TRELOAR'S SCIENCE OF MUSCULAR DEVELOPMENT

A TEXT BOOK OF
PHYSICAL
TRAINING

BY
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For the most Perfectly Developed Man in the World
At the Recent Physical Culture Exhibition
At Madison Square Garden, New York
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PUBLISHED BY
PHYSICAL CULTURE PUBLISHING CO.
Flatiron Bldg., New York City.

12 and 13 Red Lion Court, Fleet Street
London, England

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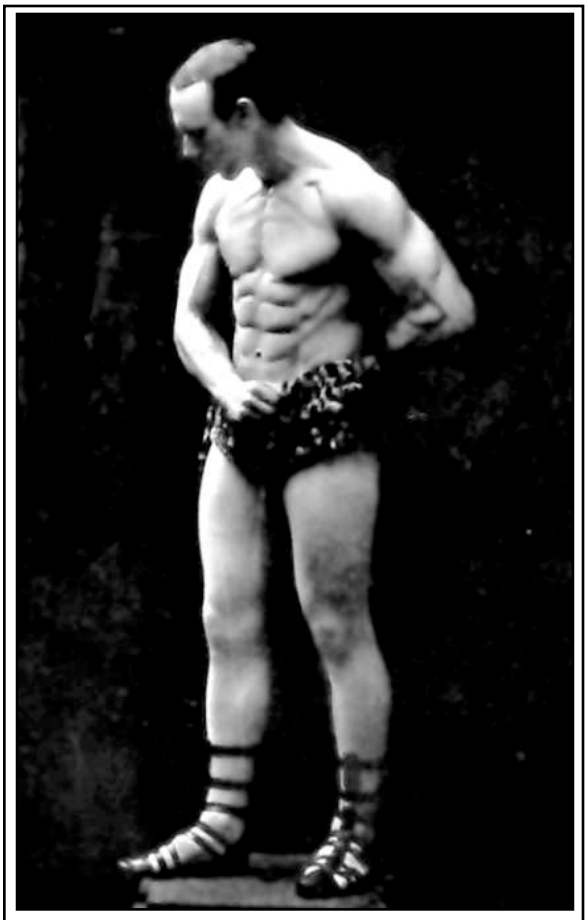
INTRODUCTION

The purposes of this book are: first, to arouse a desire for physical improvement; second, to point out what results should be desired and worked for in the development of the body; and finally, to show how these results may be obtained.

It is possible for any business or professional man to change his whole physical tone for the better through exercise, thus doubling his capacity both for work and for pleasure. Any young woman who wishes to make the most of herself physically as well as mentally, can become more perfect than the nymphs and goddesses of ancient story. The young man or boy with a partly romantic, partly practical, yet thoroughly manly desire for prowess and heroic strength can realize that desire beyond even his own imagination. All these things are actual and practical possibilities if there is no organic or functional disorder. It is the purpose of this book to show the easiest and quickest ways of securing these results.



TRELOAR.

DEVELOPMENT OF ABDOMINAL MUSCLE.

The book will also attempt to show how persons variously situated may make the most of their opportunities. In the past decade there has been enormous advance in gymnastic and developing apparatus and in gymnasium construction generally. This has been response to a great and increasing popular demand. The great college and club gymnasiums of the present day are marvels of completeness. The instructors in these gymnasiums are men of high intelligence and scientific training. So great is the demand for educated men in this line, that special normal courses in physical training have been added to the curricula of the leading universities. The standard is not so high that an instructor can scarcely hope for the best positions unless he has a medical degree besides his technical training. The day of the "short haired" type of gymnasium instructor is passed. The ex-champion fighter or wrestler, the old-time sprinter or circus performer, is no longer considered a competent instructor solely on account of his prowess, any more than a man who never had a day's sickness would be called a great physician for that reason alone.

The young man or woman who attends a gymnasium will obviously have a very decided advantage over those who do not; just as those who attend a school or college have a better chance in scholarship than those who do not go. In Physical Education, just as in the Academic

Branches, better opportunities, the association and example of others, systematic instruction, and the feeling of responsibility, tend toward more rapid advance.

It is a great mistake, however, to suppose that those who cannot attend a gymnasium are shut out from the benefits of exercise. Lincoln made himself both a scholar and an athlete in his backwoods home. Many men have achieved greatness in various branches of athletics who did their foundation work at home, without instruction and without example. Many more, both men and women, have accomplished the still more useful work of repairing their own health by persistent exercise right in their own rooms, without advantages or help of any sort.

The young woman employed in store or office, whose salary will not permit her to join the expensive "ladies' gymnasium classes," or, still less, to engage a private instructor, can yet accomplish great results in exercise. The young married man whose business of course keeps him away from home and family during most of his waking time, very naturally begrudges even two evenings a week at the gymnasium. It is possible for him, too, without the gymnasium, to make himself, by exercise, a man such as men ought to be; a man in whose strength wife and children will have confidence and pride.

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MUSCLES OF THE BACK.

It is for just such people, and many others who, for one reason or another, cannot of will not join a gymnasium, that this book is primarily intended. It will be the author's effort to make the way easy, to show how the city young man or young woman, in the little hall bedroom, may derive great benefits from certain exercises with little or no apparatus; how the country or village boy, with a yard and a barn, can contrive for himself almost a complete gymnasium; in short, to give a word of advice to all in the way that will do the most good.

SCIENCE OF MUSCULAR DEVELOPMENT

HOW TO USE THIS BOOK

To learn from the printed page is an art quite independent of the ability to read and understand the text. Some students learn most readily from books, finding it difficult to time their mental action to the spoken words of an instructor. Others are quick to understand a spoken description, and to draw quick conclusions from practical examples or demonstrations, but receive ideas only with labor and difficulty when cast and set in the form of a printed book. To get the most out of a printed book, at once to understand, to agree or disagree, and to remember its contents, is a power gained only by long practice. To acquire some degree of skill in the use of books is of great and increasing importance in every department of life. It is impossible for all to attend colleges and lectures. Not every person has a learned friend ready to discourse upon the subjects the learner wishes to know. If one waited for that knowledge which is the result of one's own experience, years would be wasted. Until further great improvements shall have been made in phonographs, telephones, moving pictures and the like, books will be, as now, practically the only means of recording and distributing knowledge.

First of all, read the index; note the arrangement and the reasons for it. The index of any well constructed book is its skeleton, and a study of it and occasional reference to it, while reading, are of the greatest assistance to the reader in systematizing and remembering the book's contents. In the case of a comparatively brief descriptive volume like this, read the whole book carefully through. In this way you will get many ideas which will help you to a better understanding of the parts you particularly want, than if you read those parts alone. Then, again referring to the index, find the practical parts that seem to apply most directly to your case, and study them in detail. Only the most experienced and skillful students can remember any considerable portion of a book without several reviews. In the review, or second reading, the index is again the guide, for it is the map of the road the author wants you to follow. Not the least important step in the careful study of a book is the final summing up of useful things you have learned from it.

Having gotten from this book as clear a general idea of the subject of Physical Training as it is able to give, and having selected a certain routine of exercises from it for your own use, commit the exercises to memory. To be obliged to stop and consult the book often while exercising, is extremely inconvenient and wasteful of time.

Even after having gone through the exercises that you select for a long time, it will be best to look at them in the book occasionally and compare your positions with the pictures. In many cases the student will find that he is missing the important part of the exercise through some apparently slight error in his way of doing it.

PRACTICAL PHYSICAL TRAINING

DIRECTIONS

The time of day for exercise depends largely on habit and convenience. For business people and students the late afternoon will probably be the most convenient. Those who work till five or six o'clock will be constrained to take their exercise in the evenings. The only rules to be observed as to time of day are in relation to meals. Exercise should not be taken less than an hour after eating. For the same reason prolonged and arduous exercise should not be taken before breakfast.

As to amount, after the habit of exercise is formed, it may be said that the results obtained will be in proportion to the amount of exercise taken. One hour twice a week will produce noticeable results. One hour four times a week will enable the student to improve very greatly in a year's time. A person with a genuine desire to develop splendid health and strength should not regard an hour a day as too much time to devote for such an end. The amount of exercise both as to time and in terms of energy expended, that is, severity of the work, should be considerable. There need be no fear of overdoing when the constitution is sound. If there is any organic disease or disability, then the exerciser is subject to limitations and should have a physician's advice if possible both as to amount and kind of exercise.

The clothing worn while exercising should be loose. The more of the body the pupil leaves bare the better except in the case of very fat people who are working specially to reduce flesh. Exercising entirely naked before an open window, if possible, and letting the air play upon the body while going through the movements is a tonic that only those can understand who have tried the experiment. Practicing before a mirror, watching the muscles as they work during the exercise especially aids in directing the flow of blood to the part of the body in use and greatly assists in bringing on the devel-

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CLASSICAL POSE.

opment that is sought.

The speed or tempo of most developing exercises should be slow and deliberate, say about forty to fifty counts to the minute on arm movements and still slower on body movements. The contraction of the muscle in some cases may be made rapid if it is complete. The return, however, should always be deliberate to allow plenty of time for complete flushing out of the tissues involved, with fresh blood.

The beginner should devote careful attention to muscle control to the end that only the muscles concerned in the exercise should be contracted. To accomplish this all movements should be done as easily as possible. Fatigue should be produced by doing a considerable number of counts but not by straining the opposing muscles.

Rests of short duration may some times be indulged in when the momentary fatigue is very great. The number of counts given in the description of the exercises is approximate only, yet the number will give some idea of what one should do. If it is found very difficult to do a certain exercise the number of times given, a short rest may be taken and then the remaining counts finished. It must be borne in mind that the rewards of exercise will not be gained by setting aside an hour and donning an exercising costume for that time. Hard work must be done and a great deal of it.

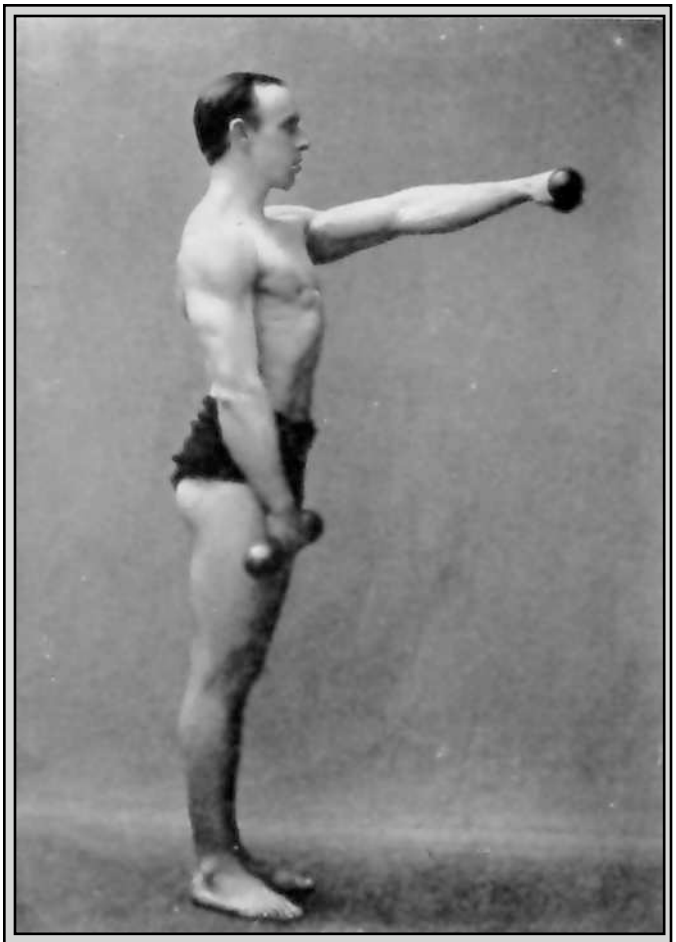
EXERCISES—DESCRIPTION

The various groups of exercises are given in the order in which they should be done. It will not be practicable to do all the exercises described at every period of exercise. Do about 20 to 25 exercises each day, selecting, say an average of two from each group. The number of counts suggested is for men of average strength. Women and children should do from one-third to three-fourths as many in proportion to their strength. But be sure your do enough to produce sensible fatigue. If you find you can easily do more than he number suggested, increase that number of 10 or 15. When an exercise can be done easily 60 to 75 times, some more severe form should be used for the same muscles, either by using a heavier weight or assuming a more difficult position.

A PLEA FOR THE BODY

Paradoxical as it may seem, the task of an advocate is sometimes more difficult on account of his own strong belief in the cause he urges. Physical exercise is now so generally regarded as a necessary part of every person's daily life that the statement "Physical culture is a good thing" seems almost axiomatic.

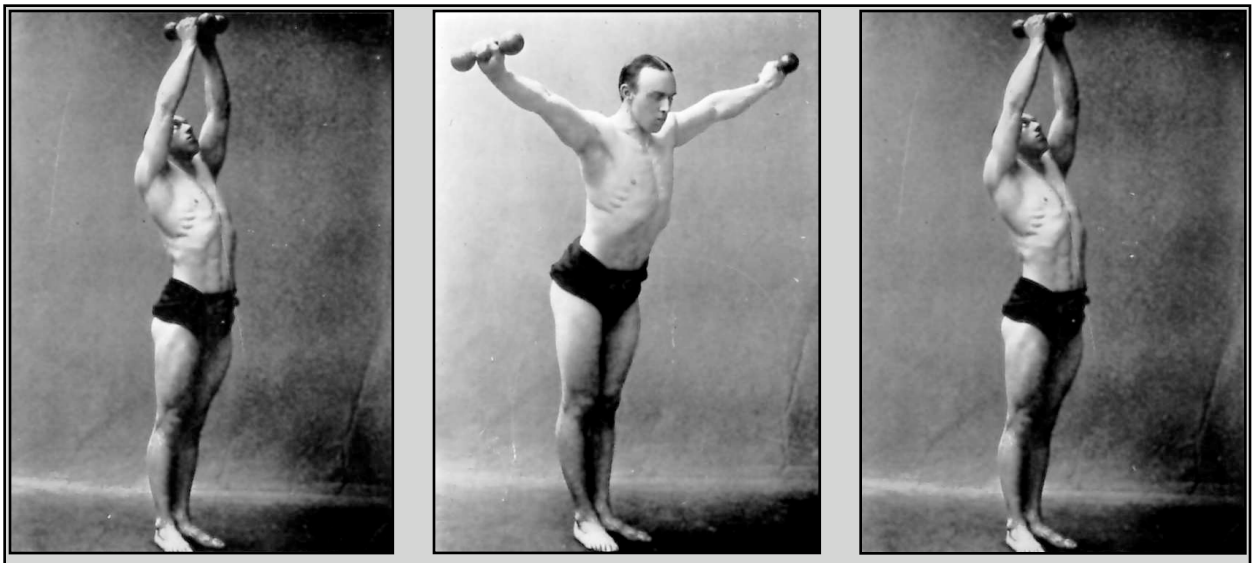
Next to a clear conscience, a strong body is the most desirable thing in life, and the possession of the latter often assures the former. Physical exercise brings bodily improvement, and therefore better health with all that that implies. Pain is the greatest affliction of human life. Good health, which nearly all can get by exercise, means freedom from pain. The study and habit of exercise call attention also to the general laws of health, and create an ambition and desire for bodily perfection, thus hastening the desired result.



Group I. (Top Shoulder Region)

Exercise 1. Stand with dumbbells resting against front of thighs. Raise bell alternately to level of eyes on front, elbows straight. Bells should pass each other at height of breast and almost touch each other in passing. 20 times, counting on one hand only. [Front deltoid.]

Another aspect of the results of exercise that will appeal to busy people is the greatly increased capacity for work produced. The business man or mental worker who gains a strong and healthy physical make-up will not only endure more hours of work, but will be able to accomplish vastly more and better work in the same time as before. Not only are one's chances of high success increased by fine bodily vigor, but from the examples we see one is almost led to believe that a well-trained and vigorous body is necessary to the best success. There have been instances of exalted genius in a puny body. Cicero and Voltaire, those two mental giants with tongues like rapiers, who, had they lived in the same age, might have been brothers—or the bitterest enemies—were men of puny physique. But they can scarcely be said to have lived successful lives. The names that we find at the top in all departments of human effort in the past and now, are those of men who intelligently cultivated their physical powers. Washington, perhaps the greatest name in the history of all ages, was a skilled athlete. Andrew Jackson, one of the most masterful executives any country ever had, was a seasoned veteran of camp and field,

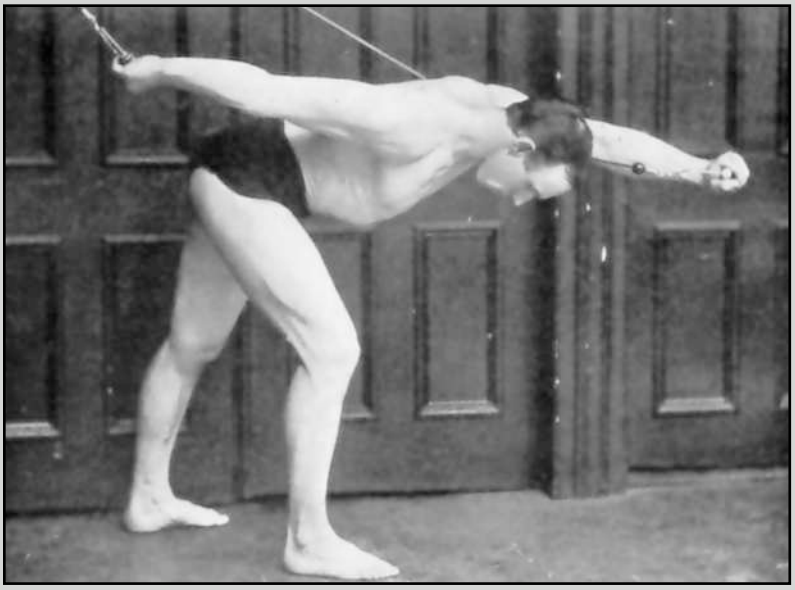


Exercise 2. Stand as in first photo, raise both dumbbells at the same time straight to the side, keeping backs of hands up and elbows straight, and maintaining the forward bend from the hips as long as possible. When you have reached position of second photo, or as near it as possible, turn the hands over, straighten up the body, and bring bells together above head as in third photo. 20 times. [Middle deltoid and upper trapezius.]

whose commanding voice and presence bespoke the robust physical manhood that marked his rugged character. Theodore Roosevelt, the young athlete who has proved himself well fitted for the highest position in the land, is by no means the least of the long list of great exponents of strenuous physical life.

Physical training and care of the body not only wing one's feet in the race for success; they change the whole mental tone and attitude. Optimism, liberality and kindliness are traits directly fostered by and resultant from physical activity. Cheerfulness is the result of health and presupposes health. The man or woman who enjoys the exhilaration of perfect health is never a victim of worry. There is no better friend in the time of adversity than the self-reliance which accompanies physical strength.

Physical and mental strength go hand in hand. The student whose memory is unre-



Exercise 3. With wall machine: Stand with back to machine and, bending forward as in photo, sweep the handles alternately downward and forward as shown in photo. 20 times. [Front deltoid and erector spinae.]

liable, and who finds it difficult to concentrate his mind, will find himself in better command of his mental forces, and the way of scholarship made smooth, if he will but set aside a short time each day for vigorous exercise. Statistics of schools and universities show that the students who excel in athletics also stand well in their classes. Also the winners of highest honors for scholarship are almost invariably men who attend the gymnasium as faithfully as the classroom. Still other instances are noted of men who studied long and hard with little success, who took up exercise and then took great strides forward in their studies.

Exercise 4. Arrange cushion support for head against the wall about the height of waist, as in photo. Start with arms hanging straight down. Raise dumbbells to the sides, keeping backs of hands up and elbows straight. On the return reach downward, thus giving the shoulders a play of several inches. 25 times. [Back deltoid, trapezius, and rhomboidei.]

Cultivation of the body lengthens life. If some great athletes have died at an early age it was not because they were athletes. Either the temptations to which their fame exposed them led them into dissipation, or their eagerness to excel caused them to overtax their powers. Under the same conditions one may be sure they would have died the sooner but for their strength. How many old men can be found who have not been physically active the greater part of their lives? The tremendous significance of the statement that exercise lengthens life commands the attention of all thoughtful men. In all the varied pursuits and standards of different lands and times there has been on great, unsatisfied wish common to all the inhabitants of the earth—the desire for immortality. Religions are founded upon it and owe their origin to it. Fable and legend of every land and language are full of its expression. Our present science of chemistry sprang from the efforts of the ancient sages to discover the fabled elixir which was to confer on wistful man the boon of endless days. Stronger than the greed for gold, stronger than the lust for power, stronger than the love of kin or country, strongest of the human passions, is the natural love of life. Of what incomparable value and importance, then, is any action such as exercise that will actually stretch out the span of life, not a little, but perhaps for many years, that will thwart, push back, delay for a time the black shadow of death, which man alone of living creatures sees ever at the pathway's end!

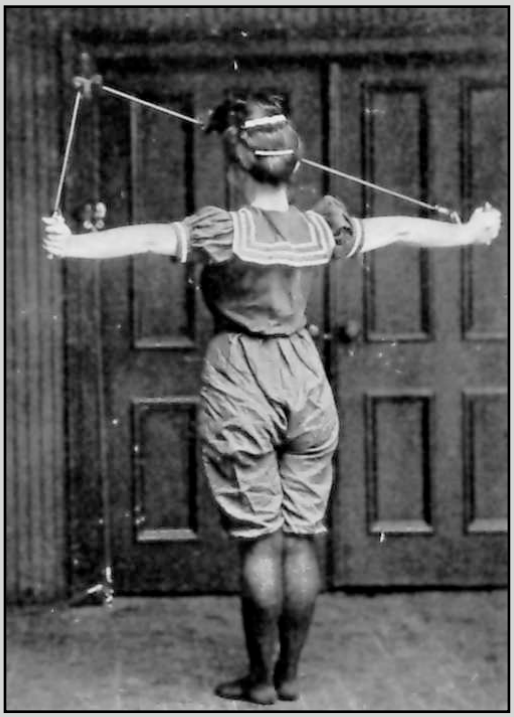
But if the arts of man are powerless to secure perpetual life we can still put ourselves in condition to get the very most of pleasure out of the time allotted to us. One of the greatest values of exercise is the increased capacity for enjoyment which it gives. If this were solely through the added powers of resistance given to the damaging effects of brutal pleasures, the cause would have no dignity; but the clear health and consciousness of strength which come from exercise give enjoyment to life in a different way. The healthy man or woman finds pleasure in mere existence, the mind is fresh and clear, enthusiasm lends delight to every deed and thought, food tastes better, sleep is sounder; in short, every part of life is brightened and made complete by exercise.

Exercise 5. Stand with dumbbells touching each other at arms length in front, height of shoulder, photo. Be sure to reach forward as far as you can by moving the shoulders, but do not bend at the hips or waist. Then swing dumbbells back forcibly, elbows straight on a plane level with the shoulders. Return slowly and repeat. Carry the head back and chin in at the same time that the arms go back. 20 times. [Whole deltoid, trapezius, and rhomboidei.]

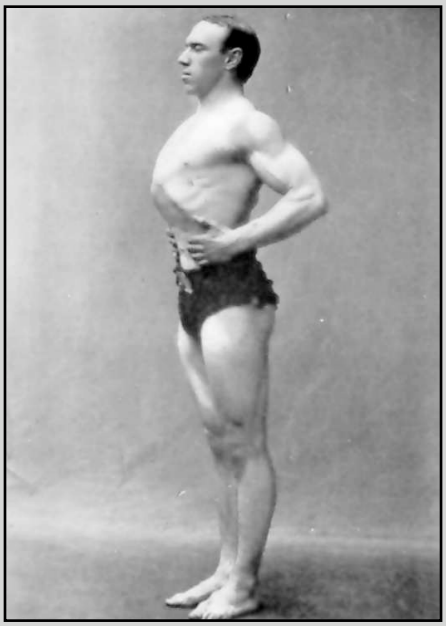
There are strong altruistic as well as selfish reasons why all men and women should build up their bodies by systematic exercise. Self-improvement is a duty to the community as much as to the individual. If all persons could find increased power for productive work through greater strength and health, and gain cheerfulness and virtue, as would surely be the case with universal exercise, the social tone of the whole nation would be raised. In fact, such pictures lead us rapidly to thoughts of the millennium, when poverty and crime shall be unknown. The stimulating effect of popular exercise on national life is forcefully illustrated in many historic instances. Greek art and civilization reached its zenith when athletic exercises were most generally practiced and admired. The Swiss people, who have given the world many object lessons in good government, have always engaged extensively in athletic sports. When Father John started the great movement for popular gymnastics in Germany his original purpose was to educate and train the people physically so that they would be able to fight for their religious beliefs and personal liberties. As the movement grew, however, a spirit of liberality grew with it; undoubtedly the result of the introduction of exercise into the daily lives of the people, so that all cause for fighting disappeared.

Attention to exercise as a means of bodily improvement is not alone a duty to the nation in that it makes the individual a more useful citizen. The duty of example is important in this as in all other policies of life. If one man takes up exercise, others will note the benefits he gains and be induced to do the same.

Our duty to future generations should be a cogent reason for physical as well as mental self-improvement. The man or woman who brings his or her body to the highest possible state of perfection not only laws up a store of health and happiness for personal enrichment, but is bequeathing to the children a legacy of strength, vigor, and life; a freedom from evil tendencies and a pleasure more valuable than palaces or titles. For the rewards of the father's right living are as surely visited upon the son through many generations as are the penalties of sins.



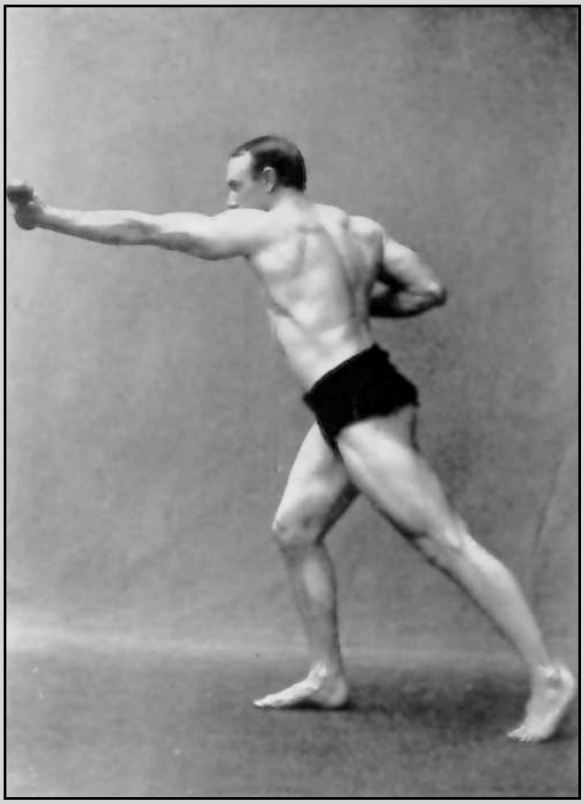
Exercise 6. With wall machine: Stand facing machine and execute same motion as Exercise 5. 20 times. [Back deltoid, trapezius, and rhomboidei.]

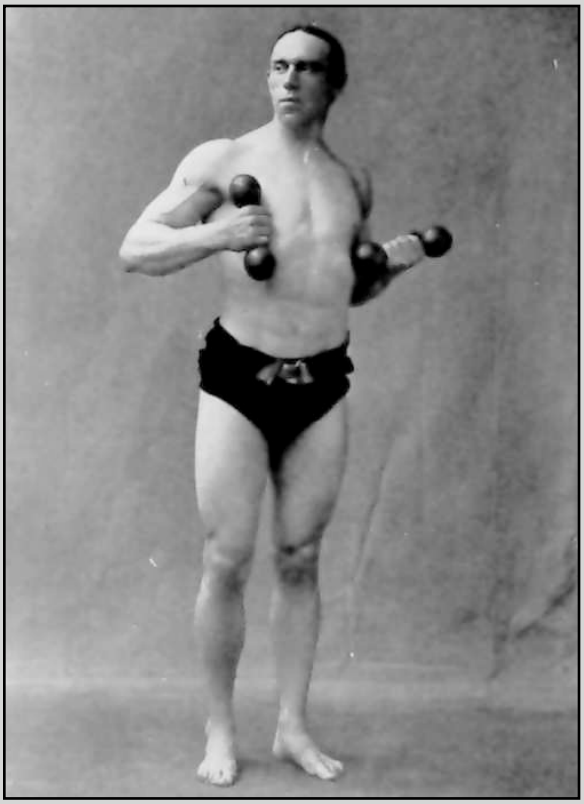


Breathing. Take four or five deep breaths, standing as in photo. Have the head well back and chin in. Inhale slowly as much as you can, then immediately exhale somewhat more rapidly. Rest a moment and then repeat.

Encouraging a love of strength for its own sake is not acquiring a new taste. It is natural to every one of us. Through all ages the love of bodily grace and vigor has characterized mankind. Savage races have worshipped strength in nature, and further progress brought the worship of gods and heroes, conceived as personifications of bodily strength. The athlete and warrior, in all history and today, holds first place in the hearts of the people. This universal admiration of physical prowess was not solely because of the greater efficiency it gave in self-defense or war, but was to a great extent a love of beauty and strength for its own sake. Our conceptions of courage, chivalry, patriotism, and honor carry with them the idea of physical strength. The picture of great strength is, therefore, rightly the delight of age, and childhood's summit of imaginary glory.

Some writers have pictured the human beings of a future age as creatures with enormous brains and little bodies, retaining just enough of physical power to operate the great machines which are to do the work of the future world. Such writers have not counted on the artistic side of human nature. Physical strength may cease to be a necessity for work, but it will never disappear. Just as the horse will surely be kept from extinction for his beauty alone, through his usefulness cease, so the artistic sense of the people will foster, not neglect, the development of strength.



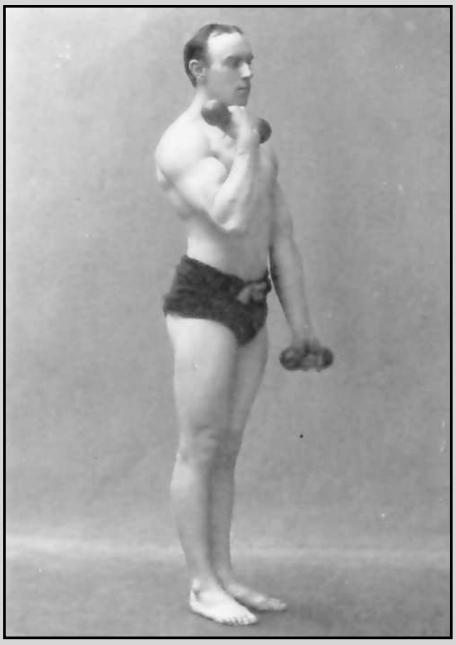


Group II. (Upper Arm)

Exercise 7. Stand with right foot advanced and left hand holding dumbbell extended to the front—left photo. Draw back dumbbell forcibly to armpit, keeping palm of hand uppermost—right photo. Return slowly and repeat 20 times.

Same with right hand, the left foot being advanced. 20 times. [Biceps, teres major.]

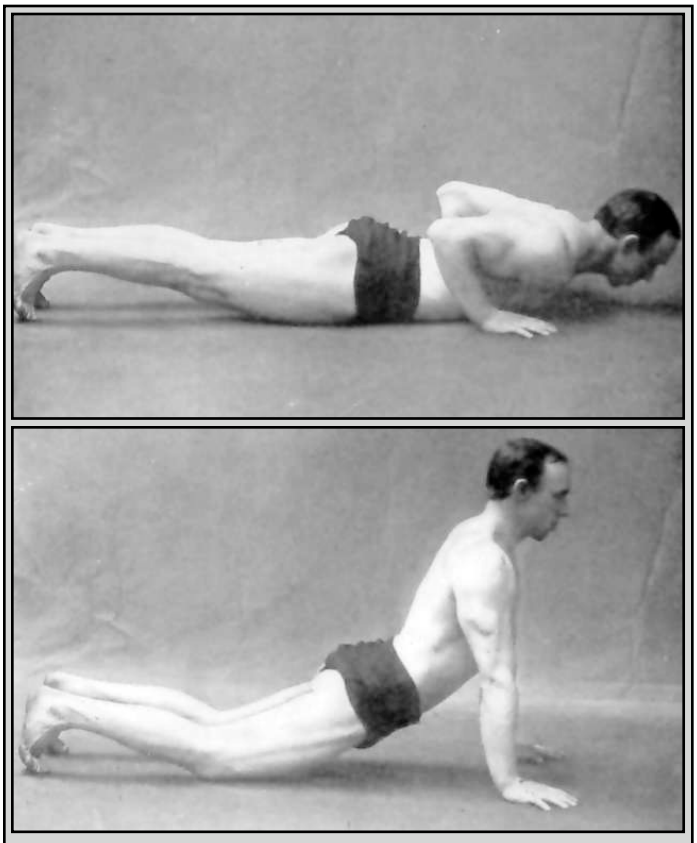
The tendency of modern thought is toward the completest life. All rational physical pleasures are conserved as adding to the great total of pleasure for which we live. Physical training, then, is advanced as one of the most effective means to the realization of the greatest ultimate pleasure in living.



Exercise 8. Stand as in Exercise 1. Keeping elbows in front of and touching hip bones, raise dumbbells alternately to shoulder height by bending elbows. Keep backs of hands uppermost. 50 times, counting on one hand only. [Biceps, supinator longus.]

IDEALS

In taking up exercise we have, of course, a general idea of greater strength, more graceful carriage, better health, etc., as the objects of our endeavor. It is doubtful, however, if many will have, without instructor, a very clear conception of the results in exercise which are of the most importance; which should be the most desired. It is no doubt a fact that people need advice as to the selection of ideals, as much as about the methods of attaining them. In development of the body, the greatest total efficiency is in the first desideratum. To gain the greatest possible quickness and accuracy of movement, the greatest possible muscular strength, the highest degree of health should be the object of exercise. Contrary to the belief of many, quickness, strength, and health are not separate qualities developed by different means, each more or less at the expense of the others. They are not separate qualities, but parts of one quality which we may call efficiency. They are not developed by different means, and it is impossible to become quicker without increasing both health and strength thereby. Strong men are not always quick, but they are quicker by reason of their strength than they would be otherwise.



Exercise 9. (a) Stand facing toward the wall at a distance of three feet or a little less, according to your height. Place hands on the wall at shoulder height and lean toward the wall, bending your elbows till your chest touches the wall. Push back to erect position by straightening elbows. 20 times.

(b) Lie prone on the chest on the floor—top photo, 1st position. Push up to straight arm, bending at the waist, knees remaining on the floor. 30 times. Bottom photo, 2nd position.

(c) Position of top photo, 1st position. Push up to straight arm, keeping body straight clear to the feet, 10 to 25 times. [Triceps, serratus magnus, pectorals.]

Note.—(a), (b), and (c) are separate exercises or separate forms of the same exercise. Weak persons should do (a), stronger persons do (b), and persons of considerable strength may try (c).

Occasionally we see a man of fine muscular and nervous organization whose health is by no means perfect. Perhaps in spite of his strength and skill his stomach is bad, or his lungs are weak. To these cases the negative argument emphatically applies; viz., if it were not for his strength, his general health would be far worse than it is. But the cases of sickly athletes are rare. In nine hundred and ninety-nine cases out of a thousand the man or woman who develops fine bodily strength will at the same time gain

buoyant, lasting health. There are probably very few persons so unnaturally constituted that they really do not desire strength. Yet many beginners are heard to say: "I don't want to be strong, I am simply exercising for health." The same amount of effort will bring great strength and health too. Why not accept both?

From the standpoint of the athlete let us study the relation of strength and quickness. Certain heavy exercises, such as lifting, increase muscular strength. It has positively been shown that these same exercises, properly done, will increase quickness.

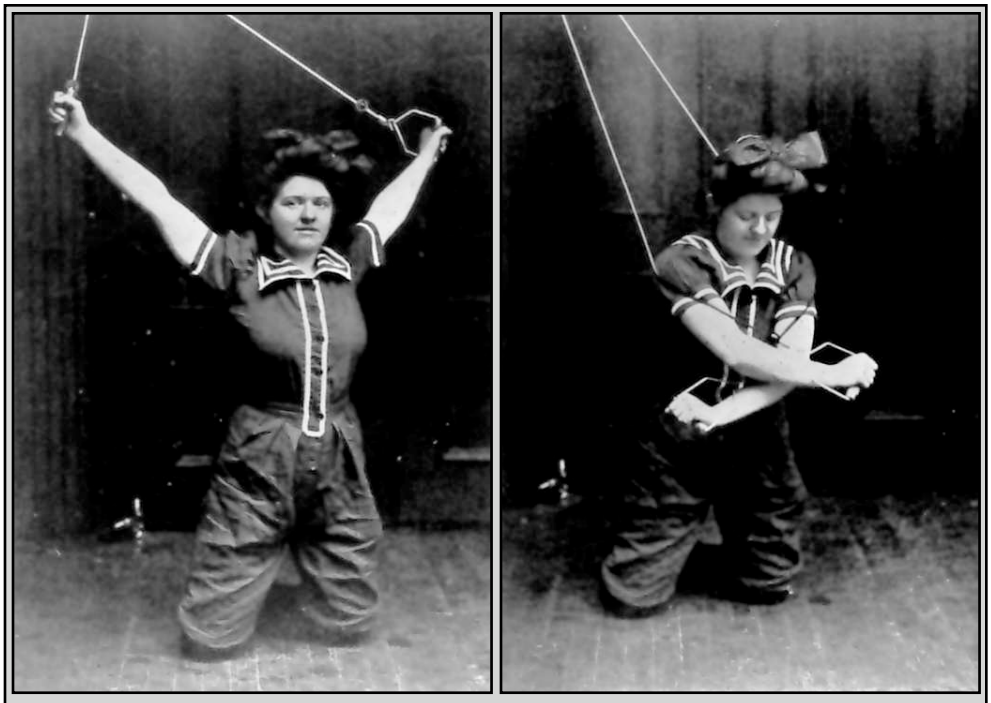
Quickness is largely temperamental and a form of skill. Some persons could never acquire quickness; others, without any training, are marvelously quick. Exercises for quickness may be summarized as the practice of quick movements. The possession of great strength developed by special exercise will be an assistance, not a detriment, in the acquirement and practice of quickness. Some athletes, following certain specialties which require quickness and particular skill, have found that much heavy exercise hurts their efficiency in their specialties. Thus some have reached the erroneous conclusion that the possession or development of strength is always at the expense of quickness. An athlete has only so much attention, so much energy to bestow, and if he devoted a considerable part of this to heavy weight exercises, or to reading, or to playing the piano, or anything outside of his chosen work, his specialty will suffer. If a musician neglected his instrument and spent all or much of his time playing billiards, he would soon lose his fine execution in his own specialty; yet no one could say there is anything about the game of billiards in itself to hurt a musician. So let the sprinter, the high jumper, the boxer, baseball player, fencer, and all the other specialists who value quickness, try a little of the heavy exercises—not enough to exhaust them for their own work—and see

Group III. (Chest)

Exercise 10. Lie on back on edge of table, bed, sofa, or row of chairs, so that right arm and shoulder will hang over as in photo. Keeping palm of hand up, elbow straight, and arm at right angles to body, raise the hand holding dumbbell to vertical position above. 30 times.

Same exercise with left arm 30 times. [Pectoralis major.]

Exercise 11. Lie on back on floor, dumbbells at sides, elbows straight, backs of hands downward. Swing dumbbells in circle, lightly touching the floor, till they meet beyond the head, still touching the floor and elbows straight. From this point bring them over at arm's length above the body and down to the starting position and repeat slowly 20 times. [Pectoralis major and expanding chest.]



Exercise 12. With wall machine kneel with back to machine as in left photo. Stooping slightly to the front, bring arms down and cross them in front of chest—right photo. Repeat, next time crossing other arm uppermost 20 times. [Pectoralis major.]

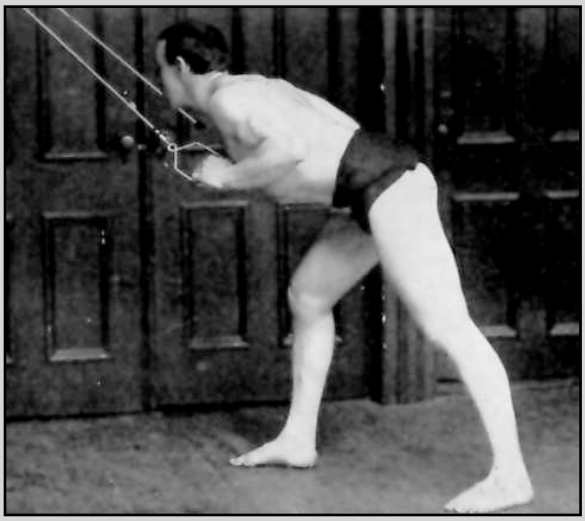
Note.—The best possible exercise for the pectoralis major is that described in Exercise 12 with an arrangement of the wall machine by which all points of attachment are about six feet apart.

how much quicker and stronger and generally effective they will become. As for the beginner, do not be led astray by fallacies. Get all the quickness you can and also all the strength you can. Develop strength in its broad meaning; strength of mind, strength of nerve, strength of sense, endurance, strength of lungs and heart, and also strength of muscle. Obey the laws of health, neglect not the acquirement of skill in the varied application of these powers, and you will be working toward the true ideal, the greatest possible efficiency of mind and body.

Physical efficiency is worth the effort, not solely because of any practical use to which we may wish to put our powers; although one's life, or the lives of others, may at any time depend upon physical strength and activity. There should be an artistic consideration in the selection of ideals—the pleasure of possessing a thing for its own sake, aside from practical use. In taking up exercise, not the least important object, consciously or unconsciously, will be, and ought to be, the symmetry, grace, and muscular beauty which distinguish the perfectly developed man and woman.

From the foregoing outline of the true general ideal in self improvement let us turn to what should be the immediate aims of certain classes of individuals. What, for instance, should be the object of the small-salaried young clerk or bookkeeper in taking up exercise? Though there is much talk about the long hours and need for more recreation for workers of this kind, the fact is that most of them do not work hard enough or long enough for their own good. There is no doubt about tyranny and oppression in the pittance of salary paid; they are always underpaid, and will be till a better social system is enforced. But if retail salesmen, office clerks, bookkeepers and others in similar lines were compelled to work ten percent harder and ten percent longer than they do, and were properly paid for it, they would be better men. The point is this: Wage earners

Exercise 13. Stand with back to wall machine, arms outstretched as in photo. Let the hands describe small circles upward and backward, allowing the pull of the machine to force the arms back and expand the chest; keep the head back and the chin in. Continue for about two minutes. [Expanding chest.]



Exercise 14. Stand facing the wall machine, bending toward it as in photo. Perform the motion of swimming 30 times. [Latissimus dorsi, teres major, long head of triceps.]

Breathing.—Expel all the air, hollow the chest, arms down and to the front. Then inhale deeply, raising the arms horizontally. After taking in all the breath you can with the first inhalation try to fill the lungs a little more by two or three short gasps or final efforts. Then exhale somewhat more rapidly than you inhaled. Repeat about five times, resting a moment between.

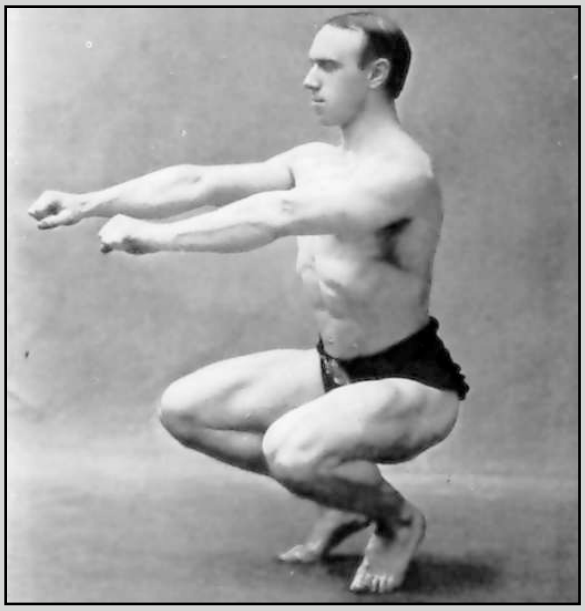
of the class described almost always have plenty of leisure time. They have comparatively little responsibility, and little or no preparation to make in connection with their work. What an admirable chance, then, to take up exercise, not merely to straighten the drooping shoulders a little, or to avert for a time the threatened attack of sickness, but for its own sake to make special athletic training a hobby.

The human mind seems to demand at least two directions of effort. This is shown by the amateur specialties, the hobbies which many people have quite apart and different from their daily work. Theodoric, a Roman Emperor, had his garden, which interested him more than his imperial duties. Fox, the great English statesman, raised pigs, on which subject he would talk enthusiastically at any time, to the neglect of affairs of state. President Cleveland was a fisherman, and President Roosevelt is an enthusiastic amateur athlete. One man devotes all his leisure time to ping pong; chess or whist may occupy the thoughts of another, even to the detriment of his business. A few spend their leisure time in the practice of gymnastic feats. By fat too great a number have no set pursuit outside of business, but look forward to the closing hour simply as a release from work. These hurry through an unhealthful meal and hasten to meet their idle associates, with whom the evening is spent in ways that leave them worse instead of better.

So much can be accomplished along the line of a hobby that a thoughtful man must feel the responsibility of selecting as an object for his leisure efforts something which will be of perma-

nent benefit to himself and the community; something that will make the world better. Of all the various pursuits, pastimes and pleasures which attract the interest of men, there is nothing so pleasing, so profitable, and of such far-reaching importance to the race, nothing so well adapted to be made a hobby, as Physical Culture. Its results are a source of pride to the possessor and a guarantee of health and fitness to his children, such as the best collection of postage stamps or the greatest skill at whist could never be.

As there are exceptions to all rules, so there are different aspects of every question. It is impossible to give one's best efforts to more than one thing at a time. The student studying for an examination which cannot be put off, the inventor on the eve of a discovery, any worker who wishes to add to the world's knowledge in his line, cannot afford a hobby, even one of such value as exercise. To be sure, exercise must not be neglected altogether by the student or specialist, or his health will slip from under him, and where will his work be then? But the man who wishes to distinguish himself in



Group IV. (The Thigh.)

Exercise 15. Stand erect with hands at sides, feet two inches apart. Sink down by bending the knees, letting the heels rise from the floor; at the same time raise the arms as in photo 15. Return to starting position and repeat. Be careful to keep the body erect throughout the movement. 20 times. [Quadriceps extensor.]

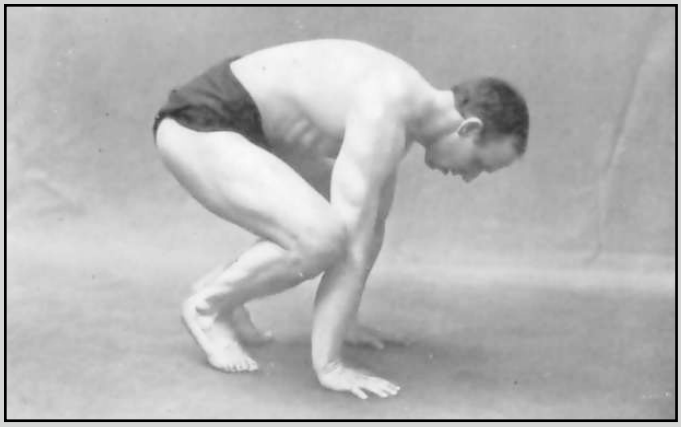
Note.—If unable to do this exercise more than 8 or 10 times at first take some of the work on the arms by holding the backs of two chairs.

Exercise 16. Balancing by a chair, raise the right foot sharply to the rear by bending the right foot sharply to the rear by bending the knee. Let it down gently and repeat. Be careful to keep the right knee back even with the left in this exercise, so that the foot describes more of an arc to the rear. 35 times. [Semi-membranosus, semi-tendonosus, biceps of the leg.] Same exercise with left leg 35 times.

Note.—Learn as soon as possible to do the foregoing exercise without holding on to a chair.

Exercise 17. Balancing by a chair if necessary, hold right knee at level of hip to the front. Rotate the foot inward as in photo. 20 times. [Sartorius.]

some line of scholarly research cannot hope for high expertness in physical things.



Group V. (Heart and Lungs)

Exercise 18. Stand erect, hands at sides. Give a jump to a position with the feet twenty-four inches apart sideways, at the same time raising the hands sideways and slapping them together above the head. Return with another jump to the starting position and repeat in continuous rhythm. 20 times, counting every time the hands slap together. [Accelerating heart and lung action.]

Exercise 19. Stand with arms extended to sides, raise the bent knees alternately till they touch the chest. Repeat as rapidly as possible, making it more severe by jumping clear from the floor with each count. 20 times, rest a moment, then 10 times more, counting on both knees. [Accelerating heart and lung action.]

Exercise 20. Place light obstacle twelve to eighteen inches high, for instance a cane or umbrella resting on two piles of books. Stand and jump over it, then turn and jump back again. Repeat as rapidly as possible. Count how many times you can jump over it in one minute by the watch. Then rest one minute and try again. Take three periods of jumping of one minute each, resting between. [Accelerating heart and lung action.]

Exercise 21. Stand erect with arms at sides, feet six inches apart. Stoop forward and place hands on floor twelve inches in front of feet (photo), give a jump and extend the body and legs of position of photo 9b, 2d position. Do one count of Exercise 9 (b or c). With another jump return to position of photo and from that to starting position, standing erect. Repeat rapidly whole exercise 12 times. [Accelerating heart and lung action.]

Breathing.—Take four or five fast deep breaths, inhaling completely with one quick effort, then instantly exhaling all the air you can with one quick puff.

Group VI. (Lower Leg}

Exercise 22. Balancing on left foot, hands on hips, describe a circle with tip of the right toe, twisting and turning the ankle strongly in every direction. Repeat continuously 40 times. [Strengthening ligaments of ankle joint.] Same with opposite foot.

Exercise 23. Rise on toes, settle back on heels, and raise toes from the floor. Repeat 25 to 50 times, counting each time you rise on toes. [Gastrocnemius, soleus, tibialis anticus.]

Group VII. (Hips and Gluteal Region)

Exercise 24. Stand erect with hands on hips. Kick straight to the side, first with one leg, then with the other. Be careful to make the motion strictly in a lateral plane. Do not twist the body to the side toward which you kick as in photo. 15 times each foot=30 counts. [Gluteus medius.]

Exercise 25. Stand erect with arms extended sideways. Kick straight to the front as high as you can, first with one foot, then with the other, keeping the knee straight and the toe extended. 15 times each foot, or 30 counts in all. Photo, Special Exercise 10a. [Long head of quadriceps, adductor muscles.]

ANATOMY

In taking up exercise the beginner is in the position of a workman who has a machine before him which is not at its best. It is his task to remedy the defects in that machine, and institute such changes and improvement as will give it the highest possible efficiency and beauty. To set about the task intelligently he must gain a good working knowledge of the machine itself. In fact the more intimate his knowledge of parts and the reasons for its adjustment, the better he can perform the task of repairing and improving it.

Exercise 26. Stand erect with arms curved upward and kick backward, trying to kick the back of your head, first with one foot, then with the other. Throw the head back to meet it. 15 times with each, or 30 counts in all. Photo. [Gluteus maximus.]

It is not within the scope of this book to give a detailed treatise on anatomy. There are many excellent works in which the subject is treated briefly and concisely and in popular style. Those who wish to make a thorough study of anatomy will be able to find plenty of material to aid them in any library or book store. In direct connection with practical physical training, however, there are certain anatomical and mechanical facts about the body which should be pointed out and explained.

THE SKELETON

The skeleton is the bony framework of the body and gives to the various parts the firmness, stiffness, or rigidity necessary to effective use. The two hundred bones which compose the skeleton vary greatly in shape and size, being long, short, flat, or irregular, according to their uses and situation. The long bones serve as levers acted upon by the muscles; the short bones are found in situations where great strength is required, flat bones afford extensive protection to delicate tissues enclosed by them, as well as offering broad surfaces for the attachment of muscles, while the irregular bones serve a great number of special purposes, according to their form and location. The various bones are jointed together in many different ways, giving great total scope and freedom of movement. Some joints, as the shoulders and hips, give almost universal freedom of movement, while in other parts of the body, where motion is unnecessary and would weaken the protecting function of the bony structure, as in the skull, the bones are dovetailed, or sutured together immovably.

The spinal column is made up of short bones like blocks piled one on top of another and separated by cushions of cartilage. These blocks, called vertebrae, are so articulated as to allow limited motion in every direction, including rotation. They are bound together by ligaments, and though prevented from great scope of movement at any one articulation they enable the column as a whole to bend quite freely.

The ribs, which serve to define the shape of the chest and to enclose and protect the heart and lungs, are jointed to the spinal column; as will be seen in the photograph, they run in general parallel to each other and each pair is approximately in a horizontal plane when the body is erect.

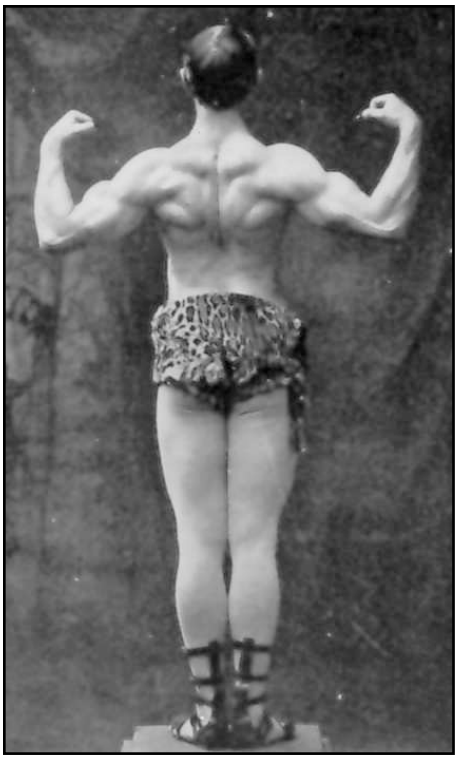
The motions of the ribs originate from the articulations with the spine and are of two kinds (taking place at the same time), viz., the raising of the front ends of the ribs, and the raising of the middle of the ribs. These motions, though very limited in scope, are of great importance in breathing. The mobility of the ribs, as also the general mobility of all the joints, varies greatly in different persons. Mobility of a joint depends largely upon the length and elasticity of the ligaments holding it together. Some people have naturally long and elastic ligaments in all parts of the body. This is the case with natural contortionists. Such people can elevate the ribs and thus expand the chest much more than others. Great mobility of the ribs is not, however, necessarily indicative of great lung capacity.

The long bones of the arm are connected with the spine and ribs indirectly through the medium of the shoulder-blade and collar-bone. The long bone of the upper arm is jointed to the shoulder-blade, which also receives the outer end of the collar-bone. The collar-bone, in turn, has its inner end jointed to the sternum, which is the bone that unites most of the ribs in front. Thus we see that the bony connection of the arm with the body is very slight. The arm is practically held in place only by the big muscles of the shoulder, back and breast.

The shoulder-blade is evidently formed especially to afford convenient attachment to many muscles. The shoulder-blade slides with considerable freedom up and down and forward and back on the wall of the chest, carrying with it the end of the humerus. It also has a rotary motion in its own plane which carries the point or interior angle outward and the articulation with the arm-bone up. It is limited in these motions principally by the collar-bone. The added scope thus given to the motions of the arm and hand will be apparent from the experiment of moving the arm in and out in a line with itself, with the elbow straight. It is by moving the shoulder-blade that one is enabled to reach a few inches further in any direction, even after the arm is fully extended. At the upper and outer corner the articulation with the humerus, or long bone of the arm, is accomplished by the glenoid cavity, which is protected by the projections or processes (the acromion and coracoid) and in which the round end of the humerus is held by the capsulary ligament.

The upper arm has but one bone, the humerus, which is a typical lever bone, affording attachment to many important muscles.

The forearm has two bones, approximately parallel and of about the same length, which are articulated with each other and with the humerus and wrist. The resultant action of the elbow joint is to permit great variety of movement, including flexion and extension (bending and straightening) of the



TRELOAR.

APPEARANCE OF BACK MUSCLES WITH SHOULDER BLADES PULLED DOWN.

A FRONT VIEW OF THE MALE SKELETON

Head and Neck

A, the frontal bone.
B, the paricta bone.
C, the temporal bone.
D, a portion of the sphenoid bone.
E, the nasal bone.
F, the malar, or cheek-bones.
G, the superior maxillary, or upper jaw.
H, the lower jaw.
I, the bones of the neck.

Trunk

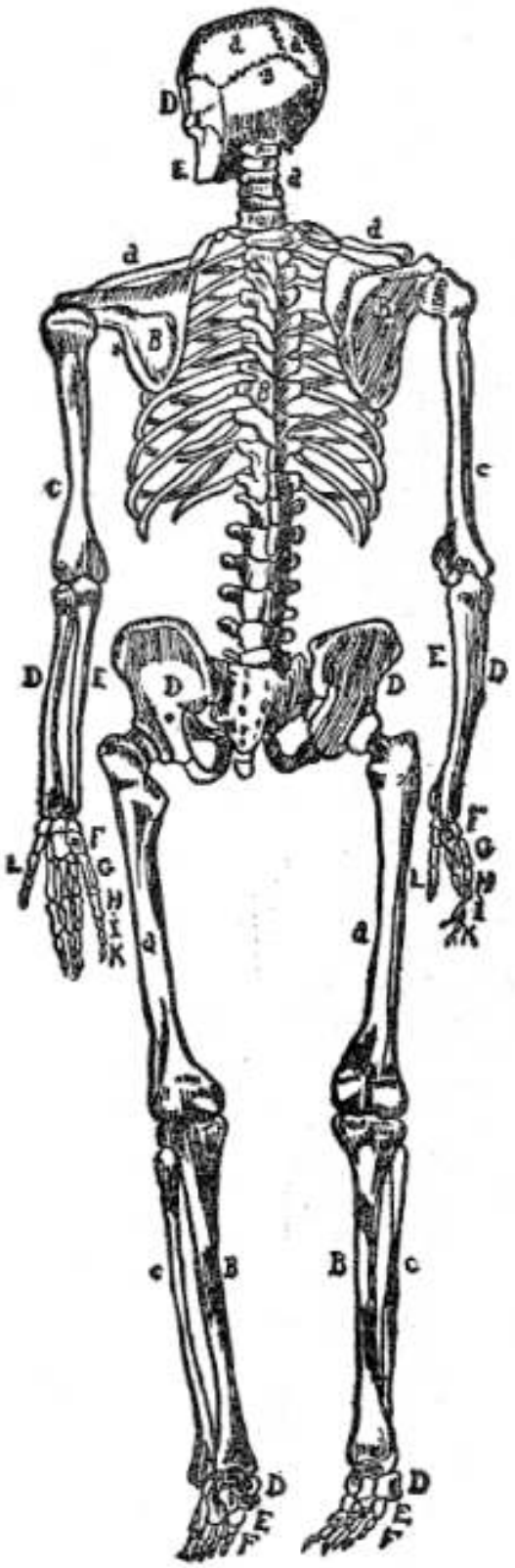
A, the twelve bones of the back.
B, the five bones of the loins.
C, D, the breast-bone.
E, F, the seven true ribs.
G, the five false ribs.
H, the rump-bone, or sacrum.
I, the hip-bones.

Upper Extremity

A, the collar-bone.
B, the shoulder-blade.
C, the upper-arm bone.
D, the radius.
E, the ulna.
F, the carpus, or wrist.
G, the bones of the hand.
H, first row of finger-bones.
I, second row of finger-bones.
K, the third row of finger-bones.
L, the bones of the thumb.

Lower Extremity

A, the thigh-bone.
B, the knee-pan.
C, the tibia, or large bone of the leg.
D, the fibula, or small bone of the leg.
E, the heel-bone.
F, the bones of the instep.
G, the bones of the foot.
H, the first row of toe-bones.
I, the second row of toe-bones.
K, the third row of toe-bones



A BACK VIEW OF THE MALE SKELETON

The Head

A, the parietal bone.
B, the occipital bone.
C, the temporal bone.
D, the cheek-bone.
E, the lower jaw-bone.

Neck and Trunk

A, the bones of the neck.
B, the bones of the back.
C, the bones of the loins.
D, the hip-bone.
E, the sacrum.

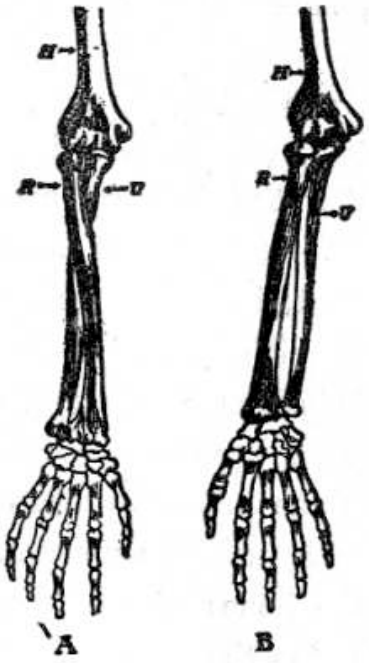
Upper Extremity

A, the collar-bone.
B, the blade-bone.
C, the upper bone of the arm.
D, the radius.
E, the ulna.
F, the bones of the wrist.
G, the bones of the hand.
H, the first row of finger-bones.
I, the second row of finger-bones.
K, the third row of finger-bones.
L, the bones of the thumb.

Lower Extremity

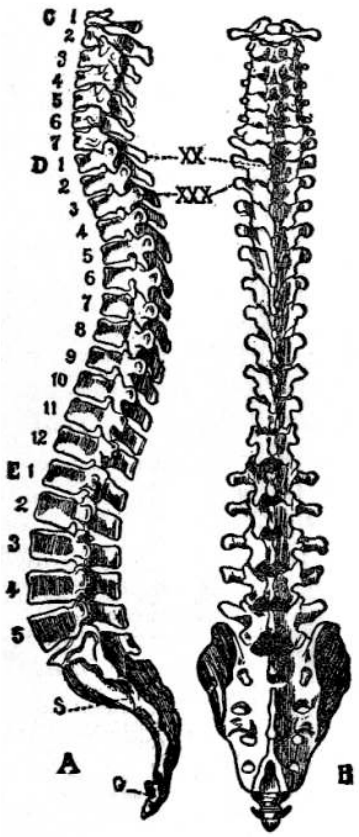
A, the thigh-bone.
B, the large bone of the leg.
C, the small bone of the leg.
D, the heel-bone.
E, the bones of the instep.
F, the bones of the toes.

forearm and pronation and supination (turning the hand palm downward and palm upward). When the hand is held in front with the palm downward it is said to be in pronation—with the palm upward, in supination. In pronation the bones of the forearm are crossed, while in supination they are side by side. Pronation and supination have a great deal to do not only with the complicated motions of the hand, but with the mechanical efficiency of the important muscles of the arm for varying purposes.



THE BONES OF THE RIGHT FOREARM IN SUPINATION AND PRONATION

A, Pronation.
B, Supination
H, Humerus
R, Radius.
U, Ulna.



THE VERTEBRAL COLUMN

To left shows side view
To the right shows back view.

C.—1-7 Cervical vertebrae.
D.—1-12 Dorsal vertebrae.
E.—1-5 Lumbar vertebrae
S.—Sacrum
G.—Coccyx
XX.—Spinous processes.
XXX.—Transverse processes.

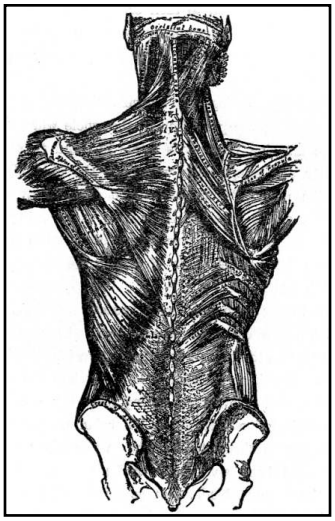
The bones of the lower extremities will be seen to present a marked analogy to those of the arms. There is a flat bone to which is articulated a single long bone for the thigh; the lower leg has two bones, all very much like the system in upper extremities. The chief differences are that the bones of the lower extremities are larger and the points permit of less extensive motion. The flat bone which corresponds to the shoulder-blade will not move independently, but with its mate on the other side and the base of the spinal column forms a rigid basin known as the pelvis. The analogue of the shoulder-blade is known as the os innominate, or nameless bone, from the fact that it resembles no known object in shape. The particular parts of it which will be convenient to think of separately in their relations to other bones and muscles, are the upper half, of ilium, the lower half or ischium, and the socket in which rests the head of the long bone of the thigh. In contrast to the shoulder-blade the os innominata is evidently formed for several other purposes besides convenient attachment for muscles. Its upper half gives support and protection to the abdominal viscera, while the point or tuberosity of the lower half is the point on which the body rests when seated. The articulation of the os innominata with the long hone of the thigh is like the shoulder-joint, except that the parts fit each other more closely and the motion is more limited.

The thigh-bone or femur is the longest and strongest bone in the body. It greatly resembles the humerus, except that it is larger.

The bones of the lower leg, two in number, continue the analogy to the skeleton of the arm. In the leg, however, the two bones are unequal in size and the larger, the tibia, articulates with the femur above, and plays the principal part in the mechanical actions of the lower leg.

THE MUSCLES

The muscles form the greater part of the bulk of the body and by their contractile power produce motion. Muscles contract as a result of stimulus from the brain or nerve centers, through the nerves. The voluntary muscles, or those directly under the control of the will, consist of bundles of fibers minutely subdivided. Besides the subdivision into fibers there seems to be a transverse division into minute discs. This structure of the muscle, as well as the nerve terminations in it, are more or less clearly made out with the microscope. When a motor nerve enters a muscle it subdivides into smaller and smaller branches, until finally it is believed a tip of a nerve filament reaches each muscular fiber.



I. Muscles of the Back.

On the left side are exposed the first layer, on the right side the second layer and part of the third.

From these facts some have suggested that the little discs which seem to make up the muscular fibers may undergo a process analogous to magnetization under the influence of the nerve stimulus, thus being drawn closer together and producing a contraction of the whole muscle.

It is well to note that from the nature of muscles, there can be no expansion or automatic lengthening. After contraction, a muscle and the bone it has moved, are returned to their original position by the action of some other muscle or muscles. In other words, muscles always pull and never push on the bones they move.

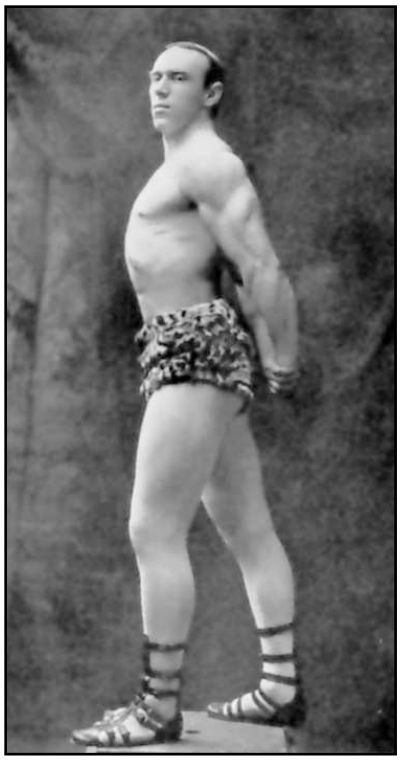
In contemplating the marvelous arrangement of the muscles, the perfection of the whole will be still more amazing when it is borne in the mind that even utility and adaptability were not the only objects in the plan. Beauty and grace of contour, symmetry, and a pleasing balance of masses, together with expression of strength and dignity are by no means least of the results effected in the arrangement of the muscles.

Beginning with the outer muscles of the upper back, we see first the trapezius, so named because with its mate on the other side it presents a four-sided surface. It originates from a large part of the spinal column and a few fibers spring from the skull near the articulation with the spinal column. The fibers converge to their attachments on the outer end of the collar-bone and the acromion process and spine of the shoulder-blade. Its action, if all the fibers pull at once and the head and spinal column are fixed, is to pull the shoulder-blade backward and inward. If the spinal column is fixed, the action of the lower fibers, acting alone, is to pull the shoulder-blade downward and inward. If the head and neck are fixed the action of the upper fibers alone is to raise the shoulder. If the shoulder is kept still the action of the upper fibers alone is to pull the head backward and to the side. The action of the upper fibers of both trapezius muscles together, the shoulders being fixed, is to draw the head straight back.

Below the trapezius is the latissimus dorsi, which is Latin for "broadest of the back." This muscle also has a very extensive origin along the lower part of the spinal column. A part of it is over-lapped by the trapezius. Some fibers of it also arise from the ilium and others from the three or four lowest ribs. Passing upward and outward the fibers converge into a strap-like tendon which passes between the chest and the arm bone around to its insertion in the inner front side of the latter.

The action of the latissimus dorsi is principally to draw the arm downward and backward when the spine and pelvis are fixed. It is one of the most important muscles used in swimming. If the arm is fixed it pulls the lower part of the spine upward, backward, and to the side. At the beginning of its contraction, when the arm is fixed it tends to raise the whole body toward the arm. It is usually powerfully developed in trapeze, bar, and ring performers. On account of the way in which its tendon winds partly around the arm bone, one of its actions is to rotate the arm inward.

Beneath the trapezius are two rather important muscles, the rhomboideus major and minor. These are virtually the upper and lower parts of one muscle. They originate from the upper part of the spinal column and are inserted in the inner border of the shoulder blade. Their action, therefore, is to retract the shoulder blade.

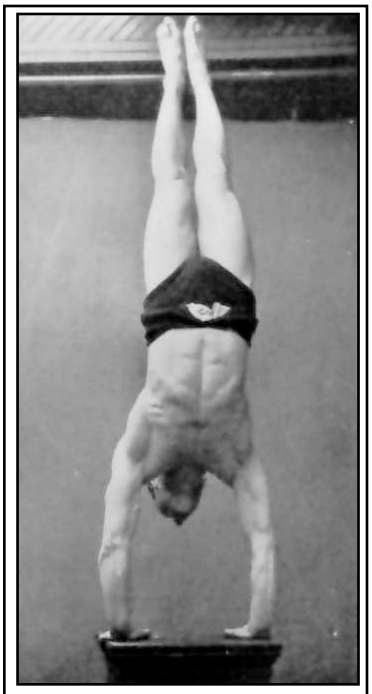


TRELOAR.

LEFT DELTOID AND TRICEPS.

The third layer consists chiefly of muscles originating from the spinal column and terminating in pointed insertions on the ribs. Their action is to assist in raising the ribs in inspiration or drawing in of the air in breathing. Another not very powerful muscle of the third layer is the splenius capitis. This muscle, although originating partly under the rhomboidei and therefore classified with the third layer, lies directly beneath the trapezius throughout most of its length. It arises from the vertebræ in the region of the base of the neck and is inserted in the skull outside of the insertion of the trapezius. The action, when the splenius capitis muscles of both sides act together, is to pull the head back, thus assisting the trapezius. When the right one acts alone it tends to rotate the head, turning the face to the right. This is just opposite to the rotating pull of the upper half of the right trapezius, which would tend to turn the face to the left. This will be readily understood from the directions of the muscles. The splendius capitis is important from its effect on the surface form in certain positions.

Most of the muscles of the fourth and fifth layers originate from one part of the spinal column and are inserted again in the spinal column higher up or in the ribs near the spine. Their actions mainly are in holding the spine and head erect and in bending the body backward. Acting on one side only they bend the trunk to the side and rotate it. The largest muscle of this group is the erector spinae. It is the muscle of the small of the back directly used in lifting weights from the ground.

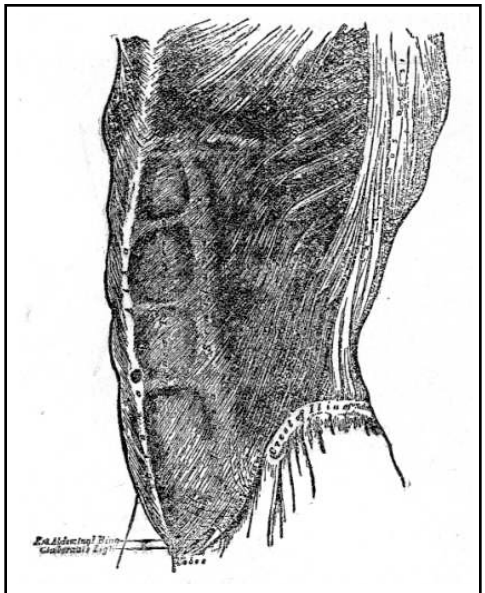


TRELOAR.

THE "HANDSTAND," SHOWING THE MODELING OF THE FRONT TORSO WHEN PUT UPON THE STRETCH.

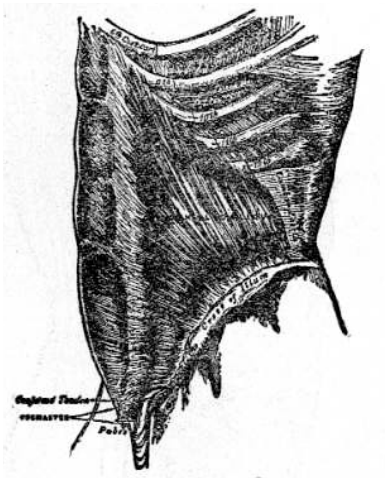
The muscles of the front of the abdomen are broad and flat and are evidently formed to enclose the vital organs within and to give a graceful contour to that part of the body as well as to produce motion. Up and down the center of the front wall of the abdomen we have the two rectus abdominis muscles, enclosed in a sheath of strong fascia or membrane, and extending from the front of the lower ribs to the front of the pelvis. Its action is to bend the trunk forward. When the upper part of the body is fixed, as when hanging by the hands from a bar or rings, the rectus abdominis would be largely instrumental in the action of bringing the feet up to the hands.

This muscle is remarkable in its formation, being interrupted in three places by tendonous lines. The contractile or fleshy parts of the muscle between these lines are seldom the same height and shape on both sides. On the outer side of the rectus abdominis are three flat, irregular muscles, one under the other; they are the external oblique, internal oblique, and transversalis. They have virtually a common action when the corresponding muscles of both sides act together, which is to help to bend the body forward. These oblique muscles are attached on either side to the system of fasciæ or membranes the surround the rectus abdominis. The side muscles therefore, assist the rectus abdominis by holding its sheath tight. The fibers of the external oblique run downward and inward, while those of the internal oblique run downward and outward. Thus it will be seen that the right external oblique, the pelvis being fixed, would tend to rotate the thorax to the left, while the right internal oblique, under similar circumstances, would tend to rotate the thorax to the right. The transversalis no doubt acts mainly as a tensor of the fasciæ of the region—that is, it steadies the action of the other muscles by pulling the membranes tight. As to surface form, the external oblique when relaxed, produces a rounded mass above the hip bone (crest of ilium) which adds very greatly to the beauty of the anterior aspect of the body. The ancient Greek sculptors emphasized this muscle strongly in their statues, perhaps making it larger than they really saw it in their models.

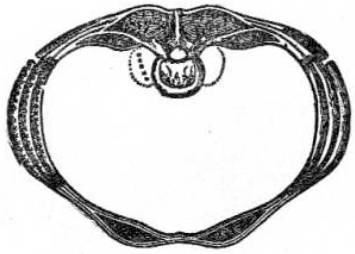


II. The External Oblique Muscle.

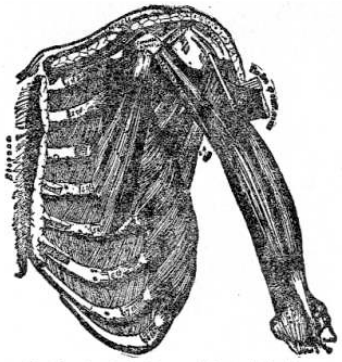
Coming now to the region of the shoulder, we will consider first the great pectoral, or breast muscle. The pectoral arises from the middle line of the chest, the fibers converging upward and outward into a flat tendon about two inches wide which is attached to the arm bone about one-third of the length of the bone from the upper



III. The Internal Oblique Muscle.



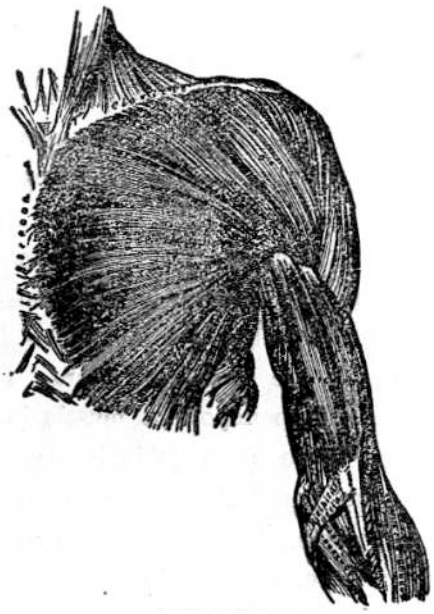
IV. A Transverse Section of the Abdomen in the Lumbar Region.



V. Muscles of the Chest and Front of the Arm with Boundaries of the Axilla.

end. Its action thus is to pull the arm down and inward across the chest. The two pectoral muscles would be exerted in an effort to touch the elbows together in front of the stomach. They are also strongly used in parallel bar and horse exercises. The pectoral muscles are very important in the surface form of the region, producing the broad, flat masses which give the upper part of the front torso its especial beauty in the antique statues and in well-developed men.

On the side of the chest, below the pectoral is a very beautiful muscle called the serratus magnus, which means "great saw toothed." It arises in pointed strands from the eight upper ribs and winds upward and back around the chest to its insertion along the inner or hindermost edge of the shoulder-blade. Its action is to slide the shoulder forward. It will be seen that this is the important muscle in reaching and pushing. Some have jokingly called it the "boarding-house muscle," because it would come into play in reaching for a distant dish at a table. It also plays an important part in the "straight lead" in boxing, enabling the boxer to reach fully six inches further by moving the shoulder. The serratus magnus comes into view in its lower three or four points of origin and in some positions even more. It is evidently formed with a definite design to ornament the side of the chest, with its pointed dentations, the break up the light and relieve the flatness of the surface in somewhat the same way as a dental molding in architecture. The curved line of its attachments to the ribs is beautifully continued by the three similar dentations of the latissimus dorsi lower down. Interlacing with the points of the serratus are the opposing strands of the external oblique, so that when this region of the body is put upon the stretch, as in bending backward, the surface presents the most varied and beautiful modeling. On account of its beauty the serratus magnus is the particular pride of athletes. The upper portion of the serratus underlies the pectoral and is consequently lost to view.



Chest and Arm.

VI. Muscles of the Chest and Front of the Arm. Superficial View.

On top of the shoulder is situated the deltoid muscle. This muscle is in three strands, the front, middle, and hindmost. The front strand arises chiefly from the outer one-third of the collar-bone, the middle strand chiefly from the acromion process—that point or hook on the shoulder-blade which overhangs the joint—and the last strand, from the ridge of the shoulder-blade. The middle strand is shorter than the other two. From these origins the fibers converge into a strong round tendon which is inserted in the outer side of the arm bone about half of its length down. The first action of the deltoid, the shoulder being fixed, is to raise the arm sideways. If the hands are fixed, as in pressing up to a handstand, the deltoid acts strongly in erecting the body on the arms. Having raised the arm laterally, the deltoid serves as a guy-rope to hold it in position during any action of the hand. The posterior or back strand of the deltoid is one of the chief agents in swinging the arm backward in a horizontal plane. When the arm is hanging at the side, the middle deltoid caps the shoulder and forms the contour. When the arm is raised to a horizontal position to the side, and the hand supinated, the front deltoid is rolled to the top and gives the shoulder an almost semicircular convex line of contour.

Under the arm we find the teres major, a muscle arising from the lower angle of the shoulder-blade and inserted in the inner surface of the arm bone near the joint. From the fact that its insertion is so high up on the arm-bone it acts at a great mechanical disadvantage. It assists the latissimus dorsi to pull the arm down and back. The teres major serves as a link to apply the power of the rhomboidei and lower trapezius muscles to the arm, as in pulling up to the chin on a bar. The teres major shows on the side of the chest just under the arm and above the latissimus dorsi. When the arm is raised it shows as a roll of flesh behind and below the arm pit.

The important muscles on the front of the upper arm is the biceps, which means two-headed. It arises in two heads from the coracoid process, of the shoulder-blade, which is in front of the joint itself, and the other from the upper edge of the glenoid cavity—virtually right in the shoulder joint. It is inserted in the inner side of the radius, the smaller bone of the forearm, near the elbow.

From an examination of the bones of the arm and forearm in pronation and supination, it will be seen that the tendon of the biceps is partly would around the radius in pronation. Its first action therefore will be to unwind, thus rotating the forearm outward, producing supination, or the turning of the palm upward. The continued contraction of the biceps bends the arm, bringing the hand and shoulder as near together as circumstances will allow. Thus it will be seen that to get the strongest action of the biceps in bending the elbow, the palm of the hand should be up, for then the tendon is straight. To bend the elbow, keeping the back of the hand up, requires more

TRELOAR.

strength since part of the force of the biceps is neutralized by the muscles which prevent the forearm from turning over. The biceps has a greater effect on the surface form than perhaps any other muscle in the body. From its prominence and the size it quickly attains as a result of exercise it is commonly taken as a standard or criterion of the general muscular condition of the body.

The brachialis anticus is a short but very strong muscle covering the lower half of the humerus and attached to the ulna. It assists the biceps in flexing the forearm and also steadies the elbow joint. It can scarcely be seen on the surface.

Opposed to the biceps, both in position and action is the triceps or three headed muscle. The three strands or heads by which it arises are designated as outer, middle, and inner. The fibers of the outer head arise from the back and outer surfaces of the humerus. The middle or long head comes from a roughened spot no the edge of the shoulder blade just below the glenoid cavity. The inner head arises from the inner side of the humerus. The fibers of these various strands converge and are inserted in the edges of a plate-like tendon which extends down to its attachment on the olecranon of the ulna. The triceps and its broad tendon or aponeurosis, as it is called, cover the whole of the back upper arm. The fleshy parts give the bulging form to the upper part of the region while the tendon makes a flat spot just above the elbow. The shape of this hard plate of tendon can be partly seen as a V-shaped depression about the middle of the back arm when the muscle is tense. The chief action of the triceps is to extend the forearm—that is, straighten the elbow. When the elbow is straight the long head helps to draw the whole arm downward and backward, thus assisting the latissimus dorsi and teres major in motions like swimming.

The muscles of the forearm are comparatively small and numerous. One of the longest and strongest is the supinator longus on the outer side of the forearm and elbow. It arises from the back of the humerus just above the elbow; its fleshy fibers wind outward, forward, and downward and form a long cord or tendon which is attached to the lower end of the radius. The action of the supinator longus belies its name for it is as much of a pronator as it is a supinator. It tends to bring the forearm to a position midway between pronation and supination. Its most important action, however, is in bending the elbow, in which it assists the biceps and brachialis anticus. The remaining muscles of the forearm may be divided into several groups according to their actions. Those which extend the hand and fingers also have in general the action of rotating the palm upward. They are situated on the outer or radial side of the forearm and in pronation are wound

TRELOAR.

SHOWING DEVELOPMENT OF THE RIGHT AND LEFT SIDES EXACTLY EQUAL.

partly around the bones forward and downward. Opposing these are the flexors and pronators which form the fleshy cushion on which the forearm rests in writing; their action is the close the hand, flex it on the wrist, and turn the palm down. The roundest part of this group of muscles is bound down by a strap of membrane called the bicipital fascia which is given off by the tendon of the biceps. Thus the flexor muscles of the forearm are steadied and held in place by the contraction of the biceps pulling this fascia tight. The groove in the surface made by the bicipital fascia is plainly visible in certain positions of the forearm.

Turning now to the muscles of the lower extremities we find first, covering the front aspect of the thigh, the quadriceps extensor, which means "four-headed." It has, however, but three distinct heads. The outer strand of this big muscle arises from a long line on the femur or thighbone, the middle and longest strand comes from the front of the ilium, or hip bone and the upper margin of the socket of the hip joint, the inner division starts from the inner and front surface of the femur. The fibers of the outer strand wind inward and downward, those of the inner strand wind outward and downward, while the middle strand comes directly downward to a little above the knee, where all three parts unite in a strong tendon which goes over the knee and is attached on the front of the tibia or shin bone. This tendon contains in its sheath a little round bone, like a butter dish, called the patella, to which the fibers are attached. The patella forms the front of the knee and its size and shape can be easily seen and felt from the outside. The quadriceps extensor is the direct analogue of the triceps of the arm in form, attachments, and action. Even the tendons are analogous for the olecranon, that bony protuberance on the ulna of the forearm resembles the patella as it would be grown on to the lower bone. The development of the parts bears out the similarity for the olecranon grows from separate centers just as the patella does, and later unites with the other bone. The long head of the quadriceps, like the long head of the triceps, has the action of flexing the whole member on the body after extension of the extremity has been accomplished. The quadriceps is the most important muscle in bicycle riding, and is sometimes developed to enormous size in wheelmen. It practically performs the whole work of straightening the knee.

Winding inward and downward around the front inner side of the thigh is a long strap-like muscle, the longest in the body, called the sartorius, or tailors' muscle, from the fact that it is

VII. Muscles of the Hip and Thigh.

used in crossing the legs as tailors sit. The sartorius arises from the upper edge of the ilium and passes spirally down and back around the inner side of the thigh, passing back of the lower end of the thigh bone. It ends in a fibrous tendon which arches forward again out of line with the muscle to an attachment on the front of the shin bone about two of three inches below the knee. The angle of the muscle with its tendon is maintained by fibers of tough membrane attached to the aponeurosis or system of membranes which enclose and support all the muscles of the region. The action of the sartorius is not principally to cross the legs as its name would imply, but to flex the lower leg on the thigh—i.e., bend the knee. Then, continuing to act it raises the whole leg toward the body and turns the inner surface of the thigh uppermost. The muscles which do most of the work of bending the knee are the semitendinosus, semimembranos, and biceps of the leg, situated no the back of the thigh. The two first named arise from the ischium and are inserted by means of long tendons in the inner side of the tibia or shin bone, near the top. These tendons form the so-called "inner hamstrings" and are plainly to be seen and felt at the back of the knee when the joint is bent at a right angle. These muscles have no direct analogue in the arm. The biceps of the leg, however, is directly analogous to the biceps of the arm which it resembles closely in shape and action. Arising in its longer head from the tuberosity of the ischium and in its short head from the linea aspera or rough line of the femur, for about the middle one-third of the length of the bone, its fibers unite in a broad tendon, which, becoming round and cord-like, is attached to the upper end of the fibula. Thus we see that the analogy to the biceps of the arm is carried out even in its insertion in the fibula which corresponds to the radius of the forearm. Besides the action of bending the knee, these three muscles help to pull the whole leg backward. They are brought strongly into play in fast running and leaping.

The adductor group of muscles on the inner side of the thigh, though consisting of several separate and distinct muscles, are so nearly alike in position and action that they may be described all at once. The adductor muscles all start from the inner front part of the pelvis. From here the fibers spread out like a fan to be inserted in the linea aspera of the femur and its continuations throughout the entire length of the shaft of the bone. The action of this group is first to adduct the leg, i.e., bring it inward. The adductor muscles of both legs acting at the same time would bring the legs together. These muscles are strongly used in horse-back riding, and in them the extreme soreness which is suffered by riders who are out of practice, has its seat. From the fact that the line of insertion of these muscles, the linea aspera, is at the back of the femur instead of its inner side, the adductors also have the action of rotating the thigh outward, in which action they assist the sartorius. The origin of this group on the front of the pelvis gives rise to another

important action, that of assisting the quadriceps and certain muscles of the hip region in bringing forward the hinder leg, as in walking and running.

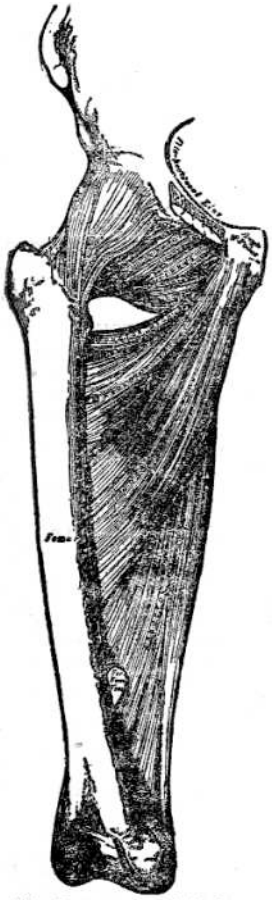
In the region of the hip we will consider first the gluteal group, situated at the back and outer side of the hip region. The largest muscle of this group, the gluteus maximus, arises from the upper back edge of the ilium and from the lower end of the spine. From here the fibers extend downward and outward to be inserted in the upper part of the linea aspera and in the fascia or strong membranes of the thigh. The gluteus maximus is very coarse in texture, and not only serves the purpose of a powerful motive engine but acts also as a cushion for the body in a seated position. It is a bulky muscle giving a roundness of form to this part of the body in all respects harmonious and necessary to the scheme of line and mass so evidently designed to give the greatest beauty as well as efficiency. The gluteus maximus may be regarded as the analogue of the deltoid. Like the deltoid, it is in a state of stress for long periods without rest and on the other hand without complete motion, as when standing for a long time in one place. The action of the gluteus maximus is principally to draw the leg backward. Thus it is an important muscle in fast running, in climbing stairs, in lifting and in throwing the body backward as in back handsprings or "flipflaps."

VIII. Muscles of the Iliac and Anterial Femoral Regions.

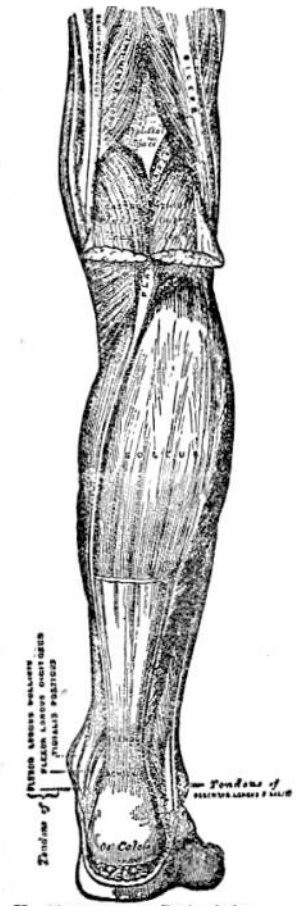
The gluteus medius and gluteus minimus extend from the crest of the ilium to the great trochanter of the femur. Their action is principally that of abductors, that is, raising the thigh outward. They come into play in balancing on one foot.

Turning now to the muscles below the knee, we find two groups opposed to each other in position and action. On the back of the lower leg are the gastrocnemius and soleus. The gastrocnemius originated in inner and outer heads from the condyles of the femur. Passing almost straight down the fleshy part of the muscle forms the greater part of the bulk of the calf. The fibers then converge into the tendon of Achilles. Lying underneath the gastrocnemius is the soleus which arises from the upper parts of both the tibia and fibula, but does not extend beyond the knee to the femur, as does the gastrocnemius. The fibers of the soleus pass downward, joining with the tendonous extension of the gastrocnemius to form the remarkable Achilles tendon. This tendon is inserted in the os calcis, or heel bone. The tendon of Achilles is named from the ancient Greek hero and warrior of that name, whose mother, Thetis, the "Silver-Heeled Lady of the Sea," dipped him, when a child, into the river Styx, to render him invulnerable to mortal weapons. Holding the child Achilles by one heel, as she dipped him in the black waters of the Stex, that heel only was not submerged. Achilles finally met his death from a poisoned arrow shot by Paris, of Troy, which found his only vulnerable spot, the heel. The Achilles tendon is the largest and strongest tendon in the body, though only about six inches in length. From the enormous mechanical disadvantage at which it acts its can be mathematically

computed that is sometimes bears a strain of nearly one ton. The action of the muscles of the calf, through the tendon Achilles is to raise the heel and thus the whole body on the ball of the foot as a fulcrum. They are thus the important factors in walking, running, and leaping. On the outer front side of the lower leg lies the tibialis anticus. This originates on the upper end of the tibia and extends downward to the lower one-third of the bone where it forms a long tendon which passes under the annular ligament of the ankle and is inserted in the inner side of the foot. Its most important action is to raise the ball of the foot. It thus comes into play in walking, in raising the toe to avoid stumbling. This muscle often feels the most fatigue in rapid heel and toe walking, though its action has nothing to do with propulsion. In such exercises as "hanging by the toes" from a bar, the tibialis anticus is the chief muscle concerned.



IX. Deep Muscles of the Inner Femoral Region.



X. Muscles of the Back of the Leg. Superficial Layer.

From the foregoing description of the principal muscles and their actions, the classification of muscles into antagonistic pairs will be readily understood. In some cases the muscles are regularly paired off against each other as in the case of the upper arm. The biceps bends the elbow, the triceps straightens it. The biceps and triceps are thus said to be antagonists. In other cases the relation is very complicated as in the action of the pectoral and latissimus dorsi against the deltoid, and yet separately to a great extent against each other. On the back of the side of the neck we have the splenius capitis, underlying the upper part of the trapezius and yet in action antagonistic to it in rotating the head. Another similar instance is the antagonism of the external oblique to the internal oblique on the same side. This will be understood from the directions of the fibers of the two muscles.

A detailed knowledge of the attachments, directions, and actions of the chief muscles will be of great assistance to the student of practical physical training in devising exercises and in using the muscles to the best mechanical advantage in actual work.

PHYSIOLOGY IN ITS RELATION OF EXERCISE

The tissues of the human body are constantly being broken down and repaired. This wearing out and renewal is the fundamental process characteristic of life in all forms. It is called metabolism, which means change. The destruction of bones, muscles, vascular walls, membranes, etc., is comparatively slow and due principally to mechanical "wear and tear," when the supply of food is normal. In the glands, however, and in the blood the change is very rapid and is at different times, both the cause and effect of the various manifestations of energy constituting life. It has been estimated that the entire body is changed and renewed in the space of about seven years.

Exercise 27. Lie on back with hands under hips, extend the legs straight up in the air. Let them fall apart and bring them together again. 20 times. Photo. [Adductor muscles.]

Group VIII. (Waist and Abdomen.)

Exercise 28. Stand erect with dumbbells held at arm's length to sides, feet eighteen inches apart. Rotate the body as far as you can each way, keeping the arms straight to sides throughout the movement. Make the twist mostly above the hips. Repeat 15 times each way, or 30 counts in all. [External oblique, internal oblique.]

The nutrition of the tissues is accomplished by the blood which has in it the nutritive elements assimilated from the food. The blood circulates to all parts of the body, the intricate ramifications of the capillaries bringing it in close proximity to all the tissues. The various tissue cells are believed to receive the elements they require for their renewal directly through the walls of the minute blood vessels, unloading upon the blood in return the waste products of their activity. The blood then becomes venous or impure and is conducted back to the heart and lungs where the impurities are, to a great extend, thrown out with the breath.

The *growth* of tissue depends upon the balance maintained between the breaking down of the tissue cells and the supply of the materials necessary to their renewal. In the muscles, growth is brought about principally by exercise, although inducing a better blood supply either by massage or by hot applications will, to a limited extend, produce growth. Comparatively little actual muscular tissue is broken down by exercise unless the work is unwontedly severe. This is shown by the fact that there is very little increase in the amount of nitrogenous material (of which, muscles are mainly composed) disposed of as waste, following exercise.

Experiments have shown that the living body is a machine for the conversion of energy from food in precisely the same way that the steam engine extracts energy from coal. There are, how-

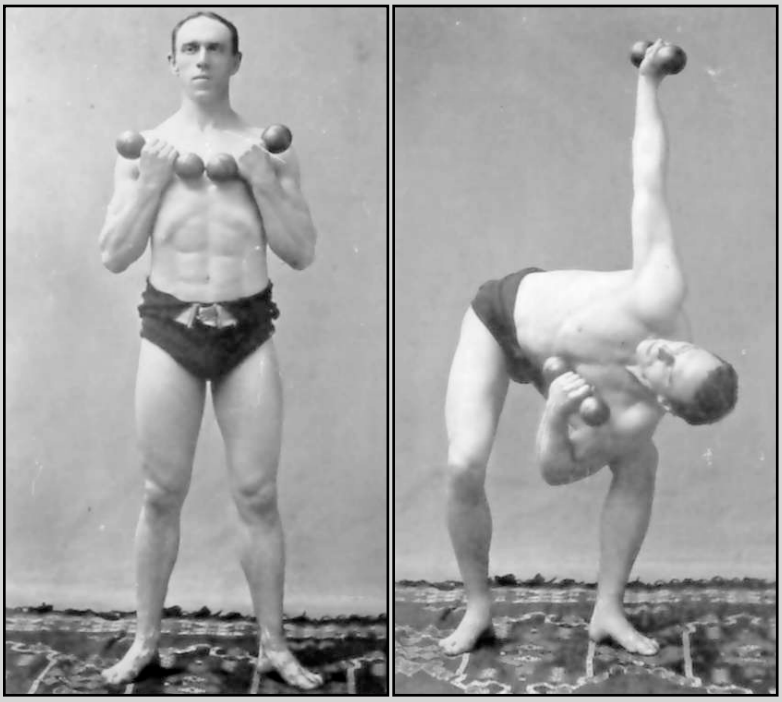
ever, certain important differences in the relative amount of heat and work developed from the latent energy of the furl (for food is the fuel of the body). The most perfectly constructed engine only gets about one-tenth of the energy from coal in the form of force or motion. All the rest of the latent energy of the coal is wasted as heat. To change the other nine-tenths of energy from heat into force has been the problem before inventors from the days of Watt down to the present. The human body, however, is able to show as force or motion one-fifth of the energy obtained from food and four-fifths as heat. In the body there is another demand on the food besides the production of energy. The tissues themselves must be renewed as fast as they wear out. To produce the necessary chemical changes in the food materials to make them suitable for incorporation in the tissues requires some of the kinetic energy developed. The steam engine, being of hard material, shows no appreciable wear or diminution in size of any of its parts, so there is no demand on the coal for material to rebuild or renew the engine itself as would be the case if the analogy to the body were complete. Ultimately some part of the engine gives out and it is renewed as a whole—not from coal—for engines are not made out of coal, but from metals.

The following closer view of the production of energy from food will show that the analogy between the body and an engine is more direct than at first glance it would seem. The same sort of food does not produce energy and rebuild tissue equally well. Muscles and soft tissues are built chiefly from nitrogen-bearing, or proteid food materials. Proteids are substances (always containing some nitrogen) like the white of an egg. Albumen is a representative proteid. Proteids of course contain some carbon and give rise to some kinetic energy, but their chief use is in rebuilding and adding to the tissues. Another action of the proteid food materials is believed by some to be that of irritating or stimulating the nerve centers. Thus the eating of meat, eggs, cheese, etc.—the principal nitrogenous or proteid foods—seems to facilitate the use of the energy derived from other kinds of food. The stimulation of a meal of meat is well known and get it has been positively shown that meat produces much less kinetic energy in the system than starch and sugar.

Exercise 29. Stand erect, arms extended to sides, bend directly to the side as far as possible, first to right, then to left as in photo. 15 times each way, or 30 counts in all. [External oblique.]

Energy is produced from food or coal by combustion or burning, that is, its combination with oxygen. Combustion may be completed in a few seconds as in the burning of a match, it may extend over years as in the gradual rot-

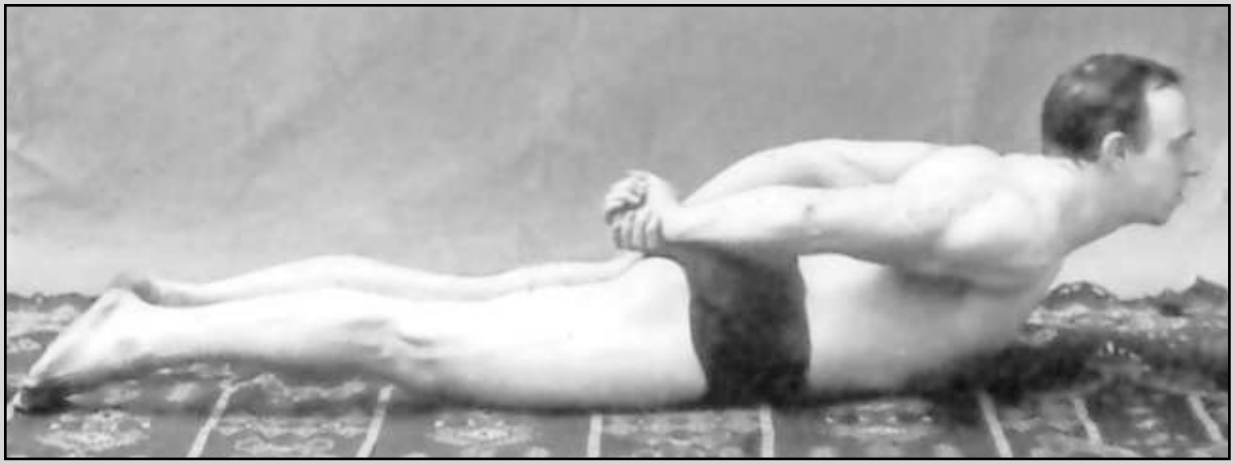
ting of a fallen tree in the forest or it may be a question of hours and be regulated by the demand for energy as in the body. The rapidity of combustion will depend upon many circumstances such as the size of the object being burned and the consequent relative amount of surface exposed, for the oxygen to act upon, the temperature, etc., etc. The kinetic energy manifested in the body as heat an motion is chiefly derived from the combustion in the blood of non-nitrogenous food materials, such as fats, which may be found in nuts, olives, olive oil, and dairy products, and starch and sugar, found in the fruit and vegetables. Just how this energy is transmitted, just how it makes the muscles move, we do not know. But that the combustion of carbon-bearing materials, does produce and limit the kinetic energy of the body is proved by the exact relation between the energy manifested by a living body and the amount known to be produced by the burning of a given quantity of food. So we see that the old idea of the body as a creator of energy and the comparison of life to a spark or the flame of a candle was not exactly accurate. From these facts we see, too, that the total amount of energy capable of being developed by the body is distinctly limited, whether it be used in mental or physical work.



Exercise 30. Stand with feet eighteen inches apart, dumbbells at chest as in left photo, swing the right shoulder to the rear, then bend forward and to the left, at the same time straightening the right arm. Keep the left dumbbell near the chest throughout the movement, continue the bend until the right arm is straight and the back of the left shoulder rests against inside of left knee as in right photo. Then come up to erect position with the body, carrying up the dumbbell still at arm's length above head. Resume starting position and repeat on the other side. 15 times each way, or 30 counts in all. [External oblique.]

Note.—Often use a heavier weight for this exercise—a dumbbell weighing from 10 to 40 lbs. if available, or both of your light dumbbells held in the same hand and changed to the other hand each count.

Before leaving the subject of energy a few words about the generally accepted theories of conservation and source of energy will undoubtedly be of interest to many. Latent energy is the term used to express the work which would be done by a given object or substance if at liberty to act. Thus the water above a dam, a stretched rubber cord, a coiled watch spring, or a pile-drive weight pulled up to the top against the force of gravity, all represent varying amounts of latent energy. When liberated, each will do a definite amount of work. Now comes the important fact. The water at the top of the fall can impart no more energy to the mill wheel than was required to raise the water in the first place. The stretched rubber when let fly will exert no more force than was used in stretching it. The spring as it uncoils will exert upon the watch wheels no more force



Exercise 31. Lie on back, hands at chest, come up to sitting position. Do not have the feet held down. Learn by giving the hands a throw as if reaching the knees. Later clasp hands back of head or hold them above head. 10 to 30 counts. [Rectus abdominis.]

Group IX. (The Neck.)

Exercise 32. Lie on stomach, hands behind back as in photo. Raise the head as high as you can, then lower it till forehead touches the floor. 50 to 75 times. [Trapezius.]

Exercise 33. Lie on back. Raise head till chin touches the breast. Repeat 30 to 50 times. [Muscles on front of Neck.]

Exercise 34. Sit or stand erect, twist the head very forcibly but slowly from side to side as far as possible. 20 to 40 counts. [Splendius capitis, etc.]

than that which would it up. As a matter of fact the energy gotten out of the machine is usually a great deal less than that put into it, on account friction, disadvantageous application, etc. For instance, the falling of a pile-driver weight could not be made to raise another equal weight to the top of the tower. It is this principle which makes perpetual motion impossible.

Another example of latent or potential energy is the chemical affinity of certain elements as oxygen and carbon. These elements are found united in nature. The light of the sun in some unknown way enables plants to separate them, incorporating the carbon in their tissues and giving off the oxygen to the air. Afterwards the carbon stored up by plant life, for instance coal, is gathered and burned by man, who thus gets back some of the energy given by the sun. Every manifestation of energy on earth can be traced back ultimately to the sun. The origin of the sun's energy can only be guessed at, but that his supply is limited and will sometime cease seems certain.

We will not turn to a more detailed consideration of the workings of the most delicately adjusted transformers of energy, the muscles of the body. Even when at rest muscular tissues display some cellular activity. Metabolism, or change, is always going on and combustion of carbon is taking place even during rest to keep up the temperature of the body. Muscles are elastic, and so arranged as to be always slightly on the stretch. If this were not so the first stages of contraction would be wasted in the tightening of the muscle.

The contraction of a muscle is produced by the contraction of its fibers, thus shortening the whole muscle and approximating—that is, bringing closer together—its points of attachment.

The irritability of muscle is its power of responding to stimulus. The stimulus which causes a muscle to act is normally transmitted to it by the nerves. Just what this stimulus is we do not know. The strength of contraction is greatest at the beginning and decreases progressively till complete contraction is reached. This refers to the muscle itself, not to its effect in work, for a muscle's leverage upon a bone is often so much better when partly contracted that more strength seems to be exerted than at the beginning of contraction. Successive contractions are progressively weaker till at last the muscle is exhausted and will respond no more until restored by rest. Exhaustion takes place very much sooner if the supply of arterial blood is interfered with. In fact a plentiful supply of fresh blood is necessary to the most effective action of a muscle. So in exercising this must be provided for by position and by frequent relaxation to allow the blood to flow through the muscle.

In tracing the analogy between the human body and the steam engine at the beginning of this chapter we considered the various ways of converting and utilizing energy in these two machines. There remains to be stated the fundamental difference between them in adaptability—the power of self adjustment to varying circumstances. No sooner is there a demand or need for certain powers in the body at attempts made to exert these powers than their development begins. There are many curious examples of this specialized development to meet unusual needs. An interesting one is the Japanese dentist who from long practice is able to pull the strongest and most deeply rooted teeth with his thumb and forefinger. In ancient times on of the contests of the gladiators consisted of a sort of boxing in which the blow was not delivered with the knuckles, but with the tips of the fingers extended and stiffened so that the hand was not unlike a sword. By thrusting the fingers against boards, etc., such strength was developed that a gladiator, getting a straight blow at his antagonist, could drive his hand right through flesh and ribs. This pleasing pastime is illustrated in Canova's great statue called "The Fighter."

Exercise 35. Lie on back, draw feet up under your, and assisting with the hands place your weight on the top of the head as in photo. Work the neck up and down and to the sides without counting. [All muscles of the neck.]

This adaptability of the human organism is shown in structural changes as the thickening of the skin in places subjected to much wear, the thickening and strengthening of bones around a fracture and finally the increase in size and strength of muscles to meet increased demands upon their energy. Practice will increase the power for any normal expenditure of energy. The best preparation for fasting or for protracted vigils, however, would not be in the experience of these conditions beforehand.

It is upon this power of the body to meet new demands that development by exercise depends. When regular exercise is begun, the muscles in some unknown way send in a requisition through the nerves for more material with which to enlarge themselves. Hence the increased desire for proteid, or tissue building food resulting from exercise. This demand is not simply to supply the place of tissue broken down or used up by exercise, for it has been determined that very little if any muscular tissue is destroyed by exercise beyond the mechanical wearing out which is to be expected from the movement of such relatively soft structures. Development or growth of muscle depends primarily on blood supply for it is the fresh arterial blood that brings the nutritive proteids to the muscle cells. The initiative part played by exercise in the process of development is two-fold. Exercise tires the muscle, uses up for the time being its contractile power. The cells of an exhausted muscle are the more ready to seize upon nutriment and thus increase in size, though just why this is so we do not know, except that it is in harmony with the general scheme of auto-adaptation to needs before mentioned. Exercise when of a proper kind, also helps to supply the demand which it creates, by accelerating the flow of blood.

The exercises which are best, then, for muscle growth are those executed with comparatively slow rhythm, so that during the time of relaxation there will be sufficient time for the blood to enter and permeate the muscle. Muscular activity calls an extra blood supply not only to the muscles directly concerned in the exercise, but to the whole adjacent region. So by exercising one set of muscles, many others lying near are benefited. It is not necessary, therefore, to analyze muscular action to the extent of devising an exercise for each muscle which shall as nearly as possible use that muscle and no others. All the muscular tissues will be just as well nourished by a less number of more general motions. In fact, exercises of a very limited local nature are not as valuable as those affecting many muscles at once, for reasons which will be set forth.

From the standpoint of Physical Training, the nervous force which stimulates muscle has two qualities, intensity and endurance. Whether either of these qualities may be said absolutely to belong to the nervous impulse or to the muscle's contractile power we do not know. For convenience we will assume that they belong to the nerve force. The only way to develop either intensity or endurance is to put the muscle often to the test. It is quite conceivable that muscles may increase in size as a result of better blood supply, etc., from exercise without increasing proportionately in intensity, which is another word for strength. To gain the strength itself the muscle must be exerted to its utmost frequently. The same principle applies in the development of muscular endurance. By frequently working a set of muscles almost to exhaustion their endurance will be in-

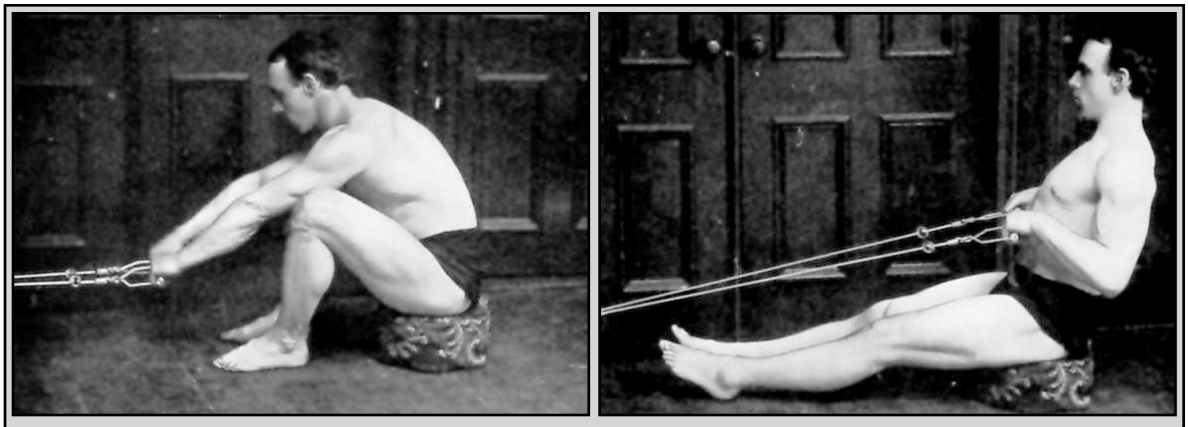
Exercise 36. Place your weight on the top of your head as in photo 36. Work the neck round and round, sideways, and up and down without counting. [All muscles of neck.]

creased.

Exercising one set of muscles produces a beneficial effect on many other muscles, not only by improved blood supply to the whole region, but through the nerves in a sympathetic way. Experiments have shown that if the right arm and shoulder are exercised and the left arm neglected the left arm will still increase slightly in size and strength, though not specially exercised at all. That exercise affects nerve power not only in its motor function, but in the mental processes is clearly shown by results in many instances.

In parts of the foregoing we have seen that a copious and unrestricted blood supply is necessary both to muscular action and growth. Let us consider then the sources of the blood supply. The blood holds in solution or suspension both the tissue building and energy producing elements which it has received from the food. Its quantity is maintained by the system of lymphatic or absorbing tubes which transfer water and food elements from the digestive tract to the circulatory system. The mechanical force which propels the blood to the various parts is the heart. When there is an increased demand for blood the heart has to do more work. The contraction of a large muscle uses up more blood than the contraction of a small one and obviously the simultaneous use of many muscles calls for a far greater blood supply and consequently harder work on the part of the heart than a local movement involving only one or two muscles. From this we see the value of general exercises or movements calling into play many muscles at the same time, for then the heart gains strength by increased work the same as any other muscle. When a course of purely local exercise is pursued, the body, to use the illustration of a well known writer on this subject, is like a factory, the engine of which is powerful enough to run one or two machines very well, but which, if all the machinery were started up at once, would be inadequate.

Heat in the body is produced by combustion of carbon in the form of fats, starch, sugar, etc. This combustion is going on all the time in the various tissues and its waste products are carried away by the blood and mostly thrown out in gaseous form by the lungs and sweat glands. A part of the energy manifested in motion is mechanically changed into heat again when motion is resisted. A working muscle develops heat in the same way that an engine gets hot from rapid mo-



Group X. (The Lower Back)

Exercise 37. Seat yourself on something about seven inches high, and with wall machine adjusted to pull from below execute the motion of rowing as in photos; continue until tired. [Erector spinae.]

Exercise 38. Lie on back, draw feet up under as far as shown in photo, arching the back. 15 to 25 times. [Erector spinae.]

tion. Some believe that this development of heat for motion is the chief cause of the increase in temperature from vigorous exercise.

In the process of breathing the blood takes a new supply of oxygen from the air for future combustion and is relieved of the gaseous products of past combustion. If the supply of oxygen is cut off, death results in a few minutes. The immediate cause of death from stoppage of the breathing, however, is not lack of oxygen but the numbing effect on the nerve centers of excess of impurities which the blood cannot get rid of. Thus it is evident that holding the breath or in any way stopping or restricting the breathing, particularly while exercising, is likely to have injurious results. When then breath is held the waste products of combustion accumulate in the blood, being carried back again through the tissues with a distinctly toxic, or poisoning effect. These effects differ from complete suffocation only in degree.

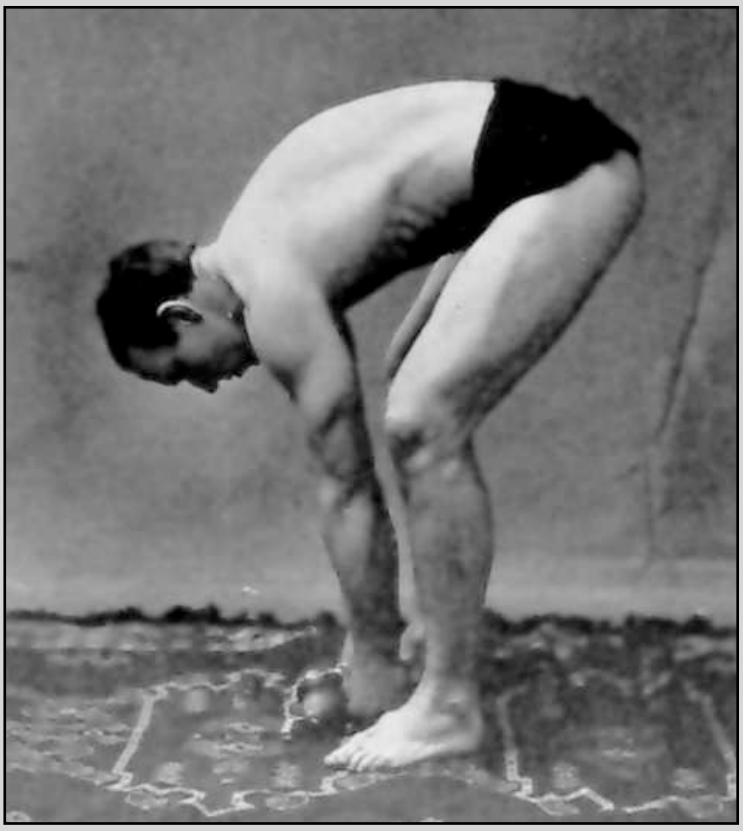
The intellect directs muscular action and is the source of the stimulus imparted by the nerves. The mind, however, has little to do with development of muscle except in the way of arranging favorable external conditions. Directing the thought or fixing the attention on the muscles during exercise is not desirable except to the extent of making sure that the position is right. The extra mental effort uses up more energy and is without result. After learning an exercise thoroughly it is just as well to think of something else while performing it. Too close a concentration of mind on the muscles being exercised is likely to produce a contraction of the antagonistic muscles, thus partly defeating the purpose of the exercise.

The immediate intellectual benefit of exercise in its recreative feature. After the habit of exercise is once formed this recreative element will not be confined to objective games, sports, etc., but will form an important part of special muscle developing exercises as well.

In working for the greatest total efficiency we must take into consideration the effect of exercises on many other tissues besides the muscles. Exercises which are limited in scope are likely to injure the joints by decreasing the anticular surfaces. The lubricating fluid will be freely secreted and the bearing kept smooth only in those parts of the articulating surfaces that come into play in frequent motion. So it is best in exercising to move every joint in every direction as far as

it will go. To limit the scope of movement is an exercise, particularly if the exercise is done rapidly, has a tendency to shorten the muscles themselves and is one of the causes of the condition known as "muscle-bound."

For convenience in producing resistance to muscular effort, and to do without external appliances, the plan has been advocated by some of making one muscle pull against another. In most cases, complementary or antagonistic muscles are so pitted against each other. This plan has many serious disadvantages. In the first place the energy developed by the body was not meant to be so neutralized and wasted internally. Of still more importance is the fact that simultaneously hardening and exerting all the muscles of a certain region seriously restrict the supply of arterial blood, which, we have seen, is of primary importance in all muscular processes. The nerve stimulus, too, is unnaturally divided, rendering skillful concentration and use of nerve force impossible. If a muscle is made to pull against some other muscle remote from it in position as in resisting with one hand the movements of the other, the natural blood supply may not be badly restricted, but the objection of the unnatural and uneconomical use of nerve force still remains.



Exercise 39. Stand with feet twenty-four inches apart, stoop over and place dumbbells on the floor between the feet. Have knees bent and back rounded as in photo. Straighten up to starting position, hands hanging at sides. Throw the shoulders back. 20 to 30 times. [Erector spinae, gluteus maximus.]

Note.—If heavier dumbbells are available a fifteen pounder in each hand or a thirty or even forty pounder held with both hands will be found better for persons of considerable strength. The number of times should then be regulated to suit the weight.

Group XI. (The Forearm.)

Exercise 40. Grasp the dumbbells tightly, and holding them near the hips rotate them strongly, carrying the whole dumbbell around a circle of which the wrist is the center. Rotate first in one direction, then in the other. Continue till the forearm muscles tire, without counting. [All muscles of the forearm.]

Exercise 41. Make two balls of paper of convenient size and squeeze them in the hands as hard as possible, or procure wrist machine, which is better for this purpose. 25 to 35 times. [Flexors of the fingers.]

Exercises involving continued stress with little or no motion are bad in that they also prevent a proper supply of blood to the working muscle. Such exercises are called "tetanizing." A muscle is physiologically spoken of as "tetanized" when it is in a condition of cramp, that is, violent and continued contraction beyond the control of the will. Holding a

weight at arm's length for a considerable time is an example of a tetanizing exercise. Such exercises decrease the irritability of the muscle and ultimately interfere with its nutrition, causing even atrophy or wasting away.

Great rapidity in exercise is to be avoided not only because it does not give the blood time to permeate the muscle, but because it wears out the joint. Many a young man going through a rapid wooden dumbbell or free hand calisthenic drill every day for his health's sake, finds himself growing stiffer and stiffer. The reasons are simply that antagonistic muscles are in action at the same time thus limiting the scope of the movement. The continuous contraction of the muscles prevents proper blood supply and the rapid movement, long continued, dries the joints. If he would take heavier weights in his hands and make the motions slower and as complete as possible, his stiffness would disappear and his muscles would increase in size. He could still cultivate quickness of nerve action by practicing quick movements such as turning suddenly and starting forward if only for a few feet, and striking out quickly at an imaginary enemy.

One of the great discouragements to the beginner in exercise is the distressing muscular lameness which usually ensues after the first day or two of vigorous work. The lameness is undoubtedly due to the accumulation in the muscles of the waste products of the unwonted combustion which has taken place to supply the unusual demand for energy, the circulation not being sufficiently developed to take away all the waste. When the exercise is very severe the muscular tissue itself is more or less broken down as is shown by the increased quantity of uric acid and other nitrogenous waste materials. Lameness can be avoided by increasing the severity of the exercises very gradually from a small beginning. It is a question, however, whether it is worth while to try to avoid all soreness, as much time would be wasted. The soreness quickly passes away and it seems to leave the muscles in better condition for rapid development.

ADDITIONAL EXERCISES FOR THOSE WHO HAVE BETTER FACILITIES

The foregoing 41 exercises are selected on account of their simplicity and directness, together with the small space and simple apparatus required for their execution. All of the preceding exercises can be performed successfully in a small room. For boys, young men, and others, who live on farms, or in suburbs or small towns, and have a fair amount of out-door space and perhaps a barn or shed, there are many very valuable exercises which are impracticable in a city room. If a barn, shed, or even basement is available, either in a city or country, several pieces of apparatus can be purchased and installed or made by a carpenter. The first in importance is the horizontal bar. The bar may be either of iron or wood and may be of any size from 1 inch to 2 inches in diameter, rigidly fastened at a height such that the pupil can just reach it. If it is to be used for gymnastic practice there should be as much space above it as under it. For the simple developing exercises to be described, however, a bar placed as much as 12 inches from the ceiling or roof will do. Great caution is necessary as to the strength of the bar. Whether of wood or iron, test it by hanging on it with another person hanging round your waist, or let as many people as can grasp the bar and hang on it at once.

Another very useful piece of apparatus similar in use and auxiliary to the bar is the suspended ladder. Any sort of ladder suspended rigidly, about 7 feet from the floor in a horizontal position, will do for this. Test all parts of the ladder in the same way as the bar.

Next may be mentioned the striking bag. Take an ordinary meal or grain bag and cut it off half length. Stuff it tightly with clean rags, and hang by a rope at the right of the shoulders. This bag should be used whether or not the quick inflated bag, now so generally used, forms a part of your equipment. The heavy bag above described will strengthen the wrists and arms much better than an air bag, and if you dance around it and try to make quick movements in using it the exercise will improve your agility just as much as the air bag.

The bar, the ladder, and the heavy punching bag may all be put up out of doors if you have space enough.

The gymnastic exercises on the bar and ladder can be found fully illustrated and explained in many excellent publications to be had in any book store or library. We will consider here only the developing exercises in which these pieces of apparatus are a great help and which should be done for some time before you take up practical gymnastics.

Special Exercise 1. Pulling up to the chin or "chinning" on the bar or ladder. Do it sometimes with the backs of your hands toward your face and sometimes with the opposite grip, the backs of the hands away from your face. As many times as you can. [Latissimus dorsi, biceps, supinator, longus.]

Special Exercise 2. Hang on the bar or ladder with hands twelve inches apart. Pull the legs and body up and touch the bent knees to the bar between the hands 8 to 20 times. [Rectus abdominis.]

Special Exercise 3. Hang on the bar or side of ladder with hands twenty-four inches apart. Pull body up sideways, bending the knees, and touch right knee to left hand. Come down to starting position or straight, hang and repeat to the right, touching left knee to right hand. 8 times each way , or 16 counts in all, resting between if necessary. [Rectus abdominis, external oblique.]

Special Exercise 4. Practice long and high jumping from both feet both forward and backward. Study the "lift" or throw of the arms. A forward "lift" is obtained by swinging the arms upward and forward just before the feet leave the ground. The backward "lift" is secured by the opposite motions: lean a little backward, swing the elbows up to the rear, hunching the shoulders, and jump backward. [Leg and shoulder muscles and heart and lungs.]

Special Exercise 5. Swinging the hammer. Get a hammer from 9 to 16 lbs. weight, with handle twenty inches long. A blacksmith's sledge with the handle sawed off to the right length will do. Another form consists of an iron ball firmly set on a wooden handle. Stand with feet eighteen inches apart, the hammer resting on the ground two feet in front, the handle held in right hand. Raise the hammer, swing it past the outside of right ankle, to the rear and up and over the head at arm's length, then down with a blow on the ground. As the hammer swings over head throw the weight of the body forward and step forward with the right foot. As the hammer bounds up after striking the ground, change it to the left hand and repeat, shifting the right foot back and the left foot forward.

As a change, sometimes, keep the feet in place all the time and swing hammer with both hands, first one over one shoulder, then the other; keep the steady rhythm by starting the swing as the hammer bounds up from the preceding blow. A strong man may profitably do 300 counts, which will take over ten minutes. Beginners should regulate the weight of the hammer and the number of times to suit the strength. Your ingenuity will suggest many variations of this exercise. [All muscles of the body and heart and lungs.]

EXERCISES FOR WOMEN

Nearly all of the foregoing developing exercises, including the special bar, ladder, and hammer exercises, can be done profitably by healthy women, grading the weight used or the number of counts done to suit the strength. There is absolutely no danger of a woman becoming coarse or masculine in appearance as a result of proper exercise. A woman's muscles will never become corded in appearance, will never stick out on the shoulders and arms like a man's muscles, no matter how much exercise she takes. On the contrary the exercise will develop strength and elasticity of muscle and impart that grace and roundness of form at the neck, shoulders, and arms that is recognized now as an absolutely essential requisite of womanly beauty. In reference to the dress of a woman aiming to become a woman in every sense, I would advise strict adherence to the rules mentioned at the beginning of this chapter. The corset has been proved to be a barbaric appliance and its use damaging to the health of women. Those who take plenty of vigorous exercise will derive more than enough support from the muscles that they have cultivated and their bodies will be carried with a finer grace and bearing than they could ever hope from the practice of wearing the unsexing corset. In addition to the developing exercises already described the following series of movements will be found of great value in acquiring graceful carriage.

In these special exercises pay particular attention to smoothness and grace of movement. If at first your movements seem awkward do not be discouraged, but try again. The position of the arms as illustrated in the photographs is very important, as it gives control of all the muscles acting in harmony. Notice that when the foot is off the floor in any position the toe should be extended or pointed.

EDNA TEMPEST.

CLASSICAL POSE.

Special Exercise 6. Charge forward with right foot to position shown in photo, rotate the upper part of the body three or four times, swinging the arms through a horizontal plane, then return to erect position. Repeat three times advancing the right foot, then three times advancing the left foot.

Special Exercise 7. Advance the right foot and bend to the right, raising the left arm as in photo, then advance the left foot and bend to the left, raising the right arm. Repeat in this way across the room and back four or five times.

Cultivate smoothness of movement.

Special Exercise 8. Stand erect, place whole weight on left foot, then bend backward, at the same time advancing the right foot and throwing the arms over the head as in photo. Let the right knee bend, but keep the left knee straight and the left heel and toe both on the floor. Repeat, changing right for left.

Special Exercise 9. Stand erect, swing right foot back and right arm up as in photo, Special Exercise 9a. Kick high to the front with right foot as if to kick right hand. After the kick place right foot as in Special Exercise 8, and bend loosely backward. Repeat kicking, etc., with left foot.

Special Exercise 10. Stand erect, kick straight to the front with right leg, with knee straight and toe pointed, at the same time raising the arms to the sides as in photo. Then swing the right leg back, bending the body back and raising the right arm as in Special Exercise 9. Repeat, standing on the right foot and swinging the left leg.

Special Exercise 11. Do Special Exercise 10, and from the second position, Special Exercise 9, give a little hop no the left foot and turn the body a quarter around to the right, swinging the right leg into the position of photo, left, the arms assuming the horizontal spread. Then drop the right leg and cross it over, raising the right arm as in photo, right, and bending the body to the left. From this raise right leg again to position of photo, right, and repeat whole exercise standing on the left foot and swinging the right leg through the four positions.

Special Exercise 12. Stand erect, slide the right foot forward, and lean forward, reaching forward with the right arm. Raise the left foot level with the neck as in photo, continuous with motion of thus going forward on the right foot, give two or three hops forward on the right foot, maintaining carefully the position described for the rest of the body. Then straighten up and, still standing on the right foot, swing the left leg forward to the position of photo, Special Exercise 10. Lean slowly forward and bring the left foot down to the floor at as great a distance as possible to the front. Shift the weight to the left leg and repeat the whole exercise with the right leg.

EXERCISES, KINDS OF.

Exercise, as the word is used in connection with Physical Training, may be defined as physical action for the purpose of increasing strength, suppleness, or skill.

Exercises may be divided into two general classes according to their purpose. Those exercises which are done solely for the purpose of developing parts or functions of the body may be termed subjective exercises. To this class would belong generally all dumbbell movements, breathing exercises, etc., actions of which the whole interest is in the results expected. The other general class may be called objective exercises. Gymnastic feats, performances of skill, games, and competitions (when entered into for self improvement) are objective exercises. In objective exercises the first thought before the mind is the accomplishment of the action and not the effect on the body.

In this book subjective exercises only are treated in detail. Simplicity and directness are desirable in subjective exercises. The human body is capable of such an infinity of different movements and the field of invention of novel exercises is such a tempting one that real strength-building value is likely to be neglected in the search for novelty in exercise.

Exercises are no less valuable because they are old and long used. Some of the most direct and effective exercises known were doubtless done, exactly as we do them now, by the athletes and gladiators of ancient Greece and Rome. So also some of the most effective methods in the healing art along the lines of dietetics and mental suggestion, date back to very ancient times and may have come down to us unchanged from the mythical Æsculapius himself. It is the intelligent use of exercises, not their novelty, that gives them their priceless value.

One of the elementary principles of exercise is that the muscles used should pull against an outside force, as gravity when we lift a weight, or the elasticity of a rubber cord when that is used. In this way the muscles not concerned in the exercise may be relaxed, giving better nerve control and permitting freer blood supply as previously explained on page 169. The so called "resistance exercises" advocated by some, in which the antagonistic muscles are set and made to work against each other are wrong in principle. Obviously a man can lift a weight or perform any other physical action better if he can use only the muscles which work directly for the accomplishment of that action, relaxing all the opposite or antagonistic muscles. If he has been in the habit of exercising by contracting all the muscles of a certain part at once, making one set of muscles pull against its antagonistic set, he will have difficulty in disposing his forces economically if called upon to perform a genuine action. One very bad feature of the so-called "resistance exercises" is the tendency to incomplete motion, thus shortening the contractile part of the muscle and limiting the scope of the joint.

In nearly all of the developing exercises described in this book, the outside force against which the muscles work is gravity and the weight is the whole or some part of the body. Even the muscles of the arms and hands can be pretty thoroughly exercised, when no dumbbells or rubber cords are at hand, by making them pull against the muscles of some other part. In this way most of the evils of the so-called "resistance" exercises are avoided.

Nearly all of the exercises described are to be done without apparatus. For those who happen to have a pair of light iron dumbbells or a wall machine, certain exercises particularly for the arms and shoulder, have been given in which these things will be of use.

EXERCISES FOR CHILDREN.

Up to the age of 12 to 14 years children should not do subjective or purely developing exercises. Young children need physical education more than they need artificial development. Training in gymnastic exercises is excellent for young children if not too rigorous and exacting. Anything which cultivates the child's muscular sense, that is, judgment of distance, balance, weight, etc., should be encouraged. It must be borne in mind that generally up to 10 or 12 years of age girls are larger, stronger, and more active than boys. All the tissues of a child's body are very soft and flexible as compared with those of an adult. For this reason a child will easily perform feats of contortion impossible to the average man. This flexibility will soon disappear as the child grows older unless it is especially cultivated by encouraging the child to do certain bending movements every day. Great flexibility (if natural) is perfectly consistent with strength and perfect health.

Very young children will be benefited by a variety of movements presented to them as play. For instance, let the child hang on your hand while you raise it off the ground. Take the child by the ankles and hold it hanging head downward. Hold by both ankles, then one ankle, then the other. In this position let the child try to double its body and get hold of your wrist. Then let it down till its hands are on the floor and let it try to walk along "wheelbarrow fashion" on the hands. Chasing and fetching a ball is splendid exercise for very young children.

REMEDIAL EXERCISES.

We have now considered both general and special exercises for normal healthy people, men, women, and children. The subject of Remedial Exercises in its complete application is quite separate from the purpose of this book and beyond its scope. Remedial Exercise, as the name signifies, is exercise taken for the purpose of correcting abnormal conditions, either disease or malformation. Some almost incredible cures of diseases in advanced stages have been effected by properly directed physical effort or exercise. It is not within our field to discuss those extreme cases in this book. There are, however, many comparatively trifling though inconvenient weaknesses and abnormal tendencies which can readily be cured by the right selection and proper use of exercises from the lists already given.

TO REDUCE FAT.

The usual causes of excessive fat may be stated briefly as too much food and too little exercise. A certain relatively small percent inherit a tendency to grow fat. The only way to get rid of fat is to oxidize it or burn it up by the heat of exercise, at the same time limiting the supply of food. If any physical instructor could find a way of certainly reducing fat he could command a prodigious salary per year, or he could make a great fortune from private pupils. In general, though, it may be said that rigorous exercise, particularly those movements which increase heart and lung action, coupled with rigid dieting will reduce excessive fat. The following will be found an excellent routine for fat people:

Dress very warmly, have the entire body covered, including the head, neck, and hands. Make sure that your heart is sound. If you have any doubts about it consult a doctor. Having made sure that your heart is all right, pitch into the exercise with great vigor. Never stop to rest but go right from one exercise to the next without a pause. Work till you are almost completely exhausted.

Group I.
Exs. 2, 4, 5.
Group II.
Exs. 7, 9 (c. if possible).
Group III.
Ex. 11.
Group IV.
Ex. 15 (very important).
Group V.
Whole of this group.
Group VI.
Ex. 23.
Group VIII.
Exs. 28, 29, 30, and 31.
Group X.
Exs. 38, 39.

For those who have an out-of-door place, Sp. Ex. 5, swinging the hammer, will be found excellent for reducing weight.

Note—Do all the breathing exercises described.

Go through the movements briskly. The object of work for reducing weight is to produce heat and fatigue. The more you perspire the more fat you will get rid of, although the perspiration is merely an accompaniment and not the direct means of destroying the fat. The foregoing selection of exercises is intended for those persons who, though suffering from obesity, still retain fair general health and heart and lung vigor. It is not within the scope of this book to describe the treatment of the other class of obesity, where the fat has invaded the muscular tissues themselves, sometimes threatening or actually affecting the muscle of the heart. As cautioned before, if you have any doubts about the soundness of your heart consult your physician.

The reduction of fat can be facilitated often by diet. The principles of dietetic treatment of obesity are to regulate the diet so as to promote oxidation and prevent the renewal of fatty tissue. Corpulent persons should limit the amount of fluids taken, especially with meals. Exceptions to this rule are in cases of rheumatism or gout accompanying obesity, when plenty of water should be taken between meals for a time to facilitate the removal of waste matter. As a rule, never more than one ordinary glassful of fluid should be taken at a meal, and still less may be used if a good quantity of water is taken between meals, a practice that should be cultivated. A total of say four glasses of water each day should be the limit for an ordinary person dieting to reduce fat. Soups of all kinds should be avoided, as well as alcoholic beverages, and what little fluid is taken should be mainly pure water. But little, if any, milk should be taken. The food should be as dry as it can be made without interfering with its flavor or nutrient value. Fruits and vegetables which consist largely of water, such as melons, raw tomatoes, etc., should not be eaten. Sugar must be absolutely denied, and fat must be used very sparingly, and only in the form of a little butter. Starchy foods, such as potatoes, cereals, etc., should be reduced to a minimum, and very little bread used. The deprivation of starchy foods can be tolerated much longer if a little fat is taken, and persons suffering from obesity do not well endure deprivation of all fats, even when starchy foods are supplied in moderation. Although it has been proved that sugar and starch are completely oxidized in the body and do not in the slightest degree enter into tissue formation even when taken in excess, they should be avoided in reducing weight. The reason of this is that when sugar and starch are taken all the energy required by the body is derived from their combustion, whatever fat there may be, being spared and stored up in the tissues, whereas, if sugar and starch are withheld, the fat will be burned up to supply the necessary energy and keep up the temperature. Salads and fresh green vegetables, those that grow above ground, should not be withheld.

I am not acquainted enough with the Physical Culture diet, nor have I experimented sufficiently with it to lay out a diet that does not include the use of meat. As far as my own experience has gone, I am of the opinion that lean meat should form the basis of all diet in obesity. Other proteid foods are safe, such as cheese, eggs, and beans, taking care to reduce greatly the total quantity of food consumed.

A host of quack nostrums are offered to a credulous public under the claim that they reduce corpulency. Some of them have achieved reputation because while they are taken the patient is also induced to regulate his diet; others merely because they have destroyed the appetite or digestion, and have made it impossible to eat too much food. Using them has resulted very frequently in death to the patient, and those who are aiming to reduce their weight cannot be warned too strongly against the use of these poisonous nostrums. It cannot be expected that any chemical

remedy can control the complex processed involved, and the substances for this purpose diminish the appetite, impair the digestion, and at the same time seriously interfere with, if they do not destroy, nutrition.

There is no drug or remedy known which acts specifically either in retarding fat formation or in causing its destruction in the body, and when any such remedy appears to have that effect, it is acting indirectly by a general lowering of vitality. Exercise, supplemented by dietetic treatment, is the only rational method, and when that fails it is hazardous to employ other means.

TO INCREASE WEIGHT.

The special directions regarding exercise to increase the weight of persons who are too thin, refer to the manner of doing the exercises rather than to the selection of the exercises themselves. To increase your weight, use comparatively heavy resistance in all exercises, regulating this either by the weight used, the tension of the wall machine, or by the position assumed. Do the movements very deliberately and loosely, stop frequently to rest, and avoid heat and perspiration. Dress lightly while exercising. Extend the habit of leisurely and deliberate movement from your exercise to the rest of your daily life. To gain weight you must free yourself as far as possible from mental strain.

Many cases of extreme leanness are the results of defective digestion, either from some for of dyspepsia or gastric catarrh. The fat-producing foods are starches and sugars, rather than fat itself, in the way before explained. If the alimentary system for any reason is unable to digest starch and sugar, leanness will result. Therefore, diet for excessive thinness should consist of plenty of proteids, which can be derived in plenty from olives, olive oil, nuts, dairy products, and starchy foods. The starch is more easily digestible than sugar. Sugar, used in connection with coffee, is particularly hard to digest and often stops the digestion of whatever starch is in the stomach. It is a good rule to take the starchy vegetable and sweet foods at one meal and the heavier proteids, such as those before mentioned, at another meal. Plenty of sleep is very necessary in training to increase weight.

GENERAL REMARKS

There are as many different opinions on the subject of cleanliness and bathing in its relations to health as there are instructors and writers dealing with it.

Bathing has little to do with the development of strength, and a bath after exercising is for comfort rather than for any physiological effect produced by it. Many people carry the bathing practice to excess. My own experience has been that one short bath each day is sufficient, and more than that irritates the skin. As to the use of cold water, follow your own inclination. If you find a pleasant stimulus in the use of cold water, use it. On the other hand, if you receive a chill from it from which you do not soon recover, abandon its use until you have become stronger in general constitution through the exercises. Do not use much soap, especially that made from animal fats. The use of soap is unnatural in principle and should be resorted to only so far as it is necessary to remove visible dirt.

The value of plenty of fresh air needs no theoretical demonstration. Exercise will do you little, if any good, if you do not breathe fresh air while doing it. You need to breathe fresh air and plenty of it continually to experience living in its truest sense. It is not the proportion of oxygen that makes fresh outdoor air so stimulating. It may be the molecular arrangement of the atoms of oxygen, the presence of ozone, or it may be only temperature. Whatever it is, the experience is universal.

In all such matters as bathing and fresh air adopt a conservative middle course. Bathe enough to keep clean and have all the fresh air you can without exposing yourself needlessly to sudden and wide degrees of temperature.

In regard to exercise, the results obtained from it will be, in general, in direct proportion to the amount and severity of the exercise taken. Every healthy student of exercise should get this principle firmly in mind, that there is practically no danger of overdoing. There is much talk about light exercise, and the danger of overdoing, but light exercise never yet made an athlete any more than light study has ever made a scholar. Light work will not bring success in business, and it will not bring success in exercise. Nothing but persistent, strenuous endeavor will build up physical strength.

After laying the foundations of strength by means of the subjective exercises described in this book, the earnest student of bodily efficiency should take up some form of objective exercise, or work requiring skill. Gymnastic and tumbling exercises should be carefully studied out and practiced either with the aid of books or with personal instruction, with a view to gaining control of your muscles and training them to practical use.

A ROUTINE OF EXERCISES WITHOUT APPARATUS.

1. Grasp the right wrist with the left hand, backs of hands up. Raise the right arm, elbow straight, as described in Ex. 1 (page 20), resisting the motion with the left hand. Repeat till muscles tire.
   Repeat, raising left arm and resisting movement with right hand, breathing, as described in Group I.
2. Tie a towel or handkerchief loosely around right leg near knee. Raise the weight of the leg, hanging lax, as shown in photo (page 48).
3. Do Ex. 9, as directed (page 52).
4. Stand two feet from a wall, facing toward it. Stretch the arms above the head and lean toward the wall, pushing back, with the hands still raised above the head.
5. Clasp hands together, in front of chest. With the left hand resist an effort to cross the right over the chest. Resist not quite strongly enough to prevent motion. Having crossed the right arm over the chest in spite of the resistance of the left, reverse the exercise, crossing the left arm over the chest, resisting with the right.
6. Hold a towel firmly by the ends. Pull the right arm down to the side and rear, resisting by pulling upward and forward with the left hand. Then reverse the exercise.
7. Ex. 15.
8. Ex. 16.
9. Ex. 19.
10. Ex. 21.
11. Ex. 23.
12. Ex. 24.
13. Ex. 27.
14. Ex. 29.
15. Ex. 31.
16. Ex. 32.
17. Ex. 33.
18. Ex. 38.
19. Ex. 41.

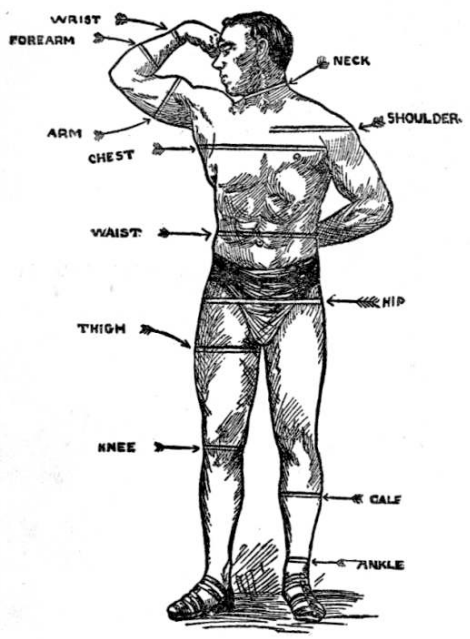
TRELOAR.

POSITION SHOWING STRETCH OF ARMS EQUAL TO HEIGHT.

PHYSICAL PROPORTIONS OF THE PERFECT MAN AND WOMAN.

Careful measurements should be taken before beginning a course of exercise, according to the system described:

1. Girth of neck.
2. Girth of shoulders.
3. Girth of chest, natural.
4. Girth of chest, contracted.
5. Girth of chest, expanded.
6. Girth of right upper arm, extended.
7. Girth of right upper arm, doubled up.
8. Girth of left upper arm, extended.
9. Girth of left upper arm, doubled up.
10. Girth of right forearm, tense.
11. Girth of left forearm, tense.
12. Girth of waist.
13. Girth of hips.
14. Girth of right thigh.
15. Girth of right calf.
16. Girth of left thigh.
17. Girth of left calf.



It is difficult to state an absolute standard of physical proportion as an ideal. One man may be a perfect type of runner, another a perfect type of a weight lifter or wrestler. Exercise will not change one's natural physical characteristics. A person born to be tall and slender may be greatly improved by exercise, but can never become thick set. An eminent authority on anthropometry, or the science of physical measurement, once measured nearly one hundred of the champion athletes in all lines, including running, swimming, etc., as well as pugilism, wrestling, and heavy lifting. He found that an average of all these measurements would be a man 5 feet 9 ¾ inches tall, weighing 180 pounds, and with principal girth measurements as follows: Neck, 16 ½; chest, natural 43; biceps, 16 ½; waist, 34; thigh 24 ½; calf, 16 ½. A man with these measurements might therefore be expected to make a good showing at a great number of different athletic performances, but to hold records at none. Averages are not ideals by any means. They may be taken, however, as a comparative standard of estimate. The proportion of weight to height and the principal girth measurements, which is generally regarded as representing perfect development, is shown in the following table.

TABLE REPRESENTING THE POPULARLY ACCEPTED OF PROPORTION FOR ADULT MEN

Height	Weight	Neck	Chest	Biceps	Forearm	Waist	Thighs	Calves
5 ft.	103-107	11 1/8	33	Same as neck	8 7/8	29	17	Same as neck
5 ft. 1 in.	107-111	11 1/2	34		9 1/4	29 1/2	17 1/4	
5 ft. 2 in.	111-116	12	35		9 5/8	30	17 1/2	
5 ft. 3 in.	116-121	12 1/2	36		10	30 1/2	18	
5 ft. 4 in.	121-127	13	37		10 3/8	31	18 1/2	
5 ft. 5 in.	127-133	13 1/2	38		10 3/4	31 1/2	19	
5 ft. 6 in.	133-140	14	39		11 1/8	32	19 1/2	
5 ft. 7 in.	140-147	14 1/2	40		11 1/2	32 1/2	19 3/4	
5 ft. 8 in.	147-155	15	41		11 7/8	33	20	
5 ft. 9 in.	155-164	15 1/2	42		12 1/4	33 1/2	22	
5 ft. 10 in.	164-174	16	43		12 5/8	34	23	
5 ft. 11 in.	174-185	16 1/2	44		13	34 1/2	24	
6 ft.	185-200	17	45		13 3/8	35	24	

Below is printed a table showing averages compiled from the measurements of some thousands of American college students, ranging in age from 17 to 25. The average measurements of biceps and forearms are not equal to those of European students. Legs and chests are slightly better developed among Americans. The whole table is disappointing, as compared with the table given above, which is, no doubt, based upon measurements of athletes. Any young man who frees himself from the "light exercise" superstition and works hard every day will certainly excel the figures given for average students.

TABLE REPRESENTING AVERAGES OF AMERICAN COLLEGE STUDENTS

Height	Weight	Neck	Chest	Waist	Hips	Biceps	Forearms	Thighs	Calves
5 ft. 2 in.	100	12 1/4	29	24 1/2	31 1/4	9 1/2	8 1/4	17 1/4	12
5 ft. 3 in.	108	12 1/2	30	25	32	9 3/4	8 1/2	17 3/4	12 1/4
5 ft. 4 in.	113	12 3/4	31	26	32 1/2	10	8 3/4	18 1/2	12 1/2
5 ft. 5 in.	122	13	32	26 1/2	33 1/2	10 1/2	9 1/4	19	13
5 ft. 6 in.	126	13 1/4	32 1/2	27 1/2	34	10 3/4	9 1/2	19 1/2	13 1/4
5 ft. 7 in.	131	13 1/2	33	28	34 1/2	11 1/4	10	20	13 1/2
5 ft. 8 in.	140	13 3/4	34	29	35 1/2	11 1/2	10 1/4	20 1/2	14
5 ft. 9 in.	149	14	35	30	36	12 1/4	10 1/2	21	14 1/4
5 ft. 10 in.	160	14 1/2	36	30 1/2	37	12 1/2	11	21 1/2	14 1/2
5 ft. 11 in.	164	14 3/4	37	31	37 1/2	13	11 1/4	22	14 3/4
6 ft.	170	15	38	32	38 1/2	13 1/4	11 1/2	23	15

Women, as a rule, come closer to the ideal figure than men in all particulars, except the waist. The unsightly notch in the side contour of many women at the waist is, no doubt, due to the corset and lack of exercise.

Following are the measurements of six New York artists' models, supposed to have figures practically corresponding with the classical ideals:

Neck	Chest	Waist	Hips	Thigh	Calf	Arm (Straight)	Forearm	Wrist	Weight	Age	Height
13	31	24	33 1/2	20 3/4	12 3/4	9 1/2	8 1/4	5 5/8	106	20	5 ft. 3 in.
12	30	22 1/2	32	20	12	9 1/2	8 1/2	6	107	19	5 ft. 4 in.
12 3/4	32	25	36 3/4	22	13	10 1/2	10	6	130	24	5 ft. 4 1/2 in.
13	33	26	38	23	14	11	10	6	138	25	5 ft. 5 in.
13	34	25	40	25	14 1/2	10 1/2	10	6	140	23	5 ft. 6 in.
14 1/2	35	31	42	23 1/2	15 1/2	12 1/2	11	6 1/4	165	27	5 ft. 8 in.
12.3*	33.6	27.3	36.6	21.1	14	11.4	10.6	6.5			5 ft. 3 in.
* Supposed classical idea as represented by the status known as the Venus De Medici											

The average height of 315,620 white men drafted for the Civil War was 5 feet 7 ½ inches; chest measure, 33 1/8 inches. The average height of American women is a small fraction less than 5 feet, 3 inches.