The Argument for a Vegetarian Diet
Part One

by Gary Null, PhD, and Martin Feldman, MD

In recent decades, vegetarianism has shed its image as an offbeat lifestyle choice and attracted many Americans who want to take advantage of the benefits offered by plant-based eating. These people are adopting a vegetarian diet to improve their health, avoid the chemicals used in animal foods, reduce food costs, conserve natural resources, adhere to religious disciplines, and respect animal life. More than 7 million Americans now eat a vegetarian diet for these reasons and others.

Despite these gains, the US remains a leading consumer of meat; and the rationale for vegetarian eating must continue to be made to the American public. A typical US diet – including, for example, eggs and bacon for breakfast, a hamburger and glass of milk for lunch, and a meat dish for dinner – can supply more than 200 grams of protein a day, or about four times the highest recommended intake. These eating habits carry serious consequences for the health of individuals and the ability of countries to feed the greatest number of people from the available food-production resources.

This article will present some of the key arguments in favor of a vegetarian diet, giving health-care providers the information to help their patients (and themselves) make healthful dietary choices.

Myths about Protein

Protein is one of the most misunderstood areas of nutrition, resulting in myths about the function of protein in the body, the dietary sources of this nutrient, and the potential consequences of consuming too little protein. These myths may be so entrenched in our collective psyche that we find it difficult to let them go, even though scientific research shows them to be false.

What follows are some of the common misconceptions about protein:

Animal Products Are Our Only Source of Complete Protein

The American Dietetic Association and Dietitians of Canada report in a position paper that they have reviewed the scientific data concerning key nutrients for vegetarians and concluded that a vegetarian diet can meet recommendations for all of those nutrients, including protein. The two groups state that "appropriately planned vegetarian diets are healthful, nutritionally adequate, and provide health benefits in the prevention and treatment of certain diseases."[1]

A Vegetarian Diet Will Make You Protein-Deficient and Sick

Scientific literature in the US has revealed what other cultures, such as the Hindu and the Japanese, have known for thousands of years: We do not need meat or dairy products to sustain human life and health. The healthiest civilizations are those that consume little or no meat and lead essentially vegetarian lifestyles. There is some evidence that people who eat primarily plant-based diets have longer, relatively healthier lives than do we in the West. Plant consumption has demonstrated a prophylactic effect against various illnesses associated with lifestyle.

In contrast, meat-eaters may be prone to illnesses of the digestive and excretory systems and disorders resulting from generalized swelling and histamine response. The saturated fats in meat have been linked to breast and colon cancer and cardiovascular disorders.

It is Impossible to Consume Too Much Protein, Because Any Excess Will Be Stored in Muscles

Protein is not stored in muscles, and excessive intake can be harmful. One potential problem is kidney damage. Excess protein causes excess urea, a byproduct of protein metabolism. The kidneys must work overtime to filter urea if it builds up in the bloodstream, and the stress can lead to kidney damage. This problem is especially serious for older people, whose kidneys function less efficiently, and people with preexisting kidney damage.

Other potential effects of an excessive protein intake include: (1) dehydration, which may result when one's water consumption is not sufficient for the kidneys to filter urea out of the bloodstream; (2) a buildup of ammonia, another nitrogen byproduct of protein metabolism, in the intestinal tract[2]; and (3) calcium deficiency, which may occur even when we consume ample calcium-rich milk. Milk is difficult to digest, and much of its calcium never gets into the bloodstream. Milk is also high in phosphorus, which binds to calcium and makes it less absorbable. Much of this calcium is then excreted in the urine.

Animal Protein Is Low in Calories, While Carbohydrates Are Fattening

Animal protein is in fact extremely high in calories because it usually contains a lot of fat. An average 16-ounce steak, for example, has about 1,500 calories. There is little doubt that excess meat consumption is one of the major causes of obesity in the US.

Humans Were Made to Eat Meat

Physiologically, we are vegetarians. Carnivorous animals have very short intestinal tracts so that meat remains in the body for only a short time. Humans, by contrast, have long digestive tracts. Some portion of ingested meat may stay in the body for three to four days, during which it begins to decompose and putrefy at our 98.6° body temperature. This putrefaction may be one of the major causes of colon and prostate problems.

Protein Basics

There is no question that protein is an essential nutrient. It helps to build, maintain, and repair just about every part of the body. It makes up our hair, fingernails and toenails, muscles, cartilage, and tendons, along with many hormones, antibodies, and enzymes.

Chemically, proteins are long-chain molecules made up of amino acids. There are approximately 22 of them in the protein we use. These same amino acids make up all protein in nature, be it plant, animal, or human. There are eight amino acids that the adult body cannot manufacture: valine, leucine, isoleucine, lysine, threonine, tryptophan, methionine, and phenylalanine. These essential amino acids must therefore be obtained from the diet. For children, histidine also is an essential amino acid; it is important for growth and development.

Because protein is so critical, we must ensure that we consume sufficient quantities. Otherwise, the body will break down more molecules than it can build up, resulting in overall deterioration. Pregnant women must be especially careful to avoid such a situation, as it will affect both their health and their unborn babies' as well.

How much protein is enough? Ideally, the most precise way to determine a person's protein needs would be to measure his or her nitrogen input versus nitrogen output in a given day. Protein is the only nutrient that supplies the body with nitrogen, and an adequate intake from the foods we eat creates a "nitrogen balance." We will have a "negative nitrogen balance" if our output of nitrogen exceeds our dietary intake.

Experiments have shown that people can maintain proper nitrogen equilibrium when consuming only plant sources of protein.[3] It is not scientifically proven that we must eat any animal foods to obtain our daily nitrogen requirements. Eating a variety of legumes, grains, vegetables, nuts, and seeds will provide adequate amounts of high-quality protein, even from the point of view of nitrogen equilibrium.

While nitrogen utilization may be an ideal way to determine one's protein requirements, this method is not practicable on a large-scale or regular basis. Therefore, we must turn to established tables that "guesstimate" required protein levels. Almost all of the statistics in this area are inflated with a safety margin to one degree or another.

The World Health Organization (WHO) and Food and Agriculture Organization (FAO) recently published a technical report on protein and amino acid requirements. This analysis finds that the safe level of protein intake for adults is 0.83 grams per kilogram (kg) of body weight per day – a level that "would be expected to meet the requirements of most (97.5%) of the healthy adult population." The safe levels of protein intake per kg of body weight are higher for children, while women who are pregnant or lactating require extra protein as well.[4]

A similar recommendation for protein intake in adults – 0.8 grams of good-quality protein per kg of body weight – comes from the Institute of Medicine, part of the National Academy of Sciences.[5] By this method, you multiply your body weight in pounds by 0.453 (to convert to kilograms), then multiply by 0.8. If you weigh 155 pounds, for example, you multiply that figure by 0.453, which is 70.2 kg, then multiply by 0.8 grams per kg to arrive at 56 grams of protein per day.

The Institute of Medicine's 2005 recommended dietary allowances (RDAs) for protein are as follows[6]:

Age	RDA For Protein
Infants*	
7-12 months	1.2 g/kg/d or 11 g/d
Children (boys and girls)	
1-3 years	1.05 g/kg/d or 13 g/d
4-8 years	0.95 g/kg/d or 19 g/d
9-13 years	0.95 g/kg/d or 34 g/d
Adolescents	
Boys, 14-18 years	0.85 g/kg/d or 52 g/d
Girls, 14-18 years	0.85 g/kg/d or 46 g/d
Adults	
Men, 19 years and older	0.80 g/kg/d or 56 g/d
Women, 19 years and older	0.80 g/kg/d or 46 g/d

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Pregnancy

All age groups.. 1.1 g/kg/d of protein, or +25 g/d of additional protein

Lactation

All age groups.. 1.3 g/kg/d of protein, or +25 g/d of additional protein

* For infants 0-6 months, the "Adequate Intake" is 1.52 g/kg/d based on human milk.

The figures on protein requirements illustrate that we really need very little protein, which is easily available from nonanimal sources.

A Focus on Protein Quality

The popularity of meat and other animal proteins in the US diet can be traced to the early 1940s, when the concept of "complete" and "incomplete" proteins was popularized. Many of us were taught that meat, eggs, and dairy products were complete proteins. The other foods – legumes, grains, nuts, vegetables, fruits – were incomplete sources. According to the original theory, complete proteins had all of the essential amino acids in the right proportions to be used by the body, while incomplete proteins lacked certain amino acids and did not have them in the right proportions. There was little recognition of the significant protein contributions of the plant foods.

What is amazing about this theory is that it remained intact for so long, when in fact it is wholly unfounded. Plant proteins contain all of the essential amino acids, although particular ones (such as lysine, sulfur-containing amino acids, and threonine) may be lower in plant foods than in animal foods. Despite these differences, the essential amino acids needed to meet the body's requirements and maintain nitrogen balance can come from both plant and animal sources: meat, fish, dairy, eggs, legumes, nuts and seeds, grains, vegetables, and combinations of these foods.

This information on protein is available to consumers from organizations such as the American Heart Association (AHA). It advises that soy protein is equal to animal proteins (making it suitable as a sole source of protein), and that whole grains, legumes, vegetables, seeds, and nuts contain both essential and nonessential amino acids. The AHA states: "You don't need to eat foods from animals to have enough protein in your diet. Plant proteins alone can provide enough of the essential and nonessential amino acids, as long as sources of dietary protein are varied and caloric intake is high enough to meet energy needs."[7]

Protein foods must be evaluated in terms of their quality. In a 2007 report on protein and amino acid requirements, WHO and FAO explain that the purpose of evaluating protein quality is to determine "the capacity of food protein sources and diets to satisfy the metabolic demand for amino acids and nitrogen. Thus any measure of the overall quality of dietary protein, if correctly determined, should predict the overall efficiency of protein utilization." On this topic, the report states that "protein utilization is generally discussed in terms of *digestibility*, a measure of the dietary intake which is made available to the organism after digestion and absorption, and *biological value*, a measure of how well the absorbed amino acid profile matches that of the requirement. Overall protein utilization, i.e. *net protein utilization* (NPU), will therefore reflect both digestibility and biological value."[8]

Interestingly, when nitrogen balance studies involve fast-growing young children, differences in digestibility, biological value, and NPU between protein sources are clear and predictable, says WHO/FAO. Values range "from near-perfect utilization ... for animal proteins, to much lower values for some plant-based diets." In contrast, studies of adults are difficult to interpret, with outcomes differing from predictable values. In a 2003 meta-analysis of nitrogen balance studies, explains WHO/FAO, the median protein requirement (0.66 g/kg per day) more than doubled the obligatory nitrogen losses ($\approx$0.3 g/kg per day) because the slope, which indicates the efficiency of protein utilization, was $<$0.5. "Furthermore, there was no significant influence of variation in the protein sources (animal, vegetable, or mixed protein) on the slope and consequent requirement. This implies that for human adults, net protein utilization values for diets of most sources are similar, but much lower than would be predicted," states WHO/FAO. It also indicates that we must gain a "better understanding of how the organism adapts to variation in protein intake."[9]

The internationally accepted method of protein quality assessment is the protein digestibility-corrected amino acid score (PDCAAS), which has been adopted by WHO for measuring the protein value of foods and by the US Food and Drug Administration for calculating protein for food labels. The PDCAAS is used to assess the quality of both individual sources of protein and food mixtures. In the early 1990s, it replaced the long-used protein efficiency ratio (PER), a rat growth assay method of assessing food proteins. According to an FAO official, because rats grow faster than humans (increasing the rat's essential amino acid requirements), PER overestimated the value of some animal proteins for human growth and underestimated the value of some vegetable proteins.[10]

The PDCAAS method evaluates the quality of protein foods based on two factors: digestibility and amino acid composition. As described by Millward et al., the amount of potentially "limiting" amino acids in a given protein food or protein combination is compared with their respective content in the reference pattern used by PDCAAS. (The reference pattern represents the essential amino acid requirements of a 2- to 5-year-old child.) This comparison identifies the single most limiting amino acid, which determines the amino acid score. "The current consensus is that meeting the minimum requirements for lysine, methionine, and tryptophan, the most limiting amino acids in poor quality proteins, determines the amino acid score and will lead to a plateau of nitrogen retention," state the authors. The amino acid score is corrected for digestibility to arrive at the test protein's PDCAAS value.[11]

The highest PDCAAS value given to a food is 100% (1.00). If the value of a food exceeds 100%, the score is truncated to 1.00 on the grounds that the nutritional benefit of a protein is not increased by essential amino acid content in excess of the reference pattern.[12] Egg white and casein have a PDCAAS of 1.00. Soybean isolate scores 0.99, and beef protein is 0.92. Examples of plant protein values include: pea flour, 0.69; kidney beans, 0.68; lentils, 0.52; and whole wheat, 0.40.[13]

One criticism of the PDCAAS method concerns mixed diets containing proteins from a number of sources. As explained by Schaafsma, the truncation of PDCAAS values to 100% makes sense only in cases where the diet consists of a sole source of protein (such as infant feeding or enteral feeding). In all other diets, where the sources of protein are mixed, the truncated values largely eliminate "differences in the power of high-quality proteins to balance the amino acid composition of inferior proteins," says Schaafsma. He offers the example of 1 gram of wheat protein (which is low in lysine). It may be balanced by 1.2 grams of casein versus 6.2 grams of soy protein. This concept is highly relevant for plant protein sources containing low concentrations of lysine, sulfur-containing amino acids, and threonine. The author concludes: "For evaluation of the nutritional significance of proteins as part of mixed diets, the truncated value should not be used. In those cases, a more detailed evaluation of the contribution of the protein to the amino acid composition of the mixed diet is required."[14]

Protein Complementation

With plants accounting for 65% of the protein supply worldwide, the concept of protein complementation warrants consideration. In the *American Journal of Clinical Nutrition*, Young and Pellett explain that some plant foods may not be adequate as sole sources of protein, especially for infants and children, due to their low concentration of protein or quality of protein. However, children can thrive and recover from severe malnutrition when eating well-formulated diets based on plant foods alone. They state: "Thus, plant foods in appropriate amounts and combinations are able to supply the essential nutrients required for maintenance of adequate health and nutrition."[15]

The authors underscore the potentially high nutritional quality of plant protein mixtures. As an example, they note that the soybean is low in sulfur-containing amino acids and high in lysine, while foods such as cereal grains and sesame flour are low mainly in lysine. Therefore, the combination of soy protein with a cereal that contains a

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relatively good concentration of s-amino acids will result in a complementary effect – that is, the protein quality of the mixture exceeds that of either food alone. This synergistic effect occurs when "one of the protein sources has a considerably higher concentration of the most limiting amino acid in the other protein."[16]

According to a meta-analysis of nitrogen balance studies, the research shows that "well-processed soy proteins were equivalent to animal protein, whereas wheat proteins were used with lower efficiency than were animal protein (beef)." Similarly, studies comparing egg proteins with rice or wheat gluten also found significant differences in utilization between the animal and plant sources of protein. However, the authors state that "whereas lysine is likely to be the most limiting of the indispensable amino acids in diets based predominantly on cereal proteins, especially wheat, the risk of lysine inadequacy is substantially reduced by the inclusion of relatively modest amounts of animal or vegetable proteins, such as those from legumes and oil seeds or, where appropriate, through lysine fortification of cereal flour."[17]

Young and Pellett conclude that plant protein mixtures "can serve as a complete and well-balanced source of amino acids. ... Consumers do not need to be at all concerned about amino acid imbalances when the dietary amino acid supply is from the plant-food proteins that make up our usual diets. Mixtures of plant proteins can be fully adequate for meeting human requirements. From the standpoint of the composition of a healthful diet, they serve as a desirable vehicle for carrying nitrogen and indispensable amino acids to meet both our needs and wants."[18]

Experts on vegetarian eating advise that it is not necessary to combine complementary plant proteins at the same meal. The important point is to eat a varied diet each day of legumes, grains, nuts, seeds, and vegetables. According to the American Dietetic Association, "Research indicates that an assortment of plant foods eaten over the course of a day can provide all essential amino acids and ensure adequate nitrogen retention and use in healthy adults, thus complementary proteins do not need to be consumed at the same meal." Young and Pellett believe "that for usual conditions of healthy living it is not necessary to consume complementary proteins at the same time and that separation of the proteins among meals over the course of a day would still permit the nutritional benefits of complementation."[20] In a letter to *Circulation,* John A. McDougall, a leading nutritional physician, states: "A careful look at the founding scientific research and some simple math prove it is impossible to design an amino acid-deficient diet based on the amounts of unprocessed starches and vegetables sufficient to meet the calorie needs of humans. Furthermore, mixing foods to make a complementary amino acid composition is unnecessary."[21] Organizations such as the Vegan Society, the Vegetarian Resource Group, and Vegan Outreach also inform consumers that it is not necessary to combine proteins at each meal.

Egg Protein Index

For vegetarians who want to consume optimal food mixtures, it is useful to understand which combinations can be used most efficiently by the body. We, the authors of this article, working with mathematician Hillard Fitzkee, analyzed by computer the amino acid structure of major animal and plant foods and evaluated the quality of many combinations of plant proteins. These plant foods can be combined in normal serving sizes to obtain all of the amino acids – and therefore protein – one needs.

We created a rating system called the egg protein index (EPI) from our research. This rating assigns a score to each food – or combination of foods – based on how closely the essential amino acids they contain match the percentage contributions of the egg, which we selected as our standard. The egg contains the eight essential amino acids in the proportions most efficient for human protein metabolism, and has an NPU value of 94 on a scale of 100. It should be noted that while the egg was selected as the ideal food with which to compare others, another food could have been chosen. Our definition of quality is not a function of egg protein in particular.

Within this unbiased rating system, a food or food combination is most beneficial if each of its essential amino acids is present in the same percentage contribution as that of the egg. If the essential protein structure of the food(s) were to match that of the egg exactly, then the EPI would be zero. The poorer the match for a food or food combination, the higher the EPI number it receives.

As an example, the EPI of rice alone is 31.14. This compares with 16.81 for whole milk. However, one could add a "balancing" portion of selected amino acids to make the rice identical to the egg. This would require 448 milligrams of seven of the eight essential amino acids per 100 grams of rice. But this type of precision is not needed to obtain desirable results. Only 180 milligrams of four of the essential amino acids obtained from a complementary food could improve rice's EPI from 31.14 to 4.52. Thus, we can increase the quality of rice by improving the essential protein portion; we do not need to produce more protein in the 100 grams of rice or optimize all of its protein.

Here are some examples of EPIs for combinations of two foods:

Food 1	Food 2	EPI
Pine Nuts	Pea, Green	8.068
Spirulina	Amaranth	8.102
Sunflower Flour	Navy Bean	8.125
Basmati	Asparagus	8.167
Pine Nuts	Snap Bean	8.197
Pine Nuts	Cauliflower	8.208
Walnut	Mushroom	8.259

This assessment of food combinations goes beyond the "limiting amino acid" approach, in which people would combine one food with another based on which amino acid it contained in the smallest amount. The problem was that as they tried to eat enough of a particular food to obtain the minimum requirement of one amino acid, they would overconsume other amino acids. Our computations took into account not merely the one or two amino acids in shortest supply in each food, but all eight essential amino acids and the extent to which their proportions vary from those of the egg. As a result, vegetarians can obtain higher-quality and more usable protein, avoid excess consumption of protein or particular amino acids, and consume fewer total calories for better weight control.

Based on our research, the two-food combinations with the highest quality of protein are:

1. Hijiki Seaweed/Amaranth
2. Triticale Flour/Amaranth
3. Basmati (Long-Grain, Parboiled)/Amaranth
4. Sunflower Flour/Amaranth
5. Pine Nuts/Swiss Chard (Raw)
6. Sunflower Flour/Green Pea (Dry)
7. Sunflower (Hulled)/Amaranth
8. Whole Wheat Flour/Amaranth
9. Sesame Seed (Meal)/Amaranth
10. Spinach (Raw)/Pine Nuts
11. Buckwheat Flour (Dark)/Basmati (Long-Grain Parboiled)
12. Walnut, Persian/Amaranth
13. Pine Nuts/Amaranth
14. Bulgur/Amaranth
15. Brown Rice (Raw, Short-Grain)/Amaranth
16. Sunflower (Hulled)/Pine Nuts
17. Couscous/Amaranth
18. Watermelon Seed/Amaranth
19. Filbert (Shelled)/Amaranth
20. Pine Nuts/Broccoli (Cooked)

A Closer Look at Meat

Despite the ability of plant foods to meet our amino acid requirements, the diet of many Americans still pivots around meat. They believe that it is synonymous with protein, health, and strength; and their diet typically includes meat and dairy products at most meals.

Major associations like the American Heart Association and the American Cancer Society have warned that this type of meat consumption is not in our best interest. But after decades of hearing otherwise, people may find this hard to believe.

So what is the truth about meat?

First, it is true that meat supplies protein, but not in the quantities or of the quality that most people think. Beef, for example, is 20% protein; the rest is fat and water. In addition, beef is one of the highest-calorie foods available, due to it high fat content. As mentioned, an average 16-ounce steak has about 1,500 calories. If this were eaten with a baked potato with butter and sour cream and a dessert, the calorie count would be 2,500. Furthermore, the fat in beef is saturated. This builds up in arteries as cholesterol and is thought to be one of the major culprits in arteriosclerosis and heart disease.

In addition, meat is one of the most chemical-ridden foods in the US diet. Five major classes of drugs are administered to food animals, according to the National Research Council. They are: (1) topical antiseptics, bactericides, and fungicides; (2) ionophores (these drugs alter stomach microorganisms); (3) hormone and hormonelike production enhancers; (4) antiparasite drugs; and (5) antibiotics to control disease and promote growth.[25] It is known that some of these drugs may be transferred to the human population via meat, dairy, and egg products.

Antibiotics are perhaps the most widely used (and abused) of these drugs. They are given in subtherapeutic doses to promote the growth of food animals. They also are used to prevent diseases that would otherwise be rampant in the close, unsanitary conditions in which animals are raised. In 1954, 490,000 pounds of antibiotics were used in livestock production. Today the figure is 25 million pounds.[26] As reported by the Sierra Club: "The routine, medically unnecessary use of antibiotics to promote the enhanced growth of livestock is making disease-causing ➤

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bacteria more resistant to the drugs, which diminishes their power to treat life-threatening diseases in humans."[27]

In addition to antibiotics, hormones are routinely used with beef cattle to regulate breeding, tranquilize, and promote weight gain. These synthetic hormones can cause cancer in the animals, which in most cases does not affect the marketability of the meat. We do not yet know the degree to which cancer is viral in its origins, but studies have found viruses to be responsible for some cancers.[28] So, apart from being unappetizing, cancerous meat may actually be the vehicle for cancer viruses to enter our bodies. Additionally, the residues of estrogen, one of the hormones commonly fed to these animals, may increase women's chances of contracting uterine and breast cancer. Children exposed to estrogen may enter puberty prematurely. DES (diethylstilbestrol), a hormone that was banned from human use in the 1960s, remained in use on animals until 1979.

Other drugs used with animals are Ralgro, an estrogenlike compound; Synovex, a naturally occurring hormone that affects weight gain; and Lutalyse, a prostaglandin, which is often given to an entire herd so that they will ovulate at the same time. This drug can affect the menstrual cycles of women and cause pregnant women to miscarry. In addition, cattle are sprayed with pesticides such as Vapona, which is in the same family as nerve gas.

Unfortunately, meat is not the only animal product filled with chemicals. Chemicals fed to or sprayed on milk cows are passed into their milk. Although federal law prohibits the use of hormones, in particular, in poultry or hogs, chickens receive other drugs that show up in their eggs or meat.[29] Chickens are given additional drugs to promote the hardness of eggshells and uniformity of yolks.

The Choice Is Yours

There is no question that we require protein. But the source of that protein is a matter of personal choice and responsibility. Red meat and other animal foods have received top billing in the American diet, but many people are beginning to assess the alternatives as they become more aware of the disadvantages associated with red meat and animal products in general.

Coming in Part Two: The Ecological Mandate For Vegetarian Eating.

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Notes

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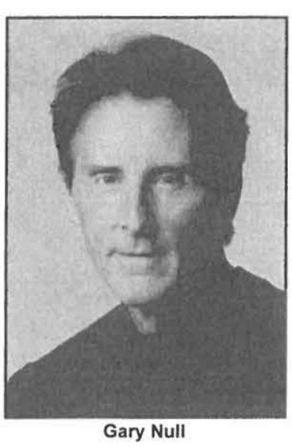

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