production — with animal products accounting for 85 percent of the total. The adverse impacts of this, he says, include soil degradation, desertification, groundwater depletion and water pollution. Hershaft adds that production of animal foods uses 95 percent of all U.S. agricultural land and is largely responsible for the extensive abuse of rangeland and forestland, for the extensive destruction of wildlife and for the loss of soil productivity through erosion and mineral depletion.

Energy consumption should also be included in dietary debates, says David Pimentel of Cornell University in Ithaca, N.Y. The average person in the United States, he says, consumes approximately 600 pounds of meat, eggs and dairy products per year. This provides 70 grams of animal protein per person per day in addition to the 32 grams of plant protein consumed. If consumption of animal proteins were cut in half, he says, total protein intake would be 67 grams — still well in excess of the 56 grams suggested for the 70 kg man by the 1980 RDA (recommended daily allowance). A 50 percent reduction in consumption of meat and other animal products, he says, could save half the energy, mineral resources and land and one-third the water used in animal production. "If Americans switched to the healthier diet," Pimentel concludes, "up to 30 gallons of oil per person would be saved each year, or one percent of the entire energy consumption of the nation."

Pimentel offers two specific energy-saving suggestions: Raise chickens instead of beef and grass feed livestock (dairy, beef and sheep). Only one-half the energy required to produce beef protein is required to produce broiler protein, he says, so a shift to chicken could greatly reduce the energy input. Grass feeding of livestock, he says, could save 135 million tons of grain per year (ten times as much grain as the U.S. human population consumes) and save up to 60 percent of the energy used. He further notes that the grain, valued at $20 billion, would be available for export.

And the economic argument goes on. Because the growing, processing and distribution of food represents the largest sector of the U.S. economy, any changes in national dietary patterns are certain to produce important shifts in the economy, particularly in the areas of employment, consumer prices and international trade, explains J. B. Penn of the USDA. A dietary shift from animal products to fruits, vegetables and grains, for example, would involve some relocation and retraining of agricultural workers. The associated reduction in the cost of food would shift personal spending into other sectors of the economy. Meats, for instance, cost five to six times as much as foods containing an equivalent amount of vegetable protein, and consumption of animal foods adds approximately $4,000 to the average household's annual budget — including the cost of increased medical care. The lower demand for foreign oil, minerals and farm machinery and the greater availability of grains and legumes for export would reduce the U.S. trade deficit and political dependence on foreign suppliers and strengthen the value of the dollar abroad.

Despite the numerous arguments put forward, we are not likely to witness an immediate, massive shift from Big Mac's to Vegiburgers. But considering the numbers —including these: 90 percent of our grains and legumes and 50 percent of our fish catch is fed to livestock while 800 million people are going hungry—the session did offer food for thought. □

Bacterical blubber: Fueling the future?

Canadian researchers have struck oil in purple blossoms on a Saskatchewan salt lake. These purple flowers, Morris Wayman and colleagues of the University of Toronto have discovered, house a bacterial partnership that can convert carbon dioxide to chains of hydrocarbons —the components of crude oil.

The bacterial oil is the end-product of an extended version of photosynthesis. That process consists of a light-driven splitting of water and a second step that uses the energy gained from splitting water to convert carbon dioxide to energy in the form of organic compounds, such as the simple sugar glucose. But the bacteria pair takes photosynthesis one step further. After one bacterium converts carbon dioxide to the energy-rich organic compounds, the other bacterium feeds on those compounds and accumulates "very high concentrations of oily material."

While Wayman and colleagues first investigated such a process in the purple-flower bacteria—*Chromatium warmingii* and a *Desulforistella* — they since have discovered more efficient algae-bacteria combinations. A hectare of these growing microbes "could produce the equivalent of 50,000 barrels of crude oil a year," providing "an alternative fuel source with greater potential than the currently popular gasohol," Wayman reported at the AAAS meeting.

Wayman explains that while both potential fuel alternatives — crop-based ethanol, or gasohol, and microbial oil — use sunshine, surface area and carbon dioxide, the microbial energy conversion may be more efficient since some of the bacteria can utilize weak light. Moreover, whereas gasohol crops must be grown on arable land, oil-bearing microbes can use land and sea surfaces. "Finally, there is no conflict with food production in microbial oil production," Wayman says, "while there is always a concern about the impact of the gasohol program on food prices (SN: 1/10/81, p. 21)." □

Antibodies tie up malaria parasite

Pure and mixed antibodies are being found effective in fighting malaria-causing protozoa. The trick is to focus the immune system defenses on parasites in a specific stage of their complicated lives, say scientists from New York University School of Medicine. Ruth S. Nussenzweig reports that protozoa inactivated in the infective stage of their life can provoke an immune response that will protect mice, monkeys and humans from infection. Pure antibody to a specific surface component that appears only during the parasite's infective stage also can protect mice, Victor Nussenzweig says.

Mature sporozoites, the form of the malaria parasite *Plasmodium berghei* that is transferred from mosquito to mouse, can be inactivated by X-irradiation. An injection of the inactivated sporozoites then protects mice against active sporozoites, but the vaccinated mice remain susceptible to infection with merozoites, the form of the protozoan that infects red blood cells, Ruth Nussenzweig explains. Mice also become immune to the parasite after repeated bites by X-irradiated infected mosquitoes. Immunity to other species of malaria-causing parasites has been conferred by injecting Rhesus monkeys with inactivated protozoa and by exposing human volunteers to the bites of infected, irradiated mosquitoes.

The sporozoites of the mouse-infecting protozoan, *P. berghei*, were used to raise pure (monoclonal) antibodies to a surface component. This protein, called Pb-44, is uniformly distributed on the infective parasite but is not present on most immature sporozoites and disappears soon after the sporozoites penetrate liver cells of the mouse. Victor Nussenzweig suggests that Pb-44 is involved with a sporozoite-specific function, such as penetration of host cells. When injected into mice the antibody, like the X-irradiated sporozoites, protects against the infective protozoa, but it does not protect against the blood form of the parasite. In separate research at the Wellcome Research Laboratories in Kent, England, other monoclonal antibodies have been developed specifically against the merozoite.

Ongoing work is identifying antibodies effective against sporozoites of other malaria-causing species, and Nussenzweig reports that monclonal antibodies against a monkey-infecting form, *P. knowlesi*, recently were shown to inactivate the parasites in laboratory culture. These results, reported at the AAAS meeting, raise the hope of malaria control through vaccination where control with drugs and mosquito eradication have failed. "Despite major expenditures for its control, malaria is still a major public health problem," Nussenzweig says. □