units. If the ribosomes are held together by the hemoglobin messenger-RNA strand, then it is possible that the ribosomes attach to the messenger at one end, gradually make their way along the messenger RNA as the polypeptide chain grows longer and finally detach at the opposite end. This attachment and detachment of ribosomal units may not be synchronous (*1*) and, therefore, it would produce a natural distribution in vivo which contained predominantly pentamers and also a smaller number of tetramers and hexamers. Thus, such a mechanism may account for the actual distribution of polysomes which is observed in the preparation. Furthermore, the spacing between the ribosomal units appears to be the same in the fresh lysate as in the negatively stained preparations. This distance seems to be fairly constant with an interribosomal gap of approximately 100 Å. However, in some cases the gap may be as much as 150 Å. Futhermore, the separation between adjacent ribosomes in an individual array is not always uniform. This divergence in the separation between ribosomes suggests that the postulated movement along the messenger strand is not completely synchronous but may be statistical in nature (*7*).

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Skin Resistance Recording in the Unrestrained Rat

Abstract. The level of basal skin resistance is proposed as a measure of motivation. It is relatively simple to obtain and can be measured concurrently with behavior of interest to the experimenter. The technique described requires a grid floor, but the assessment procedure does not affect the organism's state because of the subthreshold measuring current that is used. This method in no way restrains the rat and can therefore be used in an unlimited number of experimental situations.

Skin resistance in the form of specific responses (galvanic skin response), nonspecific fluctuations, and basal resistance level (BRL) has been used as an index of aspects of human motivation for many years. Levy and his coworkers (*1*) have added to these a continuous BRL measure obtained by using a very slow write-out and relatively less-sensitive recording, thus emphasizing the slow, less-transient shifts in skin resistance, as contrasted to traditional techniques of measuring galvanic skin response (GSR).

Lykken and Rose (*2*) have described a device for measuring GSR in rats, but have not presented any data obtained with the apparatus. Their method seriously restrains the rat: the tail must be taped down and each foot is inserted through a slot which connects it to the electrode jelly. Because of the postural restrictions and the stress caused by severely restraining the rat, the number of experimental situations in which their "rat-holder" can be used is limited. It is likely that their assessment procedure affects the skin-resistance values that are obtained.

Our report describes a technique for measuring skin resistance (BRL and GSR) in the unrestrained rat. The animal is placed on a grid floor, and a subthreshold (10 μamp) current is passed through this grid. Fluctuations in the rat's resistance appear as voltage changes which are amplified and recorded.

A servorecorder with suitable modifications is used to provide the constant measuring current, to amplify, and to record the animal's resistance. The instrument has a rectilinear write-out on a wide band (5 inches). This permits accurate and easy reading at both extremes of the scale as well as simultaneous recording of the absolute resistance (BRL) and momentary changes (GSR). Depending on the chart speed, the GSR component can be seen more or less readily. At a speed of 4 in./min, for example, resistance changes in response to a specific stimulus can be seen very clearly. At a speed of 6 in./hr, however, a record is obtained which indicates the general alertness pattern, somewhat comparable to the tracings presented by Levy *et al.* Since zero resistance is indicated at the bottom of the record, all resistance levels may be read directly and comparisons between animals are readily obtainable.

Readings obtained with hooded rats (90 to 365 days old) range between 50 kohm and 2 Mohm, depending on the situation. Because the rat makes and breaks contact with the grid as it moves, the resistance level of the rat may momentarily approach near infinite resistance. This has required the addition of a current limiter into the circuit which establishes a scale that is linear over three-fourths of its span and compresses the remaining possible readings into the top fourth of the scale. By using a suitable calibration procedure, resistance values can also be obtained over the nonlinear portion of the scale.

It might seem that the noise produced by the animal's movement would completely overwhelm the signal (possibly this assumption accounts for the

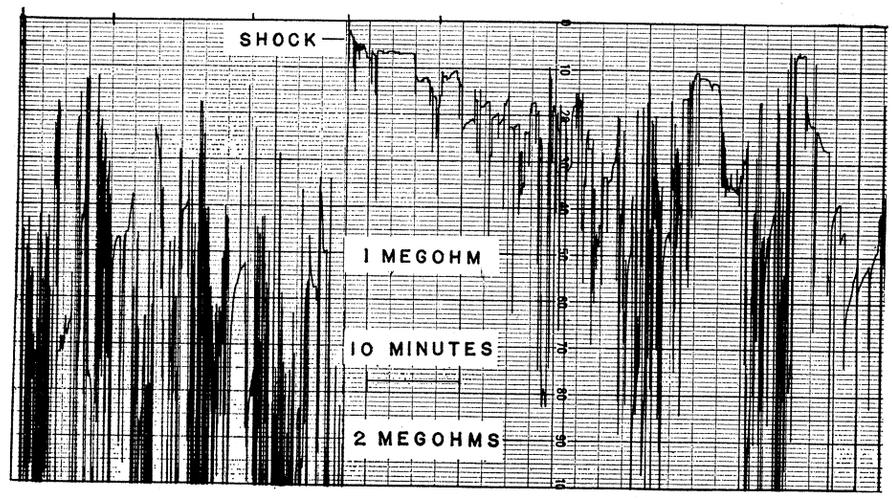

Fig. 1. A recording of basal skin resistance in the rat before and after a 5-second shock.

fact that the technique has not been used in the past). This is not the case, however. The measure is responsive to a variety of changes in the motivational states of the organism. Changes in alertness as a function of adaptation, sleep, and stressful stimulation markedly alter the resistance level. Changes in the stimulus configuration (opening the cage door, for example), as well as the effect of a specific reward are also readily seen on the BRL record. Figure 1 shows the drastic change in BRL in response to a shock of 5-second duration (at 5 ma, constant current, d-c square wave, 120 pulses per second). The post-shock resistance level, 60 kohm, represents a drop of about 90 percent.

The effect of the rat's movement is a surmountable problem. In some situations, such as straight alley mazes, the grid can be replaced by two parallel stainless-steel plates with a narrow gap, thus reducing the number of times contact with the electrodes is disturbed. Generally, in mazes where the animal's movement is restricted to a single direction, as opposed to a cage or open field, this effect is also much diminished.

The technique has several advantages. It is relatively simple to obtain; it can be used in any situation in which a grid floor can be placed in the maze or cage; it can be obtained concurrently with other measures. Furthermore, the procedure, because the rat is not restrained and does not have electrodes attached, does not alter the organism's level of motivation. Preliminary findings suggest that in the rat—as in humans—skin resistance may be considered an index of the arousal or alertness dimension (*3*).

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Mechanism for Plant Cellular Morphogenesis

Abstract. The control of the cylindrical cell form in plants appears to reside in the orientation of the reinforcing cellulose microfibrils in the side walls. In elongating cells the fibrils are typically transverse. Control of new synthesis of oriented wall texture is shown to be in turn related to the orientation of cytoplasmic elements in the cell periphery. Three properties of these cytoplasmic elements have been deduced from polarization optical properties of treated and normal cell walls. These deduced properties—namely, possession of a long axis and the ability to build microfibrils perpendicular to it, a tendency to cross-bond to make a parallel array, and a sensitivity of this alignment to colchicine—are all well-known properties of mitotic spindle and phragmoplast fibers which form the cross-wall after mitosis. It is proposed that proteins of spindle fiber nature exist in cortical cytoplasm of plant cells and are active in the control of wall texture and cell form.

The growth of the plant cell may be viewed as the yielding of the cell wall to the turgor pressure of the cell vacuole. Because the pressure is the same in all directions, the direction of growth taken by the cell must reside in the anisotropic (unequal) yielding of the wall. In elongating cylindrical cells which have expansion taking place all along the cell axis the anisotropy of structure is typically of the expected sort. There is strong transverse reinforcement due to the presence of cellulose microfibrils arranged in this direction (as hoops on a barrel). This transverse texture is maintained during prolonged extension of the cell by the active cytoplasmic synthesis of cellulose in the transverse direction (*1*). The control of cell form thus appears to reside in cytoplasmic elements near the growing side wall. Polarized light studies with growing cells of *Nitella* and *Bryopsis*, described below, indicate that the cytoplasmic elements (i) have a long axis and form cellulose microfibrils at right angles to their length, (ii) have a tendency to be bonded laterally to make a parallel array, and (iii) can be disorganized by colchicine. These properties, deduced here indirectly for the cytoplasm adjacent to growing side walls of plant cells, are well established for the spindle and phragmoplast fibers involved in cross-wall synthesis.

That the cytoplasmic elements involved in side wall synthesis are long is indicated by two experiments where the orientation of synthesis can be made to vary in relation to the direction of maximum strain, or deformation, of the cell. Long cytoplasmic elements would be expected to become aligned in the direction of maximum strain. When a lateral is induced to form by the mechanical constraint of the cell with a perforated jacket, as in Fig. 1*a*, synthesis in the lateral is perpendicular to the direction of maximum strain. A similar perpendicular relation is found when a free-growing cell is treated with 0.2-percent colchicine (Fig. 1*b*). Here the cell rotates rapidly as it elongates. The lines of maximum strain are therefore oblique, reaching 30° off-axial. The synthesis at the inner surface of the wall is also oblique, being perpendicular to the twisted lines of strain (*2*). The orientation of new microfibrils is ascertained with polarized light microscopy. The microfibrils are positively birefringent.

These results suggest that long elements in the cytoplasm adjacent to the wall can become aligned into the direction of maximum strain and then cause microfibrillar synthesis at right angles to their alignment. This alignment would occur in the cortical (gelled) cytoplasm, not in the protoplasmic stream which is considerably more remote from the wall.

There is also evidence that similar strain orientation of long cytoplasmic elements plays a role in the change of form of certain cells. The marine alga *Bryopsis* is a coenocyte whose tip produces not only a main axis but also lateral axes at regular intervals (Fig. 1*e*). Both the main and lateral axes have a transverse pattern of microfibrils. The origin of the lateral axis is seen, in polarized light studies of single layers of wall, to involve the simultaneous production of a small bulge and a concentric arrangement of microfibrils (concentric high indices of refraction). This observation, made by looking for small bulges on living cells before examining their wall, supersedes my earlier report (*3*). The simultaneity of the bulging and the appearance of the concentrically arranged microfibrils again suggest that microfibrillar synthesis can be oriented perpendicular to the direction of maximum strain. The lateral presumably starts as a local softening of the wall.

In the light of this wall behavior, that is, microfibrillar synthesis at right angles to apparent strain-oriented long elements in the cytoplasm, it is significant that a right-angle relation also obtains between the long axis of cytoplasmic fibers and the microfibrils of the developing cross-wall in many