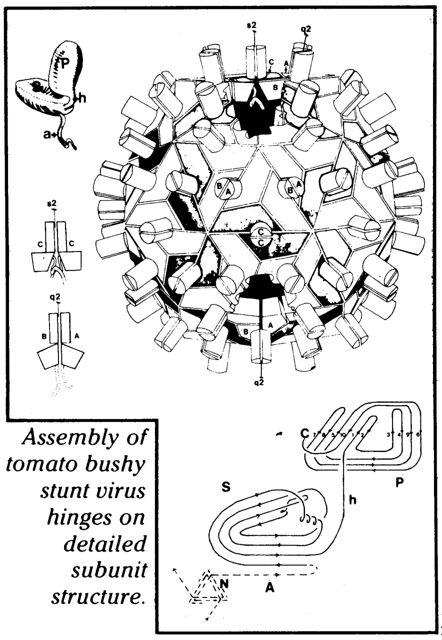
Viral arms and hinges at 2.9 angstroms

Take 60 pieces of each of three similar subunits and juggle them into a compact icosahedral shell with 90 protrusions. The resulting tomato bushy stunt virus (TBSV) is one of nature's microscopic three-dimensional puzzles, and it is a puzzle that can assemble itself. Researchers have taken closer and closer looks at TBSV and other simple viruses to learn the minute details of their intricate structures and to get clues to how the viruses self-assemble.

Earlier work, at 5.5-angstrom resolution, showed that each subunit of TBSV is a protein folded into two rigid, globular regions with a flexible hinge connecting them. The most recent work, which extends resolution to 2.9 angstroms, reveals several remarkable features, say Steve C. Harrison and colleagues at Harvard University and G. Bricogne of Cambridge, England.

One remarkable finding is that an "arm" of the polypeptide chain that makes up each subunit extends into the cavity of the virus. For two of the subunit types, the arm does not appear to be fixed in a particular position. However, for the third type of subunit (C in the diagram) arms (a) from three C subunits interdigitate, lacing together the shell. "Their configuration is rather like the overlapping flaps of a cardboard carton: chain 1, over chain 2, over chain 3, over chain 1," the researchers explain in the Nov. 23 NATURE. They point out that all sixty C-type subunits are interconnected: "That is, removal of all A and B subunits would leave a still intact, though fenestrated and cage-like, shell." They suggest that the network of linked C subunits may be the framework for self-assembly; the remaining gaps could be filled only by A and B subunits in the proper orientations.

The high resolution allowed the researchers to trace entire polypeptide chains where they are held in strict orientations. For instance, the protruding domain (P) of each subunit, a sheet made up of six strands of coiled polypeptide chain, packs against a similar sheet in the adjoining subunit. The shell domain (S) is shaped like a triangular prism with a bent four-stranded sheet forming two sides and another four-stranded sheet making up the third side. The hinge (h) between the domains is just two or three amino acid residues long. (The P domain contains 110 residues, the S domain 168 and the arm at least 33.)



Assembly of tomato bushy stunt virus hinges on detailed subunit structure.

The virus's genetic material, RNA, is tightly packed into the inner cavity. The recent data indicate that RNA does not interact in a fixed position and orientation with the subunits. While there is as yet no direct evidence, the researchers suggest the arms of the subunits as obvious candidates for protein-RNA binding.

The structure of the virus has been determined, not by direct microscopic visualization, but by X-ray crystallography. The viruses form crystals with tetrahedral symmetry that diffract a beam of light in a characteristic pattern. By applying complex mathematical formuli to almost 500,000 reflections from crystals of natural viruses and of viruses containing heavy atoms, the researchers were able to infer the spatial arrangement of components within.

Using a similar technique, A.C. Bloomer, A. Klug and co-workers at the Medical Research Council in Cambridge, England, have investigated an intermediate in the assembly of another simple virus, tobacco mosaic virus (SN: 2/12/77, p. 103). They describe their findings at high (2.8-angstrom) resolution also in the Nov. 23 NATURE. □

Largest known prime number—$2^{21,701}-1$

Two indomitable 18-year-olds, Laura Nickel and Curt Noll, of Hayward, Calif., successfully concluded a three-year quest to identify a larger prime number. (Prime numbers are evenly divisible only by one and themselves.) The find, $2^{21,701}-1$, was confirmed independently by Bryant Tuckerman of IBM's research center in Yorktown Heights, N.Y., and by D.H. Lehmer of the University of California at Berkeley. (Tuckerman had found the previously largest known prime, $2^{19,937}-1$, in 1971.) Finding the 6,533-digit number required almost fanatical zeal and 440 hours of computer time, according to the Nov. 27 Computerworld. □

Federal disaster unit: Recombinant FEMA

The confusion is understandable. First there's the Defense Civil Preparedness Agency (part of the Defense Department), concerned with nuclear attack. Then there's the Federal Disaster Assistance Administration (in Housing and Urban Development), which handles natural disaster relief operations. The Federal Preparedness Agency (in the General Services Administration) coordinates civil planning for a variety of national emergencies, the Federal Insurance Administration (in HUD) deals with floods and the like, and the National Fire Prevention and Control Administration (in Commerce) runs the federal end of programs to counter major conflagrations. "On a state and local level," says one involved observer, "officials know where to go. But if they have to find federal help, it sometimes gets complicated."

Early next year, under President Jimmy Carter's "Reorganization Plan 3," all of the above—DCPA, FDAA, FPA, FIA and NFPCA—will reemerge as a single entity called FEMA, the Federal Emergency Management Agency. Furthermore, FEMA will take on matters of earthquake hazard-reduction programs, dam safety and the Federal Emergency Broadcast System (all from the Executive Office of the President), administration of community weather-emergency programs (from Commerce), and even federal response to "consequences of terrorist incidents." The White House has estimated that the reorganization, besides making it easier to find (and send) help, will lead to savings of as much as $15 million annually.

A particular concern in disaster response, particularly for a calamity large enough to warrant federal action, is communications. The locale may be remote, the disaster may have wiped out conventional systems, or weather or terrain may have made some methods simply unusable. To meet the need, the Defense Civil Preparedness Agency (soon to be part of FEMA) is planning a system that would use space leased on a communications satellite to handle messages from small ground stations that could be readily trucked or hand-carried to the scene of an emergency.

Run from a control center near Washington, the proposed system would include a fixed ground terminal with multiple voice, data and television capability for each state capital, Puerto Rico, the Virgin Islands and 10 federal regional offices. Each area would also be equipped with a lightweight, single-channel unit that could be carried by an individual, and larger, truck-or-airborne units matching the fixed stations' capabilities would go to each area except for the regional offices.

The system is expected to go into opera-