animals has not been gradually evolved under the influence of darkness, but is the result of degenerative mutations of the same kind as those described in Mrs. Sexton's paper. She describes a series of retrogressive mutations, red-eye in 1912, albino-eye in 1915, 'spotted', and one-eye and no-eye in 1920. The absence of one or both eyes occurred among the descendants of a single mating in which the three earlier mutations were combined. In the latest degenerations, the shape of the head was frequently altered; in some cases the first antennæ were absent, the shape of the brain was abnormal, and finally there was a marked degeneration in the reproductive organs, many individuals being sterile and others intersexual. No such progressive degeneration in many directions has been shown to occur in the blind Crustacea or blind animals of other classes in the cave fauna, or in *Gammarus chevreuxi* itself in the wild state.

I would suggest that Mrs. Sexton's stock of *G. chevreuxi* offers a much closer and more obvious analogy to Japanese goldfish in their monstrous abnormalities than to blind cave animals. In both the former cases, the degenerative mutations occur in animals kept in close confinement under abnormal and unhealthy conditions, and it seems reasonable to conclude that such conditions are the real cause of the so-called mutations. Vigorous and normal development depends on normal conditions. The normal genes do not live a charmed and invulnerable existence; the evidence suggests that they are altered and enfeebled by confinement, by impurities and deficiencies in the surrounding air or water and in the diet, by want of exercise, with the result that in the course of generations their power to determine normal and vigorous development is enfeebled and all kinds of deficiencies and abnormalities appear and increase until the strain dies out. As Mrs. Sexton herself says, "the farther removed from the normal an animal is, the lower its viability".

Thus it seems to me that the significant fact is, not that blindness may be produced without the influence of darkness and that therefore the blindness of cave animals has not been due to the absence of light, but that degenerative and hereditary mutations are caused by the abnormal conditions involved in keeping animals confined in small vessels inside a laboratory for a long series of generations, and that further degeneration is produced by combining such mutations by interbreeding.

J. T. CUNNINGHAM.
35 Wavendon Avenue,
London, W.4, July 2.

[1] *J. Mar. Biol. Assoc.*, May 1932.

Cytological Differences between Closely Allied Species

IN 1931 [1] I described important differences between the watery, neutral, red-staining vacuoles of the eggs of *Rana tigrina* and *Rana cyanophlyctis*. For details references may be made to the original paper, but the most important difference is in the size of the vacuoles, those of *tigrina* measuring as much as 0·02 mm. in advanced oocytes, whereas those of *cyanophlyctis* are very much smaller.

In the course of certain experiments carried out last summer on the eggs of a large number of animals with Sudan III. and Scharlach R. to determine the exact time when the lipoidal Golgi elements become fatty, it was discovered in *R. tigrina* that the fatty yolk, which had been reported by me in 1931 to be absent in the biggest egg (1·08 mm.) then studied, actually puts in its appearance when the egg measures 1·2 mm. From this stage up to 1·5 mm. (the biggest egg I have ever examined in this species) the fats stain deeply with the above dyes, but no red granules appear in younger oocytes. In *R. cyanophlyctis*, on the other hand, the Golgi elements become fatty when the oocyte measures a little more than 0·5 mm.

In 1931 I sounded a note of caution as to "how discordant results can be arrived at by two workers investigating two species of the same genus". I added that "if I had not first studied the big vacuoles of *tigrina* I might have perhaps failed to notice those of the other species. I imagine that the British and European frogs in which no vacuoles have been described are like *cyanophlyctis*."

That is exactly what has actually happened. Prof. Saguchi,[2] working on the eggs of *Rana nigromaculata*, confirms most of my conclusions, but finds that there is no vacuole and that fat appears when the egg measures 0·3 mm.

I would like to recommend the eggs of *R. tigrina* to all teachers in India running cytology courses for demonstrating the Golgi elements, the mitochondria, and the vacuolar system in fresh oocytes without the aid of any vital dye. The most favourable stage for this is when the oocyte measures about 0·45 mm. In the highly advanced oocytes there is a well-developed cortex containing the vacuoles. This can be easily separated for demonstration.

VISHWA NATH.
Department of Zoology,
Government College, Lahore, June 9.

[1] *Zeit. Zellf.*, 1931.
[2] "Zytologische Studien", 1932.

The Inheritance of Acquired Characters

PROFS. MACBRIDE and Harrison have devoted some space to refuting a number of statements which I have never made.[1] "He suggested in his discourse that Harrison's strain of sawflies had become contaminated with a strain adapted to the new willow", writes Prof. MacBride. As the discourse is printed in NATURE of June 4 and 11, it is easy to verify the fact that I made no such suggestion. Nor have I ever made any of the criticisms found in Prof. Harrison's last paragraph. I was, however, quite aware of the facts of which he accuses me of lack of knowledge. They would doubtless have been relevant had I made the statement attributed to me above.

Perhaps the somewhat imaginative manner in which Prof. MacBride has dealt with my discourse will make readers of NATURE cautious in accepting his interpretations of the work of Dürken, Metalnikoff, and others.

J. B. S. HALDANE.
Roebuck House, Cambridge.

[1] NATURE, 130, 128, July 23, 1932.

A Reinterpretation of Relativity

THE theory of relativity is an undeniable achievement in physics and is a logical development of the theory of measurement; but it does not have the significance for the universe which is usually ascribed to it. Real time is *not* fused with space, and *absolute simultaneity does have a definite and definable meaning.*

Physics as a science is concerned with measuring and dating and so getting numerical laws. All this gives knowledge about the external world. But it would be a mistake to project this measurational knowledge into Nature without interpretation. The rejection of absolute simultaneity as meaningless has encouraged most relativists to do this.

My analyses have led me to make a distinction between *chronological time* and *real time*. Chronological time is an affair of dating and measuring in terms of some standard motion. Real time is the fact of change, or eventness. I hold that absolute simultaneity has meaning for real time, while operational simultaneity, which is the kind that relativity stresses,

is bound up with light-signalling. When two bodies are moving with respect to one another, their operational simultaneities are not identical. It follows that length (space) and t (chronological time) as numerical quantities always require a reference to the frame from which the measurements are made. It is for this reason that physicists speak of space-time. They mean that length and t as quantities are not separable.

I have no criticism to pass upon this so long as measurement is not confused with what is being measured. Measurement gives knowledge about Nature. The philosopher—and I hope the physicist also—needs likewise to think clearly about the structure of Nature. It is here that the question of the real nature of time appears. Is the Astronomer Royal's time—to use Eddington's expression—as basic as supposed? I take it that physicists like Jeans, Eddington, and Millikan are aware of this problem.

It is my thesis that real time is simply the fact of change or eventness in the universe and is always local. There is no change which runs instantaneously across the universe. The unity of the universe is spatial rather than temporal, and is of the nature of substantial coexistence and continuity. Nevertheless, it is correct to speak of a cosmic time if we simply mean the *class of events* coactual with any given event. In real time, simultaneity is the fact of co-occurrence and is not a kind of cosmic temporal relation. It is in this sense only that the universe moves abreast. Past events are those which have perished and are no longer actual. Future events are those which are not yet actual. *Simultaneous events are just the class of actual events.* This is what the philosopher and the physicist must mean by absolute simultaneity. But the physicist has a job of an empirical sort which the philosopher does not have: that of dating and measuring. The job of the philosopher is essentially that of analysis of categories. For him, real time involves the order of succession and the class of actual events in the universe. He is as much opposed as the modern physicist is to Newtonian conceptions of time.

It follows that the fusion of space and time must not be taken as valid for anything but chronological knowledge about Nature. In Nature itself, only the actual exists. I am also led to believe in determinate size apart from measurement. Quantities are cases of knowledge about and are relative to a frame; but not so the intrinsic properties of things. I am also led to believe in gravitational forces and to distinguish them from the kinematic description in terms of space-time. It follows also that relational movements have meaning as well as relative motion. Relational movements are changes of neighbourhood, while relative motion is an affair of epistemic reference, which presupposes actual movement.

Finally, so far as I can see, cosmic time has no arrow of an entropic sort. It is merely the fact of dispersed change in a substantial, extended world. I expect to find that Millikan, Lewis, and Bridgman will turn out to be right in their criticism of the application of entropy to the universe.

ROY WOOD SELLARS.

Department of Philosophy,
University of Michigan,
Ann Arbor.

The Absorption Spectrum of Hexuronic Acid

As part of a systematic study[1] of Prof. Szent-Györgyi's 'hexuronic acid' we have investigated quantitatively the absorption spectra of hexuronic acid, glycuronic acid, galacturonic acid, tetramethyl γ-fructose, and other carbohydrate derivatives. In view of the fact that hexuronic acid has been identified with vitamin C,[2] we have paid special attention to the possibility of contamination by small traces of impurity. We find that the single broad band at about 263 mμ reported qualitatively by F. P. Bowden and C. P. Snow[3] is found in equal intensity with the sample of hexuronic acid supplied by Prof. Szent-Györgyi and with rigorously purified material. It appears, therefore, that this band is definitely associated with hexuronic acid. The nature of the band in methyl alcohol (*c.* 0·002 per cent) is indicated by the accompanying table:

Mol. Extinction Coefficient (ε).	Wave-length (mμ).
1000	295
2000	220, 290
3000	228, 285
4000	235, 280
5000	241, 278
6000	245, 272
7000	254, 268
7500	263

Marked deviations from Beer's law were observed, the solutions becoming relatively less transparent on dilution. For example, at 280 mμ the molecular extinction coefficient has the values 800, 2000, and 4400 for solutions of concentration 0·02, 0·005, and 0·002 per cent respectively. Dilute methyl alcoholic solutions of hexuronic acid are unstable and show, when kept, a gradual diminution in the intensity of the band.

In water a single broad band is displayed at 260 mμ. The value of ε is about 7000 for freshly prepared solutions (*c.* 0·002 per cent), but in this solvent a rapid diminution in the intensity takes place, ε falling to 4000 within three hours.

The absorption of hexuronic acid resembles that of many ketonic substances, but differs completely from that shown by aldose or ketose sugars of the pyranose type,[4] which show no absorption bands. We have now proved that a typical keto-furanose sugar (tetramethyl γ-fructose) shows no selective absorption. Similar results were obtained with glycuronic acid and with galacturonic acid. All these substances are highly transparent in water and display weak continuous absorption, with ε in each case less than 5 at 260 mμ.

The tentative formula for 'hexuronic acid' previously suggested[5] envisages a possible keto-furanose sugar structure with the carboxyl group in position 6. In view of the above results, it seems improbable that such a structure would account for the absorption band observed with hexuronic acid, and some rearrangement of the formula may therefore be necessary. Experiments to decide this are now well advanced.

R. W. HERBERT.
E. L. HIRST.

Chemistry Department,
University of Birmingham,
July 1.

[1] E. L. Hirst and R. J. W. Reynolds, NATURE, April 16, 1932, p. 576.
[2] J. L. Svirbely and A. Szent-Györgyi, *ibid.*, p. 576.
[3] NATURE, May 14, p. 720.
[4] L. Kwiecinski and L. Marchlewski, *Bull. Acad. Polonaise*, 1927, 379.
[5] NATURE, April 16, p. 576.

Crystalline Structure of Hexuronic Acid

FROM a purified specimen of 'hexuronic acid' (identified by Szent-Gyorgyi with vitamin C) available in this laboratory I have been able to obtain sufficiently good crystals to carry out an X-ray examination by the single-crystal rotation method. The substance is monoclinic sphenoidal, with $a = 17{\cdot}71$, $b = 6{\cdot}32$, $c = 6{\cdot}38$ A., and $\beta = 102\frac{1}{2}°$, while the space-group is C_2^2 ($P2_1$), since the only true halving is