i> , <i>B breve</i> , <i>L acidophilus</i> , <i>L casei</i> , <i>L delbrueckii</i> subsp <i>L bulgaricus</i> , <i>L plantarum</i> , <i>S salivarius</i> subsp <i>thermophiles</i>	None
Riordan et al ¹³ (2003)	<i>Lactobacillus</i> spp, including <i>L plantarum</i> and FOS	Reduces primed TNF- α production by peripheral blood mononuclear cells in human cirrhotics.	<i>Lactobacillus</i> spp including <i>L plantarum</i> and FOS: Synbiotic 2000 <i>Lactobacillus</i> spp including <i>L plantarum</i>: Mega Flora (Mega Flora) <i>L plantarum</i>: Ideal Bowel Support, 10 Billion Organisms V-Capsules (Jarow Formulas) Probiotic Supplement (GoodBelly) Probiotic GX (Nature's Bounty) Probiata Digestion Support and Critical Care (Kyolic) Probiotic Balance (Sundown Naturals) Heart Healthy Probiotic Solutions (Dr Sinatra) Digestive Health Probiotic (Nature Made)	<i>L plantarum</i>: Fermented vegetables, KeVita probiotic drinks, olives (green), pickled vegetables, salsa
Lata et al ²⁴ (2007)	<i>E coli</i> Nissle	Restoration of “physiological microflora”; reduced endotoxin level in blood ($P = .07$); and a reduced Child-Pugh score ($P = .07$) (liver function tests).	Mutaflor (Tribute Pharmaceuticals)	None
Zhao et al ²⁵ (2004)	<i>Bifidobacteria</i> + <i>L acidophilus</i> + <i>Enterococcus</i>	Hepatitis viruses B and C; <i>Bifidobacterium</i> counts increased with treatment, whereas fecal pH and ammonia levels in feces and blood decreased.	<i>Bifidobacterium</i> + <i>L acidophilus</i>: Mega Flora (Mega Foods) <i>Bifidobacterium</i> + <i>L acidophilus</i> + <i>Enterococcus</i>: First Defense Probiotic (Eumaid)	<i>L acidophilus</i> in lassi, kefir, yogurt <i>Enterococcus</i> in miso
Zhao et al ²⁵ (2004)	<i>B subtilis</i> + <i>E faecium</i>	Hepatitis viruses B and C; <i>Bifidobacterium</i> counts increased with treatment, whereas fecal pH and ammonia levels in feces and blood decreased. Decreased blood levels of endotoxin levels and decreased clostridia.	<i>E faecium</i>: Enterogenic Concentrate (Integrative Therapeutics Ultimate Probiotic (4 billion; Nature's Secret) Health-Bac 100 grams (North American Herb & Spice)	None
Gratz et al ²⁶ (2010)	<i>L rhamnosus</i> GG	Mycotoxins are present from gut and liver disease. <i>L rhamnosus</i> GG can bind mycotoxins known to interfere with the intestinal mucosal barrier improving outcomes of those with liver diseases.	Probiotic LGG (Walgreens) Advanced Multi-Billion (Dophilus-Solgar)	<i>L rhamnosus</i>: Almond Dream Non-dairy Yogurt, Amande Cultured Almond Milk, Trader Joe's Cultured Coconut Milk, Nancy's Organic Cultured Soy, Nancy's Organic Cow's Milk Yogurt, all kefir, KeVita kombucha and sparkling probiotic drinks

Table 1. (continued)

Infectious Disease	Strains	Overview	Professional and Commercial Products	Foods
Loguercio et al ³⁷ (2002)	<i>L. acidophilus</i> , <i>L. bifidus</i> , <i>L. rhamnosus</i> , <i>L. plantarum</i> , <i>L. salivarius</i> , <i>L. bulgaricus</i> , <i>L. lactis</i> , <i>L. casei</i> , <i>L. brevis</i> + FOG + vitamins	No effects found on those with various forms of cirrhosis (HCV, alcoholism, and NASH).	<i>L. acidophilus</i>, <i>L. rhamnosus</i>, <i>L. plantarum</i>, <i>L. salivarius</i>, <i>L. bulgaricus</i>, <i>L. lactis</i>, <i>L. casei</i>, <i>L. brevis</i>: Mega Flora (Mega Foods) <i>L. plantarum</i>: Ideal Bowel Support, 10 Billion Organisms V-Capsules (Jarrow Formulas) Probiotic Supplement (GoodBelly) Probiotic GX (Nature's Bounty) Probiata Digestion Support and Critical Care (Kyolic) Probiotic Balance (Sundown Naturals) Heart Healthy Probiotic Solutions (Dr Sinatra) Digestive Health Probiotic (Nature Made)	<i>L. acidophilus</i>: Lassi, kefir, yogurt <i>L. bifidus</i>: Sheep's milk yogurt <i>L. rhamnosus</i>: Almond Dream Non-dairy Yogurt, Amande Cultured Almond Milk, Trader Joe's Cultured Coconut Milk, Nancy's Organic Cultured Soy, Nancy's Organic Cow's Milk Yogurt, all kefir, KeVita kombucha and sparkling probiotic drinks <i>L. plantarum</i>: Fermented vegetables, KeVita probiotic drinks, olives (green), pickled vegetables, fermented salsa <i>L. salivarius</i>: None <i>L. bulgaricus</i>, <i>S. thermophilus</i>: Kefir, all yogurt containing "live and active cultures" <i>L. lactis</i>: Activia Yogurt, Redwood Hill Farm Goat Milk Kefir <i>L. casei</i>: Nancy's Organic Cow's Milk Yogurt, all kefir <i>L. brevis</i>: None

Abbreviations: AIDS, acquired immune deficiency syndrome; ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; cART, combined antiretroviral therapy; CFU, colony-forming unit; CI, confidence interval; CRP, C-reactive protein; EBV, Epstein-Barr virus; FOS, fructooligosaccharides; GGT, gamma-glutamyl transferase; HCV, hepatitis C virus; HFMD, hand, foot, and mouth disease; HIV, human immunodeficiency virus; IFN- γ , interferon γ ; IL, interleukin; LBP, lipopolysaccharide-binding protein; LDH, lactate dehydrogenase; LGG, *Lactobacillus* GG; LPS, lipopolysaccharides; NA, not available; NASH, nonalcoholic steatohepatitis; OR, odds ratio; TLR, toll-like receptor; TNF- α , tumor necrosis factor α .

Research Overview: Infectious Disease

Bacterial vaginosis (BV) in women infected with HIV increases the transmission of HIV to their infant 3-fold.³ Hummelen et al² performed a randomized, double-blind, placebo-controlled trial showing that *Lactobacillus rhamnosus* GR-1 and *Lactobacillus reuteri* RC-14 may act as a prophylactic for BV among women with HIV. These 2 strains also normalized vaginal pH leading to the growth of beneficial bacteria. Anukam et al³ also found that supplementation with *L. reuteri* and *L. rhamnosus* GR-1 was more effective than metronidazole gel alone, whereas Martinez et al²³ found that the same strains also attenuated vaginal yeast infections when combined with fluconazole. A pilot study using the commercially available yogurts DanActive and YoPlus showed that fungal colonization of the vagina was decreased, especially when consuming the *Bifidobacterium* and *Lactobacillus* species in DanActive yogurt.¹ Supplementation of probiotics to commercially available yogurt is a novel technique to improve CD4 levels and decrease gastrointestinal discomforts such as diarrhea, flatulence, and nausea. Anukam³ showed that when conventional yogurt fermented with

Lactobacillus delbrueckii subsp *bulgaricus* and *Streptococcus thermophilus* was supplemented with probiotics *L. rhamnosus* GR-1 and *L. reuteri* RC-14 after 15 to 30 days of consumption, gastrointestinal complaints in all subjects improved and CD4 levels stabilized or increased in Nigerian women. Earlier, Anukam et al³ also showed that *L. reuteri* combined with *L. rhamnosus* GR-1 used in an intravaginal suppository worked better than metronidazole gel in the resolution of pathogenic yeast infiltration. Hummelen² showed in a randomized control trial that micronutrient fortified yogurt supplemented with *L. rhamnosus* GR-1 improved CD4⁺ levels and hemoglobin in the absence of retroviral medication. Last, D’Ettorre et al²² showed that supplementation with the following blend of probiotic species resulted in a better outcome than combined antiretroviral treatment alone (*Streptococcus salivarius* subsp *thermophilus*, *Bifidobacterium breve*, *Bifidobacterium infantis* and *Bifidobacterium longum*, *Lactobacillus acidophilus*, *Lactobacillus plantarum*, *Lactobacillus*, *L. delbrueckii* subsp *bulgaricus*, and *Streptococcus faecium*). *L. reuteri* and *L. rhamnosus* GR-1

alone or in combination with probiotic yogurts can also benefit vaginal flora and improve CD4 levels.²

HIV-positive children often have a lower BMI and are frequently labeled as failure to thrive. Cunningham-Rundles et al⁵ showed that active LP 299V (*L plantarum*) improved heights in infants with HIV and along with Resta-Lenert¹⁷ that a blend of *S thermophilus* and *L acidophilus* diminished malabsorption. Trois et al¹⁹ found that a probiotic formula containing *Bifidobacterium bifidum* with *S thermophilus* increased CD4 counts in HIV-positive children. Steenhout et al²⁰ found that *Bifidobacterium lactis* (CNCM I-3446) supplemented infant formula resulted in BMIs that were 3.1 g/day higher than those among controls. Cunningham-Rundles et al⁵ also showed that *B lactis* in combination with glutamine reduced malabsorption and increased infant weight gain and Salminen et al¹⁸ determined that *L rhamnosus* GG (ATCC 53103) shortened diarrhea associated with coinfection of rotavirus while increasing humoral response. These studies show that targeting the infant with nutrition and probiotics in its early immunomodulation period can result in better health outcomes overall.

Several strains have been directly associated with immunomodulation in patients with HIV. Salva et al³⁸ discovered that *L rhamnosus* CRL1505 could induce a recovery of B cells. Smits et al¹⁶ looked at the lipopolysaccharide (LPS) connection to T-regulatory cells as they express the toll-like receptor 4 when in contact with LPS. They determined that *L reuteri* and *L casei*, but not *L plantarum*, stimulated functionally active T-regulatory cells. Chiba et al¹⁵ discovered that *L casei* produced CD11b⁺ cells, which increased interleukin (IL)-12 leading to T_H1 balance while increasing the secretion of interferon (IFN)- γ . *L casei* also slightly decreased the proinflammatory cytokine IL-17 produced in Peyer's patches within the gastrointestinal tract. Last, chronic HIV infection enhances the responsiveness of antigen presenting cells to commensal *Lactobacilli*. Nagy et al²⁴ determined that HIV-infected patients might need to avoid *L plantarum* WCFS1, *Lactobacillus gasseri* 1SL4, and *L casei* BL23 owing to increased proinflammatory cytokine production.

Hepatitis C, a common coinfection of HIV-1, has been recognized as a separate cause of low serum micronutrients.³⁹ Microbiome restoration in patients with hepatitis results in increased prostaglandin E₂ and a decrease in TNF- α and bacterial translocation.^{31,32,40} Specifically, *Lactobacillus* GG (LGG) and the professional product, VSL#3, significantly attenuated liver injury and increased prostaglandin levels. *Bifidobacterium*, *L acidophilus*, *Enterococcus*, *Bacillus subtilis*, and *Enterococcus faecium* are the only strains that appear to directly alter hepatitis induced liver damage. This combination of probiotic supplementation increased *Bifidobacterium*, lowered urine and blood ammonia levels, and decreased damaging endotoxin levels.³⁵ The connection between circulating hepatotoxins, such as

mycotoxin, can result in cognitive decline and minimal hepatic encephalopathy. Gratz et al³⁶ found that *L rhamnosus* GG could specifically bind mycotoxins that alter the microbiome while increasing the mucosal barrier of the intestine. Lata et al³⁴ found that in cirrhotic patients, *E coli* Nissle could change the microflora while also improving liver function tests. Kirpich et al¹⁴ found that after a 5-day treatment with *B bifidum* and *L plantarum* 8RA, all liver function tests such as ALT, AST, GGT, LDH, and total bilirubin improved. This contradicts a previous study indicating that there was no effect on any markers of liver function by supplementation of *L acidophilus*, *L bifidus*, *L rhamnosus*, *L plantarum*, *L salivarius*, *L bulgaricus*, *L lactis*, *L casei*, and *L breve* plus fructooligosaccharides (FOS) plus vitamins.³⁷ It is possible that the introduction of FOS and/or vitamins altered the probiotic therapy thereby changing the outcomes. Last, Galland et al¹³ found that serum ammonia levels decreased and cognitive performance increased with *B longum* and FOS-82. Galland et al also found that a cocktail of 4 freeze-dried, nonurease producing bacteria (*Pediococcus pentosaceus*, *Leuconostoc mesenteroides*, *Lactobacillus paracasei* subsp *paracasei*, and *Lactobacillus plantarum*) mixed with beta glucan, inulin, pectin, and resistant starch also had the same effect. Modulating the microbiome in cirrhotic patients can often result in normalization of liver function markers while increasing quality of life.

Several strains of lactobacillus (LGG, *L casei* strains Shirota DN11400, *L gasseri* SBT2055, *L plantarum* DK119, and *L brevis* KB290) have proven to be prophylactic and have antiviral characteristics against influenza strains.¹¹ *L gasseri* SBT2055 specifically decreased influenza virus titers, inflammatory IL-6, and bronchoalveolar lavage fluid.¹⁰ *L brevis* KB290 significantly reduced the incidence of influenza infection in children and this effect was most remarkable in unvaccinated children.⁹ *L plantarum* DK119 given intranasally or orally resulted in 100% protection against subsequent lethal infections with influenza A viruses. It also prevented significant weight loss and lowered viral loads within the lung tissue in mice.⁸ Other strains directly target either H7N9, H1N1, and H3N2 strains. The swine flu (H1N1 and H3N2) when treated with *E faecium* NCIMB10415 was unable to replicate and the probiotic therapy decreased the inflammatory markers TNF- α , TLR-3, and IL-6 while increasing IL-10 in a porcine model.²⁷ Lu et al¹² found that *C butyricum*, *B subtilis*, and *E faecium* were helpful against N7N9, but only if the older adult patient did not have additional coinfections. Hu et al²⁶ also later found that *B subtilis* and *E faecium* reduced secondary infections in one patient and suggested that the H7N9 influenza infection might decrease intestinal microbial diversity. They noted that lactic acid bacteria recovered more quickly than the *Bifidobacterium* population during antibiotic cotherapy, indicating a necessity into future research of *Bifidobacterium*-producing strains in the influenza model.

Probiotic supplementation and consumption has also been positively correlated with other infectious diseases such as EBV, HFMDV, and Lyme disease. Chronic reactivation of EBV has been associated with elite athletes who overtrain.²⁵ Supplementation with probiotics resulted in less secretion of IFN- γ from blood CD4⁺ T cells and an improvement in clinical symptoms such as sore throat.²⁵ Kombucha fortified with Chinese antiviral herbals inhibits the replication of HFMD in vitro and vivo and may be useful in preventing HFMD outbreaks in cattle and potentially humans.²⁸ Last, probiotics are taking an adjuvant lead in the transmission of the Lyme disease spirochetes. Recombinant *L. plantarum* has shown to prevent the transmission and infection of *Borrelia burgdorferi* in a mouse model.²⁹ By utilizing commensal species of probiotics, the potential vaccine vector has less allergenic and immunomodulatory effects.

Nutritional Supplements Overview

Professional and commercial dietary supplements containing probiotics are widely available.⁴¹ In 2002, it was estimated that more than 100 companies in the United States marketed probiotic supplements and nearly 2 million adults consume them regularly.⁴² In 2012, probiotic or prebiotic use was the third most commonly used nonvitamin, nonmineral dietary supplement and global sales are projected to reach to \$42 billion by the end of 2016.^{43,44} Using probiotics for general health versus targeting a specific health concern is more complex as the properties of probiotic species are strain specific.⁴⁵ Unfortunately, research models lack consistency in naming therapeutic strains while in addition, specific strains are often not listed

on supplement labels. This challenge prevents the practitioner from distinguishing the researched strain from the supplemental product and is a limitation of these tables. If the researched strain was not readily available on the label or marketing material, the brand, potentially containing the strain, was not included in the table.

The Joint Food and Agriculture Organization of the United Nations/World Health Organization Expert Consultation on Evaluation of Health and Nutritional Properties of Probiotics developed guidelines for evaluating probiotics in food.⁴⁶ A combination of phenotypic and genotypic tests must be performed to determine the strain; however, regulations on species identification are not in place and supplement companies are not required to list this information on labels. During this multiserious review, it was identified that 30 species were specifically isolated for research purposes and were unavailable and another 56 strains were not commercially available. Owing to the wide variety of formulations on the market, lack of knowledge, and poor labeling, it is difficult for practitioners and consumers to determine which brand contains specific strains researched to address a particular health concern.

This table is designed to be a resource to see what is available “at-a-glance.” The brands were chosen by searching the probiotic strain and/ strain-species in Google, several supplement companies, Probiotics Advisor,⁴⁷ and the Clinical Guide to Probiotic Products. Based on the results and to determine what was commercially available, the search was refined using Google Shopping. In some instances, the supplement company was called to determine if the formula contained a specific species.

Table 2. Summary of Nutritional Supplements by Health Concern

Virus	Professional or Commercial Supplement	Probiotic Strain
EBV	LAFTIL10 (DSM Food Specialties, Moorebank, NSW, Australia). NA in commercial supplements.	<i>L. acidophilus</i> LAFTIL10
HFMD	Isolated for research purposes.	<i>S. pastonianus</i> and <i>A. xylinum</i> . The experimental kombucha was prepared by mixing 50 g of sugar, 1 g of (NH ₄) ₂ SO ₄ , and 1 g KH ₂ PO ₄ , 5 g of licorice (<i>Glycyrrhizae Radix</i>), 2 g of <i>Momordica Grosvenori</i> , 2 g of chrysanthemum (<i>D. morifolium</i>), and 2 g of green tea (<i>C. sinensis</i>) in 1 L of distilled water.
Hepatitis	Mega Flora (Mega Foods) 5-14 Complete Care (Innate Flora)	<i>B. longum</i>
Hepatitis	Probiotic LGG (Walgreens) Advanced Multi-Billion (Dophilus-Solgar)	<i>L. rhamnosis</i> GG
Hepatitis	Ideal Bowel Support, 10 Billion Organisms V-Capsules (Jarrow Formulas) Probiotic Supplement (GoodBelly) Probiotic GX (Nature's Bounty) Probiata Digestion Support and Critical Care (Kyolic) Probiotic Balance (Sundown Naturals) Heart Healthy Probiotic Solutions (Dr Sinatra) Digestive Health Probiotic (Nature Made) Probiotic Balance (Sundown Naturals)	<i>L. plantarum</i>
Hepatitis	First Defense Probiotic (Emauid)	<i>Bifidobacteria</i> + <i>L. acidophilus</i> + <i>Enterococcus</i>
Hepatitis	Jarro-Dophilus = FOS (Jarrow Formulas)	<i>B. longum</i> and FOS
Hepatitis	Mega Flora (Mega Foods)	<i>B. bifidum</i>
Hepatitis	Mega Flora (Mega Foods)	<i>Lactobacillus</i> spp including <i>L. plantarum</i>
Hepatitis	Mutaflor (Tribute Pharmaceuticals)	<i>E. coli</i> Nissle
Hepatitis	Nexabiotic	<i>L. paracasei</i> , <i>L. plantarum</i>
Hepatitis	NA	<i>L. plantarum</i> 8RA
Hepatitis	Sour Weapon	<i>P. pentosaceus</i> blend
Hepatitis	Synbiotic 2000	<i>Lactobacillus</i> spp including <i>L. plantarum</i> and FOS
Hepatitis	VSL#3 (Sigma-tau Pharmaceuticals, Inc)	VSL#3 - <i>B. longum</i> , <i>B. infantis</i> , <i>B. breve</i> , <i>L. acidophilus</i> , <i>L. casei</i> , <i>L. delbrueckii</i> subsp, <i>L. bulgaricus</i> , <i>L. plantarum</i> , <i>S. salivarius</i> subsp <i>thermophilus</i>

Table 2. Summary

Virus	Professional or Commercial Supplement	Probiotic Strain
HIV/AIDS	Advanced Multi-Billion (Dophilus-Solgar) Probiotic LGG (Walgreens)	<i>L rhamnosus</i> GG, LGG (ATCC 53103)
HIV/AIDS	BIODOPH-7 PLUS (Biotics)	<i>B bifidum</i> with <i>S thermophilus</i>
HIV/AIDS	Clinicians Flora Restore (Douglas Pharmaceuticals) Pro-B (Rephresh) UltraFlora Women's (Metagenics) Women's Fem Dophilus (Jarrow Formulas)	<i>L rhamnosus</i> GR-1 and <i>L reuteri</i> RC-14
HIV/AIDS	Digestive Health Probiotic (Nature Made) Heart Healthy Probiotic Solutions (Dr Sinatra) Ideal Bowel Support (Jarrow Formulas) Probiata Digestion Support and Critical Care (Kyolic) Probiotic Balance (Sundown Naturals) Probiotic GX (Nature's Bounty) Probiotic Supplement (GoodBelly)	<i>L plantarum</i> 299V
HIV/AIDS	5-14 Complete Care (Innate Flora)	<i>S thermophiles</i> with <i>L acidophilus</i>
HIV/AIDS	5-14 Complete Care (Innate Flora)	<i>B breve</i> , <i>B infantis</i> , and <i>B longum</i> , <i>L acidophilus</i> , <i>L plantarum</i> , <i>L casei</i> , <i>S salivarius</i> subsp <i>thermophilus</i>
HIV/AIDS	5-14 Complete Care (Innate Flora)	<i>B bifidum</i> with <i>S thermophilus</i>
HIV/AIDS	Mega Flora (Mega Foods)	<i>S thermophiles</i> with <i>L acidophilus</i>
HIV/AIDS	Mega Flora (Mega Foods)	<i>B breve</i> , <i>B infantis</i> , <i>B longum</i> , <i>L acidophilus</i> , <i>L plantarum</i> , <i>L casei</i>
HIV/AIDS	Mega Flora (Mega Foods)	<i>B bifidum</i> with <i>S thermophilus</i>
HIV/AIDS	Primadophilus Reuteri (Nature's Way)	<i>L reuteri</i> and <i>L casei</i> , but not <i>L plantarum</i>
HIV/AIDS	NA	<i>B lactis</i> (CNCM I-3446) supplemented infant formula
HIV/AIDS	Now Berrydophilus (kids) One-A-Day TruBiotics (Bayer)	<i>B lactis</i> in infant formula
HIV/AIDS	Sour Weapon	<i>P pentosaceus</i> blend
HIV/AIDS	Probiotic LGG (Walgreens)	LGG
HIV/AIDS	<i>L Reuteri</i> Plus (Swanson)	<i>L reuteri</i> and <i>L casei</i> , but not <i>L plantarum</i>
HIV/AIDS	Widely available in supplement formulas	<i>L casei</i>
Influenza	Dr Formulated Probiotics Mood + (Garden of Life)	<i>L brevis</i> KB290
Influenza	Advanced Multi-Billion (Dophilus-Solgar) Probiotic LGG (Walgreens)	<i>L rhamnosus</i> GG
Influenza	AOR Probiotic-3 MIYARISAN 630 Tablets (Miyarisan)	<i>C butyricum</i>
Influenza	Raw Probiotics Colon Health (Garden of Life)	<i>L brevis</i> KB290
Influenza	Isolated for research purposes only	<i>L gasseri</i> SBT2055
Influenza	NA	<i>L casei</i> strains Shirota and DN114001
Influenza	NA in human formula, only veterinary supplements	<i>E faecium</i> NCIMB10415
Influenza	Probiotic Formula (Vitaweb)	<i>B subtilis</i>
Influenza	Enterogenic Concentrate (Integrative Therapeutics)	<i>L rhamnosus</i> GG, <i>E faecium</i>
Influenza	Dr Formulated Probiotics, Urinary Tract+ (Garden of Life)	<i>L plantarum</i> DK119
Influenza	Enterogenic Concentrate (Integrative Therapeutics) Ultimate Probiotic (4 billion; Nature's Secret) Health-Bac 100 grams (North American Herb & Spice)	<i>E faecium</i>
Influenza	GHT Threelac Probiotic, Natural Lemon Flavor	<i>B subtilis</i> and <i>E faecium</i>
Lyme Disease	Advanced Multi-Billion (Dophilus-Solgar) Probiotic LGG (Walgreens)	<i>L rhamnosus</i> LGG
Lyme Disease	NA	Recombinant <i>L plantarum</i>

Abbreviations: AIDS, acquired immune deficiency syndrome; EBV, Epstein-Barr virus; FOS, fructooligosaccharides; HFMD, hand, foot, and mouth disease; HIV, human immunodeficiency virus; LGG, *Lactobacillus* GG; NA, not available.

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