epiphysis. This operation was performed on May 1st, 1884, and the parts had united and healed on Aug. 2nd. Owing to accident the radius of the same arm was fractured on two occasions after this, but when examined, about three years after the accident, the hand was sufficiently useful to allow him to carry on his employment. Dr. Hamilton,⁵ of Columbus, Ohio, records a case of a recent severe injury to the leg in which he excised about two inches of the tibia and fibula. The bones were not wired, and the patient made a good recovery with two inches' shortening of the limb. Karl Loebker⁶ excised a portion of the radius and ulna in order to bring together and suture the nerves and tendons of the forearm, in a case of contracted but healed cicatrix following a transverse wound. The case was not very successful in its results. Dr. E. Kirmisson⁷ records a case of severe burn of the forearm, resulting in cicatrization, but great contraction, so that the arm was flexed on the forearm. In order to relieve this deformity Dr. Kirmisson excised the cicatrix and three centimetres of the radius and ulna a little above the wrist-joint. Non-union of the bones after the operation resulted, and a second operation, consisting of paring the ends of the bones and suturing them, was performed. This was successful, and the patient recovered with a useful hand, but the wrist remained somewhat flexed.

3. *The partial or complete excision of a joint when the sore or contraction involves the soft parts in its neighbourhood.*—I have treated two cases upon this principle. One was a girl aged twelve, whose arm had been severely injured by the wheels of a tramway car one year before she came under my care. There was no injury to the bones, but extensive sloughing of the soft parts around the elbow and for some distance above took place, leaving a large sore. This sore had on one or two occasions nearly cicatrised, but it never healed soundly, and the elbow was fixed in a flexed position owing to the contraction of the cicatrix. On Jan. 17th, 1885, I excised the elbow-joint, removing the bones freely, so that when the portions removed were put together they measured in length three inches and a half. The case progressed favourably, and she left the hospital on March 13th, the joint being movable and the sore almost healed.

The other case was that of a boy, aged nine, who had suffered from a precisely similar accident on Aug. 3rd, 1885. When the sloughs had separated, a large sore surrounding the elbow-joint resulted, and, as it was evident some weeks afterwards that the sore would not heal properly without great contraction and flexion of the elbow-joint, I excised the joint on Sept. 30th of the same year. The boy made a good recovery, with a useful and movable joint and arm.

Mr. Neve⁸ reports the case of a girl aged ten, in which he excised the elbow-joint, including three inches of the lower end of the humerus and four inches of the upper ends of the radius and ulna, in order to relieve great contraction and an indolent sore, the result of a severe burn. This patient recovered with a useful limb. Dr. Joseph Bell⁹ records a case in which he excised, in June, 1885, three inches of the lower end of the humerus and the olecranon, in order to relieve an extensive sore surrounded by a dense cicatrix caused by sloughing of the soft textures of the arm, following an attack of phlegmonous erysipelas two years previously. The operation resulted in a sound, movable, and useful limb. Dr. Kirmisson,¹⁰ in a short and interesting paper, also records a case in which he excised the ankle-joint, with an excellent result, in order to relieve an ulceration and contraction, with deformity of the foot, caused by a severe burn of the lower part of the leg.

4. *The excision of a portion of the entire thickness of one or other of the bones of the forearm or leg in order to allow the proper approximation of the ends of its companion bone, which has suffered some loss of substance.*—In the *British Medical Journal* of Jan. 9th, 1875, I reported a case in which I (for the first time, I believe) excised on this principle a portion of the ulna in a case of ununited fracture of the radius, with loss of substance. This case was perfectly successful; and I now wish to record another case treated in the same manner but in connexion with the bones of the leg. A man aged thirty-eight was admitted into my wards on Oct. 12th, 1883, suffering from a severe compound comminuted fracture of both bones of the right leg. Some portions of the tibia were loose, and were removed.

On Dec. 30th the wound was healed, but the bones were not perfectly united. A plaster-of-Paris bandage was applied, and he left the hospital. He returned at intervals of a few weeks, and had the bandage renewed, as the union of the bones was not complete. He was again admitted on May 1st, 1884, when a careful examination of the leg was made. It was now found that the fibula was firmly united, but not the ends of the tibia, and they were separated for at least an inch. As proper union of the tibia under these circumstances and at this stage of the case was unlikely, I decided to operate. Accordingly, on May 14th, I cut down upon the seat of fracture, divided the fibrous adhesions, sawed off a slice of each end of the tibia so as to raze them, and then excised a portion of the fibula corresponding in length to the interval between the ends of the former bone. The ends of each bone were then wired, and splints applied. Two months afterwards he left the hospital, the wounds being healed, and with some osseous union of the bones. Six months after this the patient was examined, and it was found that firm osseous union had taken place, and the patient was able to bear good weight upon the limb, which was shortened a little more than an inch.

Primary operations, according to these various procedures, will rarely be advisable in cases of great injury to the soft parts, and in the large majority of instances it will be wise to delay operating until the exact extent of the loss of soft parts can be decided, and what the probable prospects of cicatrization and its results may be. I would only further remark that the experience of my cases and of the other cases recorded is encouraging, and will, I trust, assist in directing more attention to the usefulness of these procedures in suitable cases.

Edinburgh.

A CASE OF PERNICIOUS ANÆMIA.

By F. WALKER MOTT, M.D., M.R.C.P.,

MEDICAL REGISTRAR, CHARING-CROSS HOSPITAL.

J. B—, aged forty-eight, hat-maker, sought admission into Charing-cross Hospital on March 6th, 1888. As the patient walked into the room I was struck by the peculiar lemon-yellow cachectic pallor he presented. He stated that he suffered from weakness, inability to continue his work, palpitation of the heart, and swelling of the legs. While speaking he would frequently stop and sigh. The lower eyelids were œdematous; the breath sweet and offensive.

The following notes were taken subsequently, when under the charge of Dr. Green:—

March 8th.—There was nothing noteworthy in the family history. The only important point about his previous history was that he noticed he had been getting pale and suffered with palpitation for the last twelve months (probably the commencement of the disease).

General condition.—The cachectic pallor is very marked, the lower eyelids are œdematous, but there is no œdema now of the ankles. He has had no chills or rigors since admission, but he states that he had "shivers" a month ago. The temperature on admission was 99°; it is now 103°. The skin is hot and rather dry. There is no wasting of the subcutaneous fat. The pulse is small, compressible, 100, and not full between the beats. There is visible pulsation of the carotids and in the episternal notch. Heart: Marked epigastric pulsation; there is also visible pulsation in the fourth and fifth spaces; apex beat $\frac{1}{2}$ in. inside nipple line in fifth space. On auscultation a soft musical systolic murmur is heard at the apex conducted into the axilla, and a hæmic murmur at the base. Microscopical examination shows the corpuscles of the blood to be of large or average size, and of good colour; no increase of white. Estimated by the hæmacytometer, the corpuscles are 1,400,000 per cubic mm. Although the absolute amount of hæmoglobin is greatly diminished relatively to the number of corpuscles, it is normal. The tongue is moist and clean; the breath sweet and offensive; the appetite very poor; no difficulty in deglutition, and no sickness. Liver and spleen normal. The man had complained of defective sight, and ophthalmoscopic examination shows several small hæmorrhages in both eyes; the edges of the discs are a little woolly, and the veins rather full. On admission the urine was normal in quantity, of a much darker colour than natural, and sp. gr. 1018. To-day

⁵ *Annals of Surgery*, vol. v., p. 551. ⁶ *Centralblatt für Chirurgie*, 1884.

⁷ Reports of French Congress of Surgery, Sept. 3rd, 1883.

⁸ THE LANCET, Nov. 1885.

⁹ *Edin. Med. Jour.*, Sept. 1885.

¹⁰ *Loc. cit.*

it has been twice the normal quantity, of a deep amber colour, and sp. gr. 1009. There is nothing noteworthy about the respiratory system except that the respirations are full and deep, and frequently relieved by long-drawn sighs.

The patient was placed upon a very nourishing diet, which included two eggs, four ounces of brandy, and one pound of raw beef for beef-tea; three minims of liq. arsenicalis were ordered to be taken every four hours after food. He improved rapidly on this treatment, the arsenic being shortly increased to five minims. The anæmia became less marked, and the number of corpuscles increased. The urine passed daily still continued of a high colour, considering the large quantity passed. The temperature was a little above normal, but the pyrexia, which occurred shortly after admission, was not again observed. On March 14th there was a very large deposit of uric acid—more than I have ever seen in any case. The quantity was daily estimated now, and it varied from twenty-five to forty grains, the average being about thirty—that is, rather more than three times the normal. The colour of the urine was also of a very deep orange tint, and the average quantity passed was over 1000 cubic centimetres. On the 24th the red corpuscles had increased to 2,200,000 per cubic millimetre, the hæmoglobin value of the corpuscles being normal. On April 7th the red corpuscles amounted to 2,450,000, and there was marked general improvement in the condition of the patient. On the 9th he was able to get up, but had a little palpitation on attempting to walk. On the 19th diarrhœa and nausea were present, and the arsenic was discontinued. For some days previously to this the uric acid had considerably diminished in quantity.

The patient continued now to improve daily, and on May 24th the blood-corpuscles had steadily increased up to 3,300,000 per cubic millimetre. He was again put upon liq. arsenicalis, but we could never get any greater improvement of his blood. He was therefore, on June 4th, sent to the seaside, and ordered to continue the arsenic; he was obliged, however, to discontinue its use after three days, diarrhœa having recommenced. He was readmitted to the hospital on June 20th in a very bad condition, suffering from diarrhœa, loss of appetite, palpitation, and weakness; stomatitis, herpes at the angles of the mouth, and symmetrical pigmentation on the dorsal aspect of the forearms being new features in the disease. Sneezing, itching of the conjunctiva, with nausea and retching, seemed to point to the toxic effects produced by the arsenic. The diarrhœa was very difficult to check at first—opium, catechu, bismuth, &c., being ineffectual. On June 22nd the patient was a little better; the herpes was now fully developed, and there were two small vesicular swellings beneath the tongue. The throat was sore, the back of the pharynx congested, and the uvula enlarged. The percentage of corpuscles had diminished to one-third of the normal. On the 30th he was again put back upon the liq. arsenicalis for a few days, but on July 5th it was discontinued on account of profuse diarrhœa. From this time onwards the uric acid was found in large quantities in the urine. The soft, feeble, fluttering pulse, the palpitation, the heaving carotids, and the systolic murmur at the apex all pointed to dilated left ventricle from fatty change in the muscle. On July 12th the corpuscles had become reduced to 700,000 per cubic millimetre; size 7μ to 8μ . He had been spitting blood for some days. The urine was not so dark in colour, and there was no deposit of uric acid. The patient now fell into a semi-comatose condition, and on July 28th became quite unconscious, death supervening six hours afterwards.

Necropsy, made eighteen hours after death.—The fat on the abdomen was more than an inch thick, and of canary-yellow colour. There was extreme fatty degeneration of the heart, and its cavities were dilated; weight 15 oz. Weight of liver, 4 lb. 13 oz.; enlarged and fatty, and presenting a very peculiar slate colour on section, evidently the result of post-mortem changes; H_2S had been liberated, which had acted upon the free iron in the organ. The gall bladder contained about an ounce of bile. The lungs showed nothing noteworthy, except a little old pleurisy on the right side. Kidneys fatty. Spleen firm and enlarged; weight 15 oz.; paler on section than usual. The marrow of the tibia was examined, and found to contain fat; to the naked eye it appeared redder than usual. Sections of the liver, after hardening in bi-chromate of ammonia, were thoroughly washed in water and then placed in a solution of ferrocyanide of potassium; after a very short time they were stained a deep blue. The kidney and heart, treated in the same way, although left in

twelve hours, yielded no result. Microscopical examination of the liver sections showed the blue pigment formed by the action of the ferrocyanide on the free iron deposited in and between the liver cells, particularly of the portal zone of the lobule. Sections treated with sulphocyanic acid turned a blood-red colour. I regret that I did not examine at the time the fresh liver to ascertain the percentage of free iron, but an analysis made for me by Mr. Vasey showed that there was nearly twice as much iron in the ash of this hardened liver as in the ash of an equal weight of liver treated in exactly the same way from a case of paraplegia.

The subjoined is a table showing the principal facts connected with the urine for one week:—

	Quantity (in cc.).	Sp. gr.	Colour.	Quant. of nitrogen (per cent.).	Quant. of uric acid (in grms.).
March 19th	690	1018	Very dk. sherry	2.0	1.8
" 20th	1060	1022	"	2.2	3.2
" 21st	550	1024	"	2.4	1.5
" 22nd	1000	1024	"	2.4	2.75
" 23rd	870	1025	"	2.7	2.8
" 24th	700	1024	"	2.7	2.4
" 25th	945	1026	"	2.9	1.7

The urine was of a very dark colour, and there was daily during this period a large deposit of cayenne pepper crystals of uric acid. As the patient improved under the arsenic, the uric acid deposit diminished very considerably, and the urine became paler in colour. The uric acid was estimated in the manner described below,¹ and the results only pretend to be approximate; in fact, it would be impossible to estimate it accurately, for much of the urine could not be obtained, owing to the patient suffering from diarrhœa, but I think it may fairly be concluded that the uric acid was three times the normal at least. It will be noticed that the amount of waste nitrogen was high for a patient with a poor appetite.

Dr. Hunter, in a most important article on the subject published in THE LANCET, Oct. 1888, has to my mind very definitely shown that the essential features of pernicious anæmia are *excessive destruction of blood-corpuscles*, the seat of the disintegration being the portal system, more especially that portion of it contained within the liver and spleen. The process seems to commence by a liberation of the hæmoglobin in the spleen, and this is carried to the liver to be disposed of. In another case of pernicious anæmia, of which I have examined the organs for free iron, I found the portal zone of the lobules so crowded with iron that when stained with the ferrocyanide of potash and hydrochloric acid solution the sections appeared as if injected. (These were shown at the Pathological Society.) Dr. Hunter does not mention in his cases whether the urine had been excessively high-coloured, but I notice that Dr. Fagge states that this is usually the case. My opinion is that the hæmoglobin is taken to the liver, and by the action of the cells, particularly in the portal zone, decomposed, to form bilirubin or some other allied pigment, such as hydrobilirubin, the iron being left behind and accumulating as the disease progresses. Cazeneuve has stated that the urobilin is increased in all diseases where there is increased disintegration of the red corpuscles. Urobilin is identical with hydrobilirubin, and very similar to hæmatoidin. All these substances are free from iron. I think these facts, then, bear out strongly Dr. Hunter's views. In this case there was daily a large amount of urobilin lost to the body by the urine, and a large amount of iron stored up in the liver in the free state. It may be that the peculiar lemon colour of the skin and canary-yellow colour of the fat are connected with the excess of urobilin in the blood. Another point of interest was the large amount of uric acid eliminated. Was this in any way connected with the administration of arsenic? I think not; for the uric acid steadily decreased as the patient improved under its administration. The uric acid deposit and the high colour of the urine seemed to go together, so much so that it occurred to me that possibly the uric acid was the waste product of the disintegrated blood corpuscles. In leucæmia and ague we may have excess of this acid. In other forms of anæmia, as chlorosis, the uric acid is small, but in this condition we

¹ A hundred cubic centimetres of the twenty-four hours' urine were taken after vigorously shaking up the whole bulk. To this HCl was added, and the mixture set aside for twenty-four hours. Two balanced filter papers were then taken. The uric acid was collected in one filter, the other was dipped in the filtrate, and the two dried in a warm chamber. The difference in the weight of the two gave approximate results as to the amount of uric acid in 100 cc

have not a hæmolytic process. I have ventured to take up some considerable space in giving the principal clinical facts of this case, because it seemed to throw some light upon the disease, and to strongly support the conclusions arrived at by Dr. Hunter in his very valuable contribution to our knowledge of this subject.

THE PHYSIOLOGY AND PATHOLOGY OF SOME OF THE VARIATIONS IN THE HUMAN SKELETON.

BY W. ARBUTHNOT LANE, M.S.,

ASSISTANT SURGEON TO GUY'S HOSPITAL AND TO THE HOSPITAL FOR
SICK CHILDREN, GREAT ORMOND-STREET.

WE have for a long time been hampered in our progress of the study of abnormal conditions by the use of terms to which various observers give different meanings, and which others, again, use to signify conditions which do not resemble one another. The two words to which I would now take objection are *disease* and *inflammation*, both of which are used very indiscriminately. The task of drawing any definite line between what is physiological and what is pathological in the case of the skeleton, and between the changes that are inflammatory and those that are not inflammatory, seems to me to be one of the greatest difficulty. I will attempt to illustrate my point in the following statements of what I believe to be facts, each of which will be discussed under a separate heading.

1. The so-called normal anatomy of each race is dependent for its existence upon a certain fixed relationship between the normal organism and its surroundings. If that normal mechanical relationship, or, in other words, the physiology of the organism, be altered, a corresponding change is produced in its anatomy in order that it may be able to accommodate itself to its surroundings and to perform its novel functions. We understand that each portion of the skeleton, its muscular coverings and appendages, performs a definite physiological function, the character of that function varying not uncommonly at different periods of the lifetime of the individual, in correspondence with changes in its relationship to its surroundings. Take, for example, the brain of the fœtus, which can be subjected to very considerable local or general pressure without suffering any injury. We see how the structure of the skull is adapted to retain the integrity of this organ in its first most important mechanical relationship—namely, to the true pelvis of the mother—as it makes its transit into the outer world. Later, as the brain acquires a much more sensitive structure, the skull-cap is rendered just sufficiently strong and firm to shield the most sensitive organ in the body from such local and general pressure as it is exposed to under average circumstances. In the human subject, that bears to its surroundings the ordinary relationship of adult life, we obtain by these mechanical means a skull of a thickness and texture which we are accustomed to regard as normal. As the mechanical relationship which this portion of the organism bears to its surroundings differs very considerably in the several races of man and quadrupeds, we find that in each the amount of thickness and density of the vault of the normal skull varies in proportion as the necessity for such protection exists.

2. If the physiological relationship of the normal organism to its surroundings be altered in such a manner that the brain and its bony case be exposed habitually to the influence of forces other than those which affect and determined its normal structure, we see that the form, texture, and thickness of the skull is altered in order that the skull may perform satisfactorily its new functions or physiology. Such experiments are being continually performed for us owing to the necessity which exists in large communities for the subdivision of labour. If we examine the skulls of those who have been engaged for many years in carrying heavy loads upon the head or upon the back of the head and neck, and compare them with the normal or average skull of the same race, we find that the abnormal forces to which the skull has been exposed have produced changes in its several characters which vary

in type and locality with the direction and degree of the forces which have exerted their influence upon it, and also with the age and vigour of the individual.

3. I do not think that anyone would call such a skull diseased, or would assert that the abnormal characters which it presents are the result of chronic inflammation. The influence of the same heavy load that produced the alterations in the skull determines in the other portions of the skeleton through which its weight is transmitted changes whose character and causation are identical with those present in the skull, yet pathologists almost without exception insist on describing the more obvious and local changes in the former as inflammatory and not physiological. Up to a very recent date they were regarded as the product of the disease called rheumatoid arthritis. The changes to which I refer are a general increase in the density of the structure of the bones, and a more marked local increase along the lines of greatest pressure; a compression and induration, or a partial or complete removal of the soft structures intervening between adjacent bones; the formation of large bosses or margins of dense bone in the seats of greatest pressure, where they perform a definite physiological function; a frequent partial or complete ankylosis of adjacent bones, together with the occasional conversion of an amphiarthrodial joint into one of an arthrodial type, &c. It seems to me absurd to argue that, because the bones and the bosses or margins that project from them have acquired a density of structure and a power of resisting pressure which is necessary to them in order that the organism may continue to perform its abnormal functions, and which are enormously in excess of the average or normal, the condition is inflammatory and not physiological. The skeleton of such a labourer is brought into a remarkable and unusual relationship to its surroundings, which entails its habitually and constantly performing certain special functions which are somewhat similar to those performed by the normal subject, but demanding the expenditure of an enormous amount of muscular energy in the support of an immensely heavy load. Similar changes ensue in animals other than man which have to draw or carry heavy loads. Practically it is impossible to pursue any occupation entailing the habitual performance of any sequence of movements or the carrying of any weight without the several portions of the skeleton influenced by it rapidly undergoing distinct and characteristic changes.

4. Let us go one step further in our research, and suppose that the labourer continues to perform his heavy work under disadvantageous circumstances, such as diminished physical energy due to want of sufficient food, exposure, or disease, disproportionately heavy load, &c. We find that, while very extensive ankylosis ensues between certain bones, in other joints, as that of the hip, the organism may be no longer able to render the upper margin of the acetabulum sufficiently dense and strong to support the pressure transmitted to it through the upper surface of the head of the femur. In consequence of this the margin yields, and the head, while itself undergoing changes in form, is gradually displaced further and further upon the dorsum ilii. During the displacement of the head the organism makes continuous vigorous efforts to stay its ascent by the formation of bone above it and in the ligaments. Are we to regard this condition as pathological, and the manner in which the changes have been brought about as inflammatory and not physiological? I maintain that we are not. The organism has placed itself in a very abnormal relationship to its surroundings, which differs very greatly from that which determined and serves to retain unimpaired the normal form of its skeleton; in fact, it has attempted to perform a physiology for which it was structurally unfitted without its several portions undergoing such extensive changes as finally to unfit it for performing perfectly their original functions. These are the changes that are regarded as inflammatory in origin and the product of disease.

5. In the performance of many forms of heavy labour, and not unfrequently as the result of deformity, enormous strain is sustained habitually by certain muscles—as the deltoid, subscapularis, gluteus maximus, psoas, soleus, &c. The presence of this strain determines the extension of bone into the tendinous attachments of these muscles or along the direction of the traction which they exert. I allude to the development of the third trochanter on the femur, to the elongation of the lesser trochanter, to the separate formation of bone in the psoas tendon, to the increase in