

any one term in the denominator in equation (A) exclusively dominates, except conditionally the first term.  $y$  is temperature sensitive at high  $L$  and high ( $\text{CO}_2$ ) due to  $D$ ; at high  $L$  and low ( $\text{CO}_2$ ) due to  $Q_1$ ; at low  $L$  and low ( $\text{CO}_2$ ) only if  $Q_1 - Q_2$  is appreciable; and is temperature insensitive at low  $L$  and high ( $\text{CO}_2$ ).  $Q_1$  and  $D$  appear to vary from organism to organism, and differently, so that the temperature coefficient is sometimes a function of ( $\text{CO}_2$ ) (contrary to conclusion of Baly<sup>3</sup>). The dissociation constant in (I) is about  $5 \times 10^{-6}$  M.  $\text{CO}_2$  for most plants, and the heat of reaction ( $Q_1 - Q_2$ ) zero in *Chlorella pyrenoidosa*. Specific narcotics normally effect (III)-(IV), indifferent narcotics mostly (I).

Suggestive in connexion with future experimentation, comprehensive but conservative, fairly rigid but capable of flexible, consistent extension, this 'minimum' mechanism may be harmonised, for common points considered, with the well-known mechanisms of Willstätter and Stoll, Warburg and Uyesugi, James, van den Honert, Müller, and Emerson and Arnold<sup>9</sup>.

DEAN BURK.  
HANS LINEWEAVER.

Bureau of Chemistry and Soils,  
United States Department of Agriculture,  
Washington, D.C.

<sup>1</sup> Baly and Morgan, *NATURE*, **133**, 414; 1934.

<sup>2</sup> Emerson and Green, *NATURE*, **134**, 289; 1934.

<sup>3</sup> Baly, *NATURE*, **134**, 933; 1934.

<sup>4</sup> Submitted to *J. Amer. Chem. Soc.*

<sup>5</sup> Kautsky and Hirsch, *Biochem. Z.*, **274**, 422; 1934.

<sup>6</sup> Van der Pauw, *Rec. Trav. bot. néerl.*, **29**, 497; 1932.

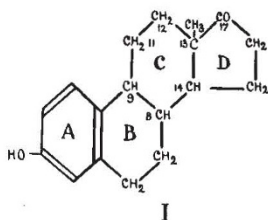
<sup>7</sup> *Science*, **73**, 268; 1931.

<sup>8</sup> Lineweaver and Burk, *J. Amer. Chem. Soc.*, **56**, 658; 1934.

<sup>9</sup> *J. Gen. Physiol.*, **15**, 391; 1932.

### Chemistry of Œstrogenic Substances

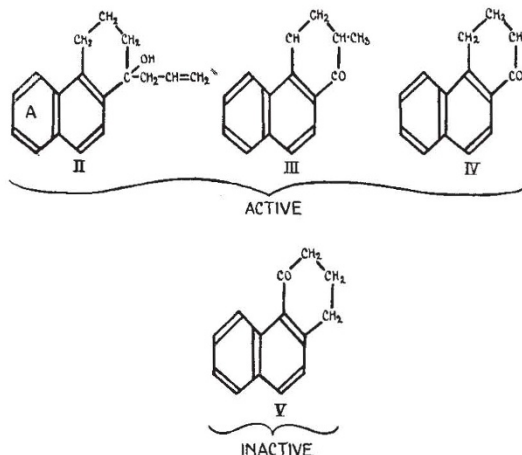
In œstrin (I) the carbonyl group in 17 is connected with the aromatic ring A through the carbon atoms 13, 12, 11, 9 and through the atoms 13, 14, 8, 9.



The four carbon atoms 13, 14, 8, 9 are the four centres of asymmetry of œstrin. At the same time, they form the junctions between rings B and C (8, 9) and C and D (13, 14). The orientation in the space of the whole œstrin molecule therefore is due to the arrangement of the four carbon atoms 13, 14, 8, 9.

It is remarkable that, in order to induce œstrogenic activity, it is not necessary to connect the carbonyl group with the aromatic ring through four carbon atoms orientated in a definite way. A connexion through two carbon atoms is sufficient to produce distinct, although weak, œstrogenic activity. This result can be deduced from the work of Blum and Bergmann<sup>1</sup> and Cook, Dodds and Hewett<sup>2</sup>. These authors investigated some hydrogenated phenanthrene compounds. In the work of Blum and Bergmann, 1-oxy-1-allyl-1.2.3.4-tetrahydrophenanthrene (II) and 1-keto-2-methyl-1.2.3.4-tetrahydrophenanthrene (III) were active. Cook, Dodds and Hewett got œstrus production with 1-keto-1.2.3.4-

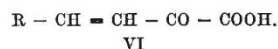
tetrahydrophenanthrene (IV), whilst 4-keto-1.2.3.4-tetrahydrophenanthrene (V) was completely inactive:



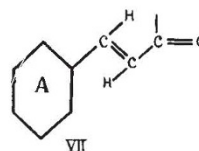
The formulæ II-V compared with œstrin demonstrate that, in order to produce œstrus, the carbonyl group (III, IV) or the corresponding alcoholic group (II) must be connected with ring A through two carbon atoms, as in II, III and IV, whilst the connexion through one carbon atom as in V is insufficient.

Rings B and C of œstrin are connected in the *trans* position, since œstrin is a flat molecule, a flat molecule being possible only if the connexion is of this type. This fact, combined with the results obtained with hydrogenated phenanthrene derivatives, suggested the question as to whether rings B and C are necessary for the synthesis of substances having œstrogenic properties, and if not, whether fatty-aromatic compounds, in which a carbonyl group is connected with an aromatic ring through two carbon atoms in the *trans* position would be œstrogenic.

Substances fulfilling these conditions are easily available. Aromatic aldehydes, combined with pyruvic acid by caustic soda, give unsaturated  $\alpha$ -ketonic acids of the general formula (VI):



Their connexion with the problem under investigation is shown by the following formulation (VII):



The sodium salts of these unsaturated  $\alpha$ -ketonic acids can easily be prepared in high purity, as I have shown recently<sup>3,4</sup>, and it was found that the aldehydes and pyruvic acid are condensed in these compounds in the *trans* position (M. Reimer<sup>5</sup>, E. Friedmann<sup>3</sup>). So far as tested, unsaturated  $\alpha$ -ketonic acids, injected into spayed mice, produce œstrus of the same order as 1-keto-1.2.3.4-tetrahydrophenanthrene.

This result can be developed further. Even the aromatic ring, corresponding to ring A of œstrin, is not necessary for the development of the œstrogenic effect, as the benzene nucleus can be replaced

by the furane ring, fural-pyruvic acid (IX) being even more active than benzal-pyruvic acid (VIII):



Recent experiments suggest the possibility of getting oestrogenetic activity in ring-free compounds by arranging the carbon atoms 13, 14, 8, 9 of oestrin in a suitable way. Work is in progress to see whether these results can be confirmed by the capon-plumage test.

The application of the views developed above for the preparation of cancer producing substances can easily be seen. Investigations in this direction have been started.

E. FRIEDMANN.

Sir William Dunn Institute of Biochemistry,  
University, Cambridge.  
Feb. 25.

<sup>1</sup> O. Blum, E. Bergmann, *Naturwiss.*, **21**, 578; 1933.

<sup>2</sup> J. W. Cook, E. C. Dodds, C. L. Hewett, *NATURE*, **131**, 56; 1933.

<sup>3</sup> E. Friedmann, *Helv. Chim. Acta*, **14**, 783; 1931.

<sup>4</sup> E. Friedmann and H. Mai, *Helv. Chim. Acta*, **14**, 1213; 1931.

<sup>5</sup> M. Reimer, *J. Amer. Chem. Soc.*, **48**, 2454; 1926.

### A Gyroscopic Top which will Walk Down Steps

IN his book on "Gyrostatics and Rotational Motion", the late Prof. Andrew Gray explained how a top can be made to move along two parallel horizontal wires when they are rocked so as to change the point of support from one wire to the other. A few years ago, I discovered that a spinning top will automatically walk down two parallel wires arranged as an inclined plane.

While working with high speed motors, it occurred to me that a rapidly spinning top would have a very slow precession and could be made to walk down two wires bent so as to form a succession of steps. The top and steps are shown in Fig. 1.

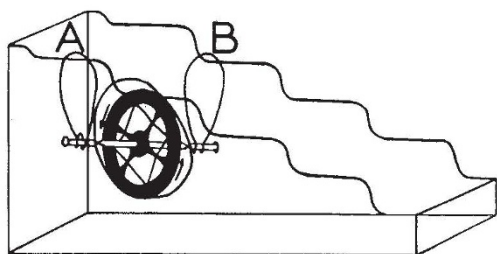


FIG. 1.

My assistant, Mr. Fullmer, who built the top, found that the length of the steps and the height of the risers must be very accurately proportioned to the type of top used. The steps should not form a sharp corner with the risers, but must be curved at each junction.

The top is spun at four to five thousand revolutions per minute and held with one hook in the middle of the highest step while the hook on the opposite side is pressed against the second highest riser (see points A and B in Fig. 1). The top, when released, will walk down the steps.

R. C. COLWELL.

Department of Physics,  
West Virginia University.

### Infra-Red Photography of Coal

IN a letter in *NATURE* of February 2 (p. 265) Prof. J. Walton has remarked that infra-red photography of thin sections of coal should give interesting results. We would like to direct attention to some results of work on this subject.

We should mention first that there are already some references to this topic in the literature of coal petrography—for example, Klingner<sup>1</sup>, Boddy<sup>2</sup>, and Wandless and Macrae<sup>3</sup>. The last-mentioned paper includes a few illustrations of infra-red photographs of coal sections made by one of the present writers.

Besides these examples, however, several hundred other photomicrographs have been taken in this laboratory, and the infra-red plate has proved more generally useful than the panchromatic. Our experience of the two types of plates enables us to make the following generalisations concerning their use in this class of work.

(1) The principal advantage of the infra-red plate will be better understood if we first consider briefly the special photographic problems presented by coal sections. These sections consist of heterogeneous mixtures of substances of the following colours: white (empty spaces), brilliant yellow (spores and cuticles), and a continuous series of shades from pale red through deep red to black (vitrain, fusain, etc.). Obviously it is extremely difficult to make realistic pictures of such objects in black and white, no matter what photographic plate is used. In order to obtain detail in any one of these colours, detail in others must necessarily be sacrificed.

Panchromatic plates, even when the developing and printing process is adjusted to give a 'soft' effect, generally give prints which suggest that the colour transition between pale red and black is less gradual than is actually the case. In infra-red photographs, however, this defect is considerably reduced; hence they generally produce much more realistic pictures.

(2) There are special cases in which the panchromatic is still to be preferred to the infra-red plate; for example, photographs of cell structure in vitrain. In such cases, there may be no yellows and whites to be depicted, the entire field consisting of reds; so, contrary to the usual rule, 'contrasty' prints may be required.

(3) Infra-red plates show another advantage over panchromatics for this work. The field appears to be flattened.

(4) Our laboratory methods for infra-red photography involve the use of the Ilford infra-red plate in conjunction with the deep red filter specified by the plate-makers, and a light source sufficiently intense to enable the image to be focused by eye. Using a weaker light and focusing by computation has not proved a success.

J. J. WALKER.

L. SLATER.

Coal Survey Laboratory,  
Portobello Street,  
Sheffield.  
March 22.

<sup>1</sup> *Montanistische Rundschau*, **26**, 1; 1934.

<sup>2</sup> Eleventh Annual Report, Safety in Mines Research Board, p. 16; 1932.

<sup>3</sup> *Fuel in Science and Practice*, **13**, 4; 1934.