But in spite of these irregularities that tend to obscure the more important facts, the heterotype division can be recognised with certainty in every malignant growth so far examined; and it is precisely similar in character to the normal heterotype that occurs in the sexually reproductive cell series. The same peculiarities in the early differentiation of the chromosomes culminating in the production of rings, loops, &c., the same reduction in the number, and the same transverse division of each one when attached to the spindle, reappears in these cells with the greatest uniformity.

This peculiar mitosis seems to be confined in tumours to those of a malignant character, for it has not been observed up to the present in any benign growth. It would thus appear to serve as a means of distinguishing between the two classes of growths.

Following upon the heterotype division, the homotype stage is reached, but it very soon becomes unrecognisable in most cases owing to the occurrence of the irregularities above mentioned.

The conclusion to be drawn from the above account is that, in a most important respect, some of the cells of a malignant growth have gone through a change similar to that which in normal tissues is confined to the production of the generations ending with the formation of the sexual cells. Such a conclusion is further supported by considerations derived from other sources.

It has already been pointed out that whereas in animals the differentiation of the sexual elements follows closely after the occurrence of the heterotype mitosis, this is not the case in most plants. Thus in a fern, the whole prothallium is composed of post-heterotype cells, and the sexual elements only arise from a relatively small number of them. Similarly in the embryosac of a flowering plant, there are certain post-heterotype cells that are not normally destined to give rise to sexual structures. But it is a matter of considerable interest to find that cells that fail in this respect not seldom exhibit marked irregularities in their modes of further division. Sometimes direct fission of the nuclei may occur with suppression of chromosome differentiation; in other cases the chromosomes may appear, but in quite irregular numbers.

The similarity of these irregularities to those already indicated as present in cancerous growths will at once be obvious from what has already been said.

The investigations of Bashford and Murray have served to confirm the statements previously made as to the occurrence of heterotype and homotype mitoses in the human subject. These investigators have identified the same divisions in malignant growths that occur in other mammals, in reptiles, and in fish. Whether, therefore, the explanation advanced to explain them, which involves the admission of an essential similarity as existing between the malignant growths and sexual reproductive tissue, be accepted or not, it is a fact that will have to be reckoned with.

It has been held by some persons that a transformation of somatic into reproductive tissues cannot occur, and it is, therefore, necessary to examine briefly the grounds on which such an opinion rests.

In plants the difficulty does not really arise, for a large number of cases are known in which cells that have long discharged somatic functions may revert to an embryonic condition, and then, after a heterotype division, produce from amongst their descendants the sexual elements that take part in fertilisation. This fact robs the objection of any *a priori* force it might have had. It is, however, true that amongst animals the conversion does not normally occur, but the existence of the diagnostic mitosis described above as appearing in the malignant growths affords cogent evidence for regarding them as representing such a changed condition, the true nature of which is, however, masked by the invariably pathological features that accompany it.

It is not urged that the cancer cells are functionally active sexual elements, but rather that they are homologous with such; it has, therefore, been proposed to express this idea by applying the term "gametoid" to them.

But whilst the existence of the heterotype mitosis emphasises the gametoid nature of the cells that have just passed through it, there are other phenomena that suggest the interpretation may possibly be carried on to another and further stage. Just as the true gametes (sexual cells) may fuse, so, too, cases of nuclear fusion are not very uncommon in the post-heterotype cells of malignant growths. It would be premature at the present juncture to attempt to do more than indicate that there may be something beyond a mere abnormality latent in these fusions. It is, however, a fact that in individual cases the fusion figures strongly recall instances of normal fertilisation. Should the suggestion turn out to be well founded, and many instances apparently support it, much that is still difficult of explanation will immediately become clear. The irregular nuclear divisions, for example, will be no more surprising than are those so frequently to be seen in the endosperm of an angiosperm, or even in the more abnormal results consequent on polyspermy. The independence of the neoplasm and its parasitic habit, to which attention has already been directed, would be still quite explicable, for in a general sense it may be stated that a new generation habitually preys on its forbears whenever continued association with them admits of it.

But the problems that especially invite attack are those concerned with the causes of the transformation of somatic, into reproductive, cells and tissues. These fall within the scope of the physiological chemistry of the cell. Something has already been done in this direction so far as plants are concerned; and, indeed, it would seem that the lower members of the vegetable kingdom offer a more convenient material for investigation than animals. They are comparatively easy subjects of experiment, and their simpler specialisation avoids the difficulties consequent on the presence of complicated subsidiary mechanisms. The ease with which Spirogyra, for example, can be directed into either the reproductive or the vegetative phase is a case in point, and it is only one out of many that could be cited.

J. B. FARMER.

SCIENCE AND MILITARY EDUCATION.

THE *Journal* of the Royal United Service Institution for January contains a full account of the important discussion on November 9, 1903, initiated by Lieut.-Colonel F. N. Maude, *late* R.E., on the subject of military education, and on January 18 there was published a revised scheme of subjects for the entrance examinations to the Royal Military Academy and the Royal Military College respectively. The discussion at the United Service Institution, which was of a decidedly discursive character, dealt to a large extent with a real or supposed deterioration of the public school boy of to-day, or at least of those public school boys who desire to obtain commissions in His Majesty's Army.

This part of the discussion was based very largely on statements made by army tutors, which, though there may be some truth in them, must be rather carefully scrutinised. First, because army tutors are human,

and have been suffering severely for some years past from the fact that the public schools now pass their boys directly into Woolwich and Sandhurst in greatly augmented numbers, and therefore send far less of them to the tutors than formerly. And, secondly, because, owing to the above mentioned circumstance, very few boys now go to the army tutors from the public schools, in normal circumstances, unless they are a good deal below the average of public school candidates; whilst formerly, when these candidates were much less carefully looked after in many schools than they are now, a great many boys of more than average ability passed from the schools into the hands of the tutors. The change in the quality of the boys who come into the classes of the latter, therefore, probably is not due to a deterioration of the work done in the schools—even if there be such a deterioration—but to an entirely different cause, viz. that which we have indicated above.

The truth of the matter, judging from what was said in the discussion and other evidence, appears to be something of this sort, that the Sandhurst and Woolwich candidates of to-day, so far as concerns those "who are at all likely to obtain a commission," are seldom "wanting in the moral qualities of an officer," are "willing to learn" and "easily interested in their work for a time," but a great many of them are "mentally incapable of concentration" for anything but short periods of time. The cause of this defect is to be sought and remedied partly in the schools, partly also in modern English home life; but we fear it will never be eradicated so long as the military profession continues to be not self-supporting. And for this reason:—The supply of able and ambitious young men who desire a soldier's career and who are in a position to follow a profession which will not, in most cases, support them is somewhat small, whilst the number of such young men required for officers is large. The result is that though the competition for commissions in the engineers is a real one, that for the other branches of the army is much less severe than is generally supposed. Hence the spur to work is much less than the interests of the army demand.

Other very important topics which came up in the discussion were the methods of teaching mathematics and the great need for more science in the education of officers. On both these points Colonel Maude is thoroughly sound. He advocates a far wider use of graphic methods in mathematics, and realises that the subject could and should be made more interesting, though apparently he is unaware of the recent great changes that have been effected in this department, for he remarks that he is told the method is in use in France, and that he learns from the *Engineer* that Prof. Perry recommends it in England.

On the second subject he says, "Primarily, we need" in our officers "the power to observe facts accurately, *i.e.* scientific teaching"; and again, in the discussion on his paper he pointed out, what we ourselves directed attention to a few days later, that under the proposals formulated for the examinations for entrance to the army in the future it would continue to be possible for candidates to get into the army "with no knowledge of science" and, it may be added, with no scientific training to enable them to sift facts and distinguish the true from the false.

A few days after Colonel Maude's paper was read a protest on the subject of the new regulations was made in NATURE, and there were many others, some made through the Press and others directed to the Advisory Committee. These various appeals appear to have induced the committee to reconsider the matter. But, alas! we find from the announcement made on January 18 that the committee has quite failed to understand the objections to its scheme, and that in its main feature, though not in all its details, the revised scheme is indistinguishable from that which preceded it.

In the first scheme, that which was published in November, 1903, the provisions were as follows:—

(1) That there should be a qualifying examination, which might take the form of a leaving certificate, for all candidates, and that this must include English, history and geography, mathematics (elementary), French or German, and either (*a*) science, or (*b*) Latin or Greek.

(2) That there should be in addition a competitive examination, and that for Woolwich this should include three compulsory subjects, viz. English, either French or German, and mathematics i., together with any two of mathematics ii., science, history, French, German, Latin, Greek; whilst for Sandhurst there were to be two compulsory subjects, English and French or German, together with any two of mathematics i., mathematics ii., science, history, French, German, Greek, Latin.

On the publication of this scheme it was quickly pointed out in our columns and elsewhere that it would go near to killing science in many, and perhaps in most, public schools, since, for reasons which need not be repeated, Latin would hold an advantage too great to be withstood in such a competition. On January 18 some alterations in the scheme were announced. These are as follows:—

(1) The subjects covered by the qualifying certificate will be divided, as shown below, into two classes.

Class i.—(1) English, (2) English history and geography, (3) mathematics (elementary). N.B.—All candidates must take up and qualify in each of the above three subjects.

Class ii.—(1) Science, (2) French or German, (3) Latin or Greek. N.B.—All candidates must take up and qualify in any two of the above three subjects (1), (2) and (3).

(2) No candidate will be allowed to take out a leaving certificate or its equivalent, or pass the qualifying literary examination, before he has attained the age of seventeen years.

(3) The languages which may be taken up as voluntary subjects at the competitive examination for admission to the Royal Military Academy or Royal Military College will be—German or French, and Latin or Greek.

No doubt at first sight this seems a considerable change in the right direction, since it appears to put science on an equal footing with French or German and with Latin or Greek. But if we look more closely into the proposal we see that one of these three subjects, viz. French or German, and one only, is compulsory for both Woolwich and Sandhurst in the competitive part, and must, therefore, be taken up at the qualifying stage also by practically every candidate. Thus the scheme in its new form is only the original scheme rewritten. The real alternative is still, as before, between science and Latin or Greek,[1] and between these two only.

It is nothing less than astounding that the body of officers and gentlemen who have now had this matter before them for several months should so little understand the certain effect of their own regulations that they could put forward this change, which is no change, after all that has been said and written on the subject.

Taken as a whole, the new proposals do, it is true, make a slight alteration. In part ii. candidates will be unable to take up two modern or two classical languages, which may tend in some slight degree to widen the school training of a few of the candidates.

[1] Really, in effect, between science and Latin.

But on the main point they wholly fail to meet the objections that have been brought forward.

In our opinion it is a great misfortune in view of the present state of affairs that the War Office has only so lately become aware of the existence of the University of London, and that consequently Sir Henry Roscoe, who has given much attention to the subject of army examinations for many years past, has only joined in the consultations of the Advisory Committee since the committee concluded the consideration of this subject. For this circumstance has prevented the committee from having the benefit of his opinion upon the doubly vital question—vital equally for the army and for English public school education in the immediate future—What is the proper position for experimental science in the education of an officer?

MINERAL OUTPUT OF INDIA.

THE progress of India as a mineral-producing country is made plain by the following diagrams, which have been compiled from a statistical abstract recently issued by the Indian Government.[1]

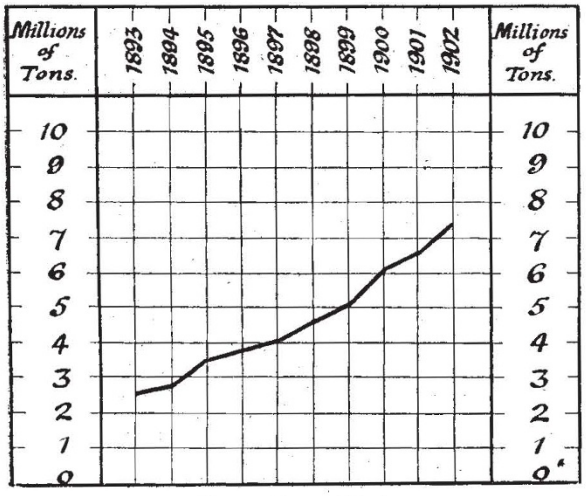

FIG. 1.—Output of Coal.

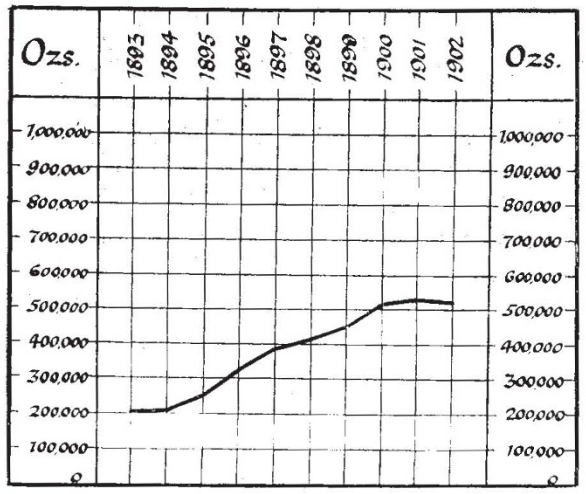

FIG. 2.—Output of Gold.

[1] "Statistics of the Mineral Production in India in the Ten Years 1893 to 1902." (Calcutta, 1903.)

The output of coal has risen from $2\frac{1}{2}$ million tons in 1893 to nearly $7\frac{1}{2}$ millions in 1902; 84 per cent. of the coal is raised in Bengal. The yield of gold, which

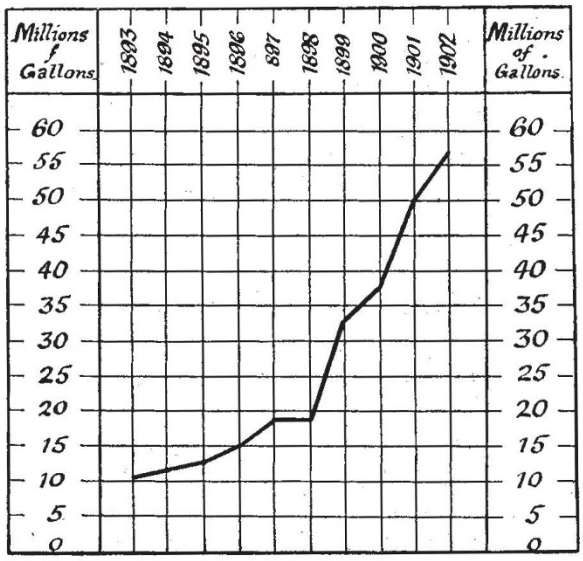

FIG. 3.—Output of Petroleum.

comes mainly from Mysore, is $2\frac{1}{2}$ times what it was ten years ago. The quantity of petroleum produced has increased more than five-fold, and the rise in the

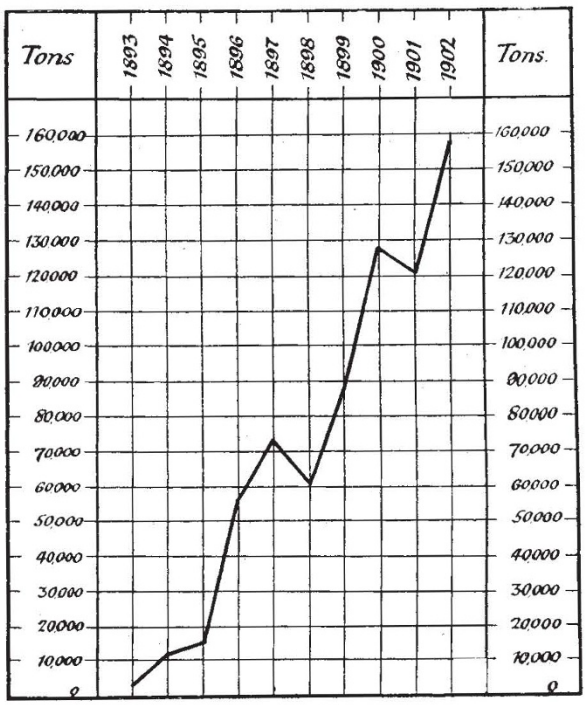

FIG. 4.—Output of Manganese Ore.

output of manganese ore is still more striking. The petroleum is supplied principally by Burma, whilst the manganese ore comes partly from the Central Provinces and partly from Madras.