inhibition with group III phages at 1000 times the routine test dilution, 111 (97 percent) could be typed with UC-18 at routine test dilution. The sources of the isolates varied; 76 were from the hospital environment, 35 were from infections in patients.

During the past 5 months this phage pattern has figured prominently among our isolates capable of being typed. A total of 249 isolates have been lysed by UC-18. Of the 249 cultures, 203 (82 percent) were lysed by UC-18 alone; 46 (18 percent) were lysed by UC-18 in combination with other phages at routine test dilution. Ninety-seven were from the environment, 113 were from patients and personnel in our own hospital, while 39 were from patients from four other hospitals—three in the Boston area and one in Worcester, Mass. Thus, if only routine test dilutions had been used, 203 isolates would not have been identified with the standard set of typing phages.

Of the cultures from patients, one-third of the isolates came from wounds and another third from nose and throat cultures; the remainder came from miscellaneous sources, urine, blood, stool, sputum, and burns. The wounds were predominantly postoperative infections that occurred on surgical services. There has been a series of infections following orthopedic procedures, open heart surgery, and renal transplantation. The body surfaces of six recently burned patients were colonized by this strain.

We were able to make daily bacteriological studies of a patient with 60 percent of her body surface afflicted with second and third degree burns. On admission, her nasal cultures showed only *S. epidermidis*, and her skin surfaces yielded only *S. epidermidis* and *Bacillus cereus*. One week after admission, a culture of the bottom bed sheet and pillow case yielded one colony each of *Staphylococcus aureus* UC-18. On the following day *S. aureus* UC-18 was recovered from her left nostril and, on subsequent days, from the right nostril also; it was recovered from her burned surfaces on her 11th hospital day, and daily thereafter. From her 7th hospital day, environmental cultures consistently yielded *S. aureus* UC-18 on her bedding, on settling plates, and in volume-air samples taken by the Wells air centrifuge. No other strain of *S. aureus* was ever recovered from her body surfaces or her environment. A biopsy, the full thickness of the skin, was taken on the 11th day after the burn to determine the extent of penetration by staphylococci and other organisms. Gram-negative rods and *S. aureus* UC-18 were present, even in the deep layer of the dermis. The three organisms consistently recovered until the death of the patient were *Pseudomonas aeruginosa, Klebsiella aerobacter*, and *S. aureus* UC-18.

At present approximately 10 percent of the staphylococci isolated in our laboratory are of the UC-18 phage pattern; they are resistant to penicillin, tetracycline, and streptomycin.

On the other hand, no UC-18 strains were encountered in isolates from 150 high school students who had no association with hospitals.

All cultures of *S. aureus* UC-18 recently isolated have come from patients, carriers, or other hospital environments. It appears to be a strain indigenous to hospitals and capable of producing infection in burns and surgical wounds.

The addition of UC-18 phage to the standard international set of typing phages is therefore recommended to reduce significantly the number of untypable staphylococci recovered from hospital sources (*2*).

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2. R. D. Comtois of the National Staphylococcus Phage Typing Reference Center of Canada has just written that UC-18 strains of *S. aureus* are currently causing sepsis in Canadian hospitals.
3. Aided by U.S. Army contract DA-49-193-MD-2455.

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A Cell System in Which Rate and Amount of Protein Synthesis Are Separately Controlled

Abstract. *The mean cross-sectional area of Haversian systems in adult human ribs tends to be constant in the face of sevenfold changes in the rates at which these systems are made. This implies that different mechanisms control the total amount of cellular work in making Haversian systems and the rate at which this work is performed.*

Haversian systems are units (or a form) of bone which are synthesized by specialized cells called osteoblasts. These systems contain both an organic part which is largely collagen and an inorganic mineral portion. The cross sections of Haversian systems are a good measure of the amount of collagen present in them. This is true because these systems have a cylindrical shape and because the amount of collagen in a unit volume of bone (*1*) tends to be constant, namely, 0.11 mg of collagen nitrogen per cubic millimeter of hydrated matrix (*2*). Other things being equal, changes in areas of cross sections of cylindrical structures are representative of changes in volumes. Therefore changes in the amount of collagen (which is a crystalline protein) in Haversian systems can be estimated by measuring changes in cross sections of these systems.

When the antibiotic tetracycline, which is fluorescent, is administered to patients, it is deposited at the place of new bone formation. The rate at which Haversian systems are formed can be found by measuring the thickness of such tetracycline tissue markers—which appear like growth rings in trees—deposited in the skeleton during known periods of time, as well as by measuring the distance between two markers deposited within several weeks of each other (*3*). Since Haversian systems are formed centripetally by the addition of new matrix on the walls of previously prepared tubular holes, the tetracycline markers resemble growth rings when seen in cross section by fluorescence microscopy. The thickness of the rings is a function of the number of days during which the marker is given, as well as of the rate at which layers of new matrix are added.

Measurements were made on 191 cross sections, made by hand grinding on silicon carbide paper under running water, cut from the middle third of the 5th, 6th, or 7th rib taken from 85 subjects (*4*). Of these, 60 subjects (120 sections) were metabolically normal, having died suddenly for various reasons (*5*). The other 25 subjects (71 sections) had diabetes mellitus which was considered to be under good control with insulin or tolbutamide. Of

Table 1. The mean cross-section areas of osteons in ribs is shown for nondiabetic and diabetic persons.

Age (yr.)	Cases (No.)	Sections (No.)	Cross-section area (mm^2)
	Nondiabetic (6500)		
0–9	10	20	0.035 ± 0.004 *
10–19	10	20	.040 ± .005 *
20–29	10	20	.045 ± .007 *
30–39	10	20	.041 ± .007 *
40–49	10	20	.037 ± .005 *
50–59	10	20	.033 ± .008 *
Mean †			.038 ± .007 * (9×10^{-5}) ‡
	Diabetic (2200)		
20–29	2	4	0.037
30–39	2	4	.035
40–49	3	6	.039
50–59	7	14	.036
Mean †	14	28	.037 ± .006 * (2×10^{-4}) ‡

* One standard deviation. The areas exclude the area of the Haversian canals. † Of 60 cases, 120 sections. ‡ Standard error of the mean.

the diabetics, 11 had been marked in vivo on one or more occasions with a tetracycline antibiotic in such a way that the thickness of the layer of new bone matrix added daily at actively forming Haversian systems could be measured.

The mean cross sectional areas of 6500 Haversian systems in the 60 nondiabetic subjects and of 2200 systems in 14 diabetic subjects were measured. These areas excluded the areas of the Haversian canals. The measurements were made with a Zeiss integrating eyepiece I, by a method described by Chalkley and by Hennig (*6*). The accuracy of each Haversian system measurement was ± 0.0015 mm^2 at one standard deviation, and precision was ± 5 percent. With a calibrated Zeiss eyepiece micrometer, the thickness of fluorescing tetracycline markers was measured in 43 sections from 11 labeled diabetic subjects by blue-light fluorescence microscopy. Each marker in 234 separate, labeled Haversian systems was measured at each of four equidistant points around its circumference and the mean of the four was recorded. The accuracy of each measurement was ± 0.5 micron at one standard deviation, and precision was ± 11 percent. Both measuring procedures have been described in detail (*6, 7*), as have been comparable values for the daily increment in new matrix added in actively forming Haversian systems in nondiabetic children and adults (*8*). The case material and data are listed in Tables 1 and 2.

Table 2. The mean thickness of new bone matrix added to the inner wall of tetracycline-labeled Haversian systems. The average time between deposition of the markers in the skeleton and the event which led to skeletal sampling (column 3) is noteworthy in that the markers were deposited long before the incidents which allowed the skeleton to be sampled, and so were unaffected by them. The difference between the means of the adult diabetics and nondiabetics, and adult diabetics and nondiabetic children, was highly significant ($p < .001$).

Mean age (yr)	Osteons measured (No.)	Av. time between labeling and sampling (mo)	M_f* (μ/day)
	6 Children, nondiabetic†		
7	298	11	1.53 ± .7‡
	13 Adults, nondiabetic†		
43	301	31	0.93 ± .4‡
	11 Adults, diabetic		
57	234	27	0.21 ± .07‡

* M_f is the depth of layer of new organic matrix added to underlying bone in microns per day. † From reference *8*. ‡ One standard deviation.

The measurements reveal the following. (i) Over the 60-year span of life that we studied, the mean area of the cross sections of Haversian systems remains within 20 percent of the mean value of 0.038 mm^2. The differences between diabetic and nondiabetic subjects are not significant and average less than 15 percent of their means. (ii) The thickness of the layer of new organic matrix added to an actively forming Haversian system ranges from 1.53 microns per day in nondiabetic 7-year-old children to 0.21 microns per day in 57-year-old diabetic adults. Since the sizes of the osteons in these two groups are comparable, these facts mean that there are inversely proportional changes in the time taken to make the average Haversian system, that is, it takes about seven times longer for the adult diabetic to make an equivalent amount of Haversian bone than it takes the nondiabetic child.

It can be concluded from this study that the agencies which somehow control the rate at which Haversian systems are formed, and those which control the amount of bone in them when they are finished, are different. This situation might exist in other modes of bone remodeling and in some soft tissues.

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References and Notes

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Ecological Design of Irrigation Canals for Snail Control

Abstract. *The snail hosts of schistosomiasis have found ideal conditions for rapid colonization in many irrigation and drainage canal systems. By studying the hydrodynamic aspects of snail dislodgment it may be possible to devise a control method based on engineering the snail's microenvironment. For* Australorbis glabratus, *a velocity exceeding 33 cm/sec at shell height produces a hydrodynamic drag force sufficient to dislodge the snail from its position on the solid boundary of a canal.*

The agricultural benefits provided by the vast irrigation and drainage systems constructed in tropical countries are often offset by a concomitant public health problem which is assuming serious proportions in many countries (*1*). Schistosomiasis, a debilitating parasitic disease, is transmitted by certain strains of fresh-water snails. In arid and semi-arid regions, where the disease is often endemic, the snail populations are usually held in check by periodic drought. Construction of canals and provision of a continual supply of water can lead to an explosive rise in snail population and a marked increase in the distribution and intensity of schistosomiasis. The design of canals without regard to this factor can lead to conditions like those shown in Fig. 1. If such canals are poorly maintained the snail populations thrive.

Previous studies with *Australorbis glabratus*, the intermediate host of