OBSERVATIONS

ON THE

STRUCTURE AND ECONOMY

OF

PLANTS:

TO WHICH IS ADDED

THE ANALOGY

BETWEEN THE

ANIMAL AND THE VEGETABLE KINGDOM.

BY ROBERT HOOPER,

OF PEMBROKE COLLEGE, OXFORD, M. D. F. L. M. S.
AND FELLOW OF THE LINNEAN SOCIETY.

Veniet tempus quo iſta, quæ nunc latent, in lucem dies extrahat.
LINNÆUS in Introit. ad Syſt. Nat.

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MURRAY and HIGHLEY, Fleet Street, LONDON.

1797.

TO THE

REV. JOHN SMYTH, D. D.

MASTER OF PEMBROKE COLLEGE

OXFORD,

AND

PREBENDARY OF GLOUCESTER;

THIS ATTEMPT TO EXPLAIN

THE STRUCTURE AND ECONOMY

OF

PLANTS,

IS RESPECTFULLY DEDICATED

BY

THE AUTHOR.

INTRODUCTION.

THE following obſervations are of an elementary nature, and principally intended for thoſe who have not made the ſubject their particular ſtudy. I have therefore ſelected ſuch uſeful information, and elementary intelligence, as may enable the reader to view this department of animated nature with pleaſure and advantage; and rather than ſatisfactorily gratify curioſity, have endeavoured to excite it.

The writers who have deſcribed with the greateſt accuracy the Anatomy and Phyſiology of Plants, are GREW, MALPIGHI, LINNÆUS, PLENCK, DU HAMEL, HALES, JACQUIN, HEDWIG, IN-

GENHOUZE, WINDENOW, USLER, and others. To the labours of these writers I am greatly indebted, and ingenuously declare, that from them I have extracted many interesting passages.

At the end is subjoined a general Analogy between the Animal and Vegetable kingdoms. In doing this I have consulted and benefited by the remarks of the most celebrated writers on the subject; particularly BUFFON and BONNET, to whose extensive and learned observations the reader is recommended for further information.

Pembroke College, Oxford,
May 15, 1797.

CONSPECTUS.

THE STRUCTURE AND ECONOMY OF PLANTS.

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Shortly will be published by the AUTHOR,

THE

ANATOMY AND PHYSIOLOGY

OF THE

HUMAN INTESTINAL WORMS,

WITH PLATES,

IN WHICH WILL BE GIVEN

AN ACCOUNT AND DRAWING

OF THE

TRICURIS OR LONG THREAD WORM

LATELY DISCOVERED.

CHAP. I.

The Structure of Plants in general—Of the Trunk—Of the Root—Of the Leaves—Of the Flower—Of the Veſſels and their Fluids.

THE STRUCTURE OF PLANTS IN GENERAL.

A PLANT is a living, irritable, organic, hydraulic body, deſtitute of ſenſibility and voluntary locomotion; compoſed of three parts, namely, ſolids, fluids, and a vital principle.

The SOLID PARTS of plants, like thoſe of animals, are formed of *ſimple* fibres, ſo arranged, as to give a proper ſupport to their various parts, and that degree of ſolidity, that each may require.

The SIMPLE FIBRES, intermixed in various ways, form the membranes, cellular ſubſtance, receptacles, and veſſels.

Out of the ſimple ſolid parts, are formed the *organic* parts of vegetables, as the trunk, root, leaves, parts of fructification, &c.

THE TRUNK.

The trunk of a tree, is compoſed of ſix organic parts, namely, epidermis, cortex, liber, alburnum, wood, and medulla.

The Epidermis, or *cuticle*, is the external or outermoſt bark, formed of fibres, which croſs each other in every direction. Its texture is ſometimes ſo thin, that the direction of the fibres becomes viſible, by holding it againſt the light. The uſe of the epidermis is to defend the cortex, which lies next to it, from the injuries of the air; to keep open, by its callous nature, the pores of the exhaling and inhaling veſſels; to modify the impreſſions of external objects upon the vegetable; to protect the extreme ramifications of the aerial or aqueous veſſels; and to cover the cellular ſubſtance, in which the ſeveral fluids are elaborated.

When the epidermis is deſtroyed in the living plant, it is regenerated; adheres more firmly to the cortex, and forms a kind of cicatrix or ſcar.

The Cortex, or *outer bark*, is ſituated next to the epidermis, is of a hard texture, and looſely adheres

adheres in *trees* to the next covering or liber; but in tender plants it is ſoft, and called the *cutis* or *ſkin*.

The Liber, or *inner bark*, is the third integument of the trunk of trees; it is membranous, flexile, and ſometimes wholly ſeparable from the cortex and alburnum, hereafter to be deſcribed. Theſe two coats of a tree, namely, the cortex and liber, are formed of laminæ, as will appear by macerating them in water; by which the cellular ſubſtance is deſtroyed, and the laminated appearance becomes conſpicuous. They appear to be parts very eſſential to the life of the vegetable, for in them the principal functions of life, as nutrition, digeſtion, ſecretion, &c. are performed; as is evinced in thoſe trees which are hollow within, and plants which are kept in vigour by the good ſtate of their barks, although rotten internally.

The Alburnum, is the next integument to the liber, ſituated between it and the wood, compoſed of a ſoft white ſubſtance, not eaſily diſcernible in ſome trees; but in the *oak* and *elm* it is harder and more apparent. It is, as it were, an imperfect wood, not having acquired the degree of conſiſtence proper to perfect wood; on which account, it may be compared to the cartilages of animals, which at length become bone. It is that ſtate between bark and wood, that the former muſt neceſſarily arrive at, before it can become the latter. The hardneſs of the alburnum is in proportion to the vigour of the plant.

The Wood, or *Lignum,* is the compact fibrous ſubſtance, diſpoſed into concentric layers, ſurrounding the medulla or pith. It appears to be compoſed of a congeries of dried veſſels, and in annual and biennial plants is called the *Fleſh.*

The Medulla, or *pith,* or innermoſt ſubſtance of trees, is ſoft and veſicular, and differs from cellular texture by its ſnow white colour. In young trees it is moſt copious; but, as the plant grows, it diminiſhes and at length diſappears. Thus it is evident that the medulla is neceſſary in the beginning of the life of plants, but not for its continuation. Perhaps nature reſerves a ſuperfluous nutritious humour in the medulla, if from any cauſe the young plant ſhould become dry; that it then may be abſorbed and converted into aliment.

What has been ſaid of the trunk, is applicable, in every reſpect, to its branches and ramifications; they having the ſame parts, continued from the trunk, of which they form a part.

THE

THE ROOT.

The root of trees is only a continuation of the trunk defcending into the earth, and it appears to confift of the fame parts, although lefs confpicuous: thus, if the trunk of the Salix or Willow, or any other tree, be torn up, and inverted, fo that the trunk and branches be put into the ground; then the part, which was originally trunk and branches, becomes root, and the root is converted into trunk and branches.

The root and its ramifications are fixed in the earth, left the plant be torn up by the wind.

The radicles, which are every where given off from the root and its ramifications, abforb a nutritious juice from the earth, for the increafe, &c. of the vegetable; thus, the radicles, with the leaves of the plant, conftitute the *abforbent organ.*

THE LEAVES.

The leaves are produced from the barks of the trunk of the plant, and confift of an epidermis, a vafcular net-work, and a parenchyma full of a greenifh juice. They are every where fupplied with fibres, which are commonly termed the *nerves* of the leaf, but which are merely its veſſels running in every direction, and branching out into innumerable ſmall threads, interwoven with the parenchyma, like fine gauze or lace.

The *ſurface* of the *epidermis* of a leaf, like that of an animal, is full of pores, which ſerve both for reſpiration and the abſorption of dew, air, &c. Theſe pores or orifices differ both in ſhape and magnitude in different plants, which appears to be the cauſe of the variety of texture, peculiar to every plant.

The *parenchyma* conſiſts of very minute fibres, diſpoſed in extremely ſmall cells, which are of various ſizes in the ſame leaf.

All leaves, of whatever figure, have a marginal fibre, by which the reſt are bounded. The particular ſhape of this fibre determines the figure of the leaf.

The *veſſels* of the leaf have the appearance of inoſculating; but when examined by a microſcope, they are found only to be interwoven or laid along each other.

The uſe of the leaves is to nouriſh the plant with the nutritious juice they reſerve in their parenchymatous ſubſtance; and to expire and inſpire air and water.

THE

THE FLOWER.

All the parts of a plant appear to contribute to the fructification, by which is underftood the flower and fruit of plants; for although the fruit does not fwell and ripen until after the flower has fallen, its rudiment or firft beginning is in the flower, of which it properly makes a part.

The Flower is a temporary part of vegetables allotted to generation, terminating the old vegetable, and beginning the new. It confifts of feven principal parts, namely, the calyx, corolla, ftamina, piftillum, pericarpium, femina, and receptacle; the four firft belong properly to the flower, and the three laft to the fruit.

1. The *Calyx*, empalement, or flower-cup, is the termination of the cortex or outer-bark of the plant, which, after accompanying the trunk through all its branches, breaks out in the flower, and is prefent in the fructification in this new form. Its chief ufe is to enclofe and protect the other parts of the flower. It receives different appellations according to the circumftances with which it is attended.
2. The *Corolla*, foliation, or leaves of the flower,

is the termination of the liber or inner-bark, continued to and accompanying the fructification in this new form of painted leaves. Its uſe is the ſame as that of the calyx, ſerving as an inner work of defence, for the parts it encloſes; as the calyx, which is uſually of a ſtronger texture, does for an outer one. The leaves, of which the corolla conſiſts, are called *petals*. The corolla receives different names according to the number, form, &c. of the petals.

3. The *Stamina*, threads or chives, are the male part of the flower, deſigned for the preparation of the pollen. Each ſingle *ſtamen* conſiſts of three parts,

   1. The *Filament*, or thread, which ſerves to elevate the anthera or ſummit, and at the ſame time connects it with the flower.
   2. The *Anthera*, or ſummit, ſituated on the top of the filament, which contains within it the pollen, and when come to maturity diſcharges the ſame.
   3. The *Pollen*, farina fecundans, or meal, contained within the anthera, is a fine duſt ſecreted therein, and deſtined for the impregnation of the germen, hereafter to be deſcribed. Each portion of this meal is by a microſcope ſeen to be concealed in

a very

a very fine pellicle (which at the time of impregnation burfts) containing the prolific liquor.

4. The *Piftillum*, piftil or pointal, is the female part of the flower, defigned for the reception of the pollen. It confifts of three parts,
   1. The *Germen*, which is the rudiment of the fruit, accompanying the flower, but not yet arrived at maturity. It is fituated at the bottom of the ftyle, and is generally called germen until the antheræ have difcharged their pollen; after which period, it becomes the pericarpium.
   2. The *Style*, which is the part that ferves to elevate the ftigma from the germen.
   3. The *Stigma*, or fummit of the piftillum. It is moftly covered with a moifture, for the purpofe of retaining and diffolving the pollen.
5. The *Pericarpium*, or feed-veffel, is the germen juft defcribed when grown to maturity, and which, when ripe, difcharges the feeds it contained. The pericarpium of feveral vegetables has a confiderable quantity of a proper juice, contained in a parenchymatous fubftance or in veficles, every where fupplied with very minute air and fap veffels. Thefe are called *fruits*.

6. The

6. The *Semina*, or feeds, are a deciduous part of the vegetable, each feed including the rudiment of a new one; endowed with a vital principle by the fprinkling of the pollen, which they are capable of retaining for an immenfe time. The following parts are obferved in a feed.

   1. The *Corcule*, or embryo of the new plant, within the feed. It is divided into the plumule and roftel.

      The *plumule*, is the fcaly afcending part, confpicuous when a feed begins to vegetate.

      The *roftel*, is the plain part of the corcule, and always defcends into the earth.

   2. The *Cotyledon*, or fide of the feed, of a porous and perifhable fubftance.

   3. The *Aryllus*, or exterior covering of the feed, which comes off fpontaneoufly.

   4. The *Hilum*, or external mark or fcar on the feed, where it was faftened to the pericarpium.

7. The *Receptacle*, is the bafe which connects the other parts of the flower together.

Upon thefe parts of the flower, but more immediately upon the number, pofition, &c. of the ftamina and piftils, the beautiful SEX-

UAL SYSTEM of vegetables is founded; a fyſtem, the diſcovery of which was reſerved for the immortal LINNÆUS.

From what has been ſaid reſpecting the uſes of the different parts of the flower, the following principles may be deduced.

1. That *every* vegetable is furniſhed with flower and fruit, there being no ſpecies where they are wanting.

2. That there is *no fructification* without anthera, ſtigma, and ſeed.

3. That the anthera and ſtigma conſtitute a *flower*, whether the coverings (calyx and corolla) be preſent or wanting.

4. That the ſeed conſtitutes a *fruit*, whether there be a pericarpium or not.

It would be needleſs to deſcribe the texture and nature of the veſſels of flowers, as they are very ſimilar to thoſe of the trunk to be deſcribed; and it would be foreign to the ſubject, to take any notice of the characters and diſtinctions of the different parts of the flower, which belongs to the ſcience of botany.

Every part of the flower is perfectly formed before it appears outwardly, and the flowers, which appear this year, are, properly ſpeaking, thoſe of the laſt; mezereon, for example, flowers

flowers in January, but the flowers were completely formed in the month of Auguſt preceding. This fact will alſo be demonſtrated, if the coats of a tulip root about the beginning of *September* be ſeparated; for in the center a kind of cell will be found, in which the young flower is ſituated, which is not to make its appearance until the following *April* or *May*.

THE VESSELS OF VEGETABLES.

Vegetables, like animals, have their fluids contained in certain appropriated veſſels, ſtrengthened by a thin fibrous texture. By theſe veſſels, which are diſpoſed in a regular order, the different functions neceſſary to the growth of the vegetable and its various ſecretions and excretions are performed.

The veſſels of vegetables are divided into,

1. The *Succous*, which aſcend perpendicularly, and carry the nouriſhment or chyme of the plant from the root, to every part. At their extremities they are generally called *abſorbents*.
2. The *Utriculous*, which run horizontally in the cellular texture, and are evident upon cutting the trunk in a ſtreight direction.

3. The

3. The *Medullary*, which belong to the medulla; they are few in number, and never faſcicu-lated, and run very irregularly in an hori-zontal direction.
4. The *Proper*. Theſe are very thin, and found lying cloſe to the larger veſſels. May not theſe be veſſels of nutrition?
5. The *Spiral*. Theſe are contorted in a ſpiral form, and are larger than the ſuccous veſ-ſels, by which they are ſurrounded in cluſ-ters. They are ſituated under the external ſkin, and carry air and their proper juice at the ſame time. They are alſo called ſpiral *tubes* or *tracheæ*, but may with greater pro-priety be termed pneumato-chymiferous veſ-ſels. When a leaf is ſlowly broke, they ap-pear like ſmall woolly fibres, connected at both ends of the broken leaf.

The internal ſurface of the ſuccous veſſels is *villous*; as the plant encreaſes, they gradually thicken; and in the ſtems of annual and bien-nial plants, they at length form a ligneous *ring*. In the trunks of trees two of theſe annuli are found every year, which are ſeparated from the preceding by a denſe cellular texture.

THE

THE JUICES OR HUMOURS OF PLANTS.

The fluids contained in the veſſels and receptacles of plants, are of two kinds; namely, proper and common.

The common juice is inodorous and aqueous, and is, as it were, the very *blood* of the plant. It is found in all the veſſels of the plant, and is that from which nutrition is performed, and the other fluids ſeparated.

That plants contain *water*, is evident from wounding their trunks, in the beginning of ſpring. Thus a copious liquor, little different from common water, flows from the Acer or Maple tree, from the Betula or Common Alder tree, and from the Vitis Vinifera or Vine.

If an inciſion be made in the cortex only, little or no water flows out; but the deeper the inciſion into the wood, the more copious the efflux.

If an inciſion be made before the trees are furniſhed with leaves, no juice flows out; but after their developement, it begins to bleed, and that from both the lips of the wound.

Wounds made in autumn, remain freſh in the winter, and drop as often as warm weather follows

follows after froſt; but only in that part of the trunk oppoſed to the ſolar rays.

From theſe experiments it is evident, that the aqueous veſſels are principally ſituated in the wood of trees; that the water of a tree furniſhed with leaves, is carried through the veſſels to ſupport thoſe leaves; and that the fluid is conveyed upwards and downwards.

The proper juice is ſecreted from the common juice, and occupies peculiar veſſels and receptacles, and differs in its nature, ſmell, taſte, colour, &c.

In ſome liliaceous plants it is *green*; in the Fig, *lacteal*; in the Celandine *yellow*; in the Plum tree, *gummy*; in the Pine tree, *reſinous*; in the Maple, *ſweet*; in the Poppy, *narcotic*; in the Spurge, *cauſtic*; and in many plants, *bitter*.

Although this juice may appear to reſide in every part of the plant, yet its proper place ſeems to be between the cortex and alburnum; for if an inciſion be made in that part, it drops in greater abundance: hence it follows, that the veſſels deſtined to convey the juice, are principally ſituated between thoſe barks.

Such is the mechaniſm, by which vegetables are nouriſhed, grow, and unfold their parts.

CHAP.

CHAP. II.

Of the Elements—Principles—External Qualities—Native Place and Use of Plants.

THE ELEMENTS OF PLANTS.

THE most simple bodies of a vegetable substance which can no longer be divided by chemical analysis, are called its *Elements*.

The elements of vegetables as yet known are heat, light, electric matter, carbon, hydrogen or inflammable air, oxygen or vital air, azot or mephitic air, phosphorus, sulphur, metals, and an earth, as are explained in chemistry.

A thermometer was plunged into a hole made in a sound tree, and it constantly indicated a *temperature* several degrees *above* that of the atmosphere, when it was below the 56th degree of Farhenheit: but in very hot weather the heat of the vegetable was several degrees *below* that of the atmosphere. It is also proved, that the sap of a tree will freeze at 32° when

when taken from the vegetable; but in the tree it will not freeze, unlefs the cold be augmented 15° more. Thus it appears, that heat refides in every part of a plant, and conftitutes its temperature, which, it would feem to have the power of increafing or diminifhing. In this manner the atmofphere is continually tempered by the greater or lefs degree of heat, produced in plants; and the fcorching heat of the fun, moderated by the evaporation that takes place throughout the whole body of a tree, but particularly its leaves: hence the atmofphere furrounding trees, is confiderably cooler than in other places.

Vegetables deprived of *light* become pale. Plants which grow in dark places, incline to the light, if it be fuffered to enter through a hole or crevice. Without light plants prefent one lifelefs colour, and are deprived of thofe beautiful fhades which fo much enliven the vegetable creation. By the abftraction of this element, celery, endive, and other plants are blanched, lofe their green colour, and are rendered white and fickly; and by this means fome poifonous plants are deprived of their noxious qualities, and become agreeable to the tafte. Thefe experiments prove, that light enters into the compofition of plants; yet there are ſome philoſophers, who contend, that it is not an element, but conſider it as a ſtimulus or agent, which decompoſes their nutritive principles.

That the *electric matter* (concerning the nature of which, the reader is referred to the many valuable treatiſes already publiſhed) is an element of plants, is evident from ſeveral vegetable ſubſtances affording this fluid, and which, therefore, exhibit the phenomena of vegetable electricity.

The other elements are ſufficiently explained in chemiſtry, and in the tranſpiration of plants, hereafter to be mentioned.

The nature, form, arrangement, and union of theſe elements, determine the ſpecies of vegetable. The cauſe of this union appears to depend upon the *vital principle*, which exiſts in every part of the plant, and which conſtitutes its life; for, by its means, a mode of union is induced, widely different from that which ariſes from the common laws of chemical affinity: in conſequence of which, nature produces the ſap and proper juices, as the reſins, gums, ſugar, &c. &c.

The laws of vital affinity having once ceaſed to operate, conſtitutes the death of the part in which they thus ceaſe; then, the elements, recovering

recovering their former properties, become obedient to the laws of chemical affinity, and enter into new combinations, from which new principles, or the products of putrefaction, are produced. In this manner the putrefaction of vegetables and animals is explained, to which inorganic subftances, as minerals, are in no refpect liable, as they are not compounded according to the laws of vital, but only according to thofe of chemical affinity.

THE PRINCIPLES OF PLANTS.

The SOLID PARTS of plants are compofed of vegetable gluten and a fmall portion of calcareous earth.

Chemiftry demonftrates that the *gluten* is compofed of carbon or charcoal, and azot or mephitic air.

Calcareous earth does not appear, according to chemical experiments, to conftitute the effential element of this gluten; for all the *Byffi*, and many of the *Octofporæ* and *Pezizæ*, or cup mufhrooms, do not afford it in the fmalleft quantity.

The FLUID PARTS of plants are conftituted by the following principles; namely, water, an unguinous oil, an ethereal oil, a farinaceous, gummous, viſcous, ceraceous, melleous, reſinous, balſamic, camphorated, ſaccharine, bitter, ſaponaceous, narcotic, acrid, aſtringent, colouring, acid, alkaline, neutral ſaline, mediate ſaline, and laſtly an extractive principle; as will appear by the following obſervations.

If in the ſpring an inciſion be made in the *Betula alba*, it will often yield, in one day, eight or ten pounds of ſweet *Water*. By drying, vegetables are reduced from a pound, to two or one ounce, or even half an ounce in weight, as the *Cucurbita pepo*, or Gourd.

If the nuclei of almonds, walnuts, olives, linſeed, hempſeed, the ſeeds of the poppy, cocoa, and thoſe of the ricinus or caſtor-oil tree, be expreſſed, *an Unguinous oil* is extracted. The manner in which the oil is generally obtained, is by firſt cruſhing the ſeed between large ſtones, into a kind of paſte; which is put into bags and ſqueezed in a preſs: the oil is thus forced out of the ſeed, and received in a proper veſſel.

By diſtillation, plants give over with the water, a quantity of *Ethereal oil*, which floats on the top in ſmall globules. It is collected by pouring a quantity of the diſtilled water with the oil, as it comes over, into a veſſel, ſo conſtructed, as to ſuffer the watery part to eſcape from

from a ſtop-cock, near the bottom; the veſſel is again filled, and when ſettled, the water is again let out: in this manner the oil is collected in great quantities, floating upon the ſurface of the water. The ethereal oil reſides in a particular appropriated part of the plant; thus it is only found in the corollaceous petals of the roſe, chamomile, jaſmine and hyacinth; in the ſtigmata of the *Crocus ſativus*, called ſaffron; in the calyx of the clove tree; in the leaves of mint, balm, ſage, and ſavine; in the root of valerian, ſweet ſmelling ruſh, and angelica; in the cortex of the caſcarilla tree; in the liber of the cinnamon tree; in the epidermis of the caſſia tree; in the wood of ſaſſafras and yellow ſaunders; in the whole fruit or berries of the juniper tree and laurel; in the bark of the fruit of the lemon and orange trees; in the pellicle of the bitter almond; in the ſeeds of aniſeed, fennel, and caraways, &c. &c.

The farina, flour or *Farinaceous principle*, is obtained by grinding or bruiſing the ſeeds of cereals, and ſeparating the fine part from the huſks. It may alſo be procured from the root of the potatoe plant, from yams, &c. from the fruit of cheſnut trees; and by a particular proceſs, from the roots of acrid plants, as bryony, cuckow pint, and pæony. This principle confifts of vegetable gluten, ftarch, and fweet mucilage. See chemiftry.

In warm climates (and even from fome trees in this country) the *Gummy principle* exudes fpontaneoufly, in the form of tears, from the bark of trees; as the gum Arabic from the Egyptian fpiny mimofa, *(Mimofa Nilotica Linnæi)* the Senegal gum from various fpecies of trees, near the river Senegal; the cherry gum, from the cherry-trees; and the gum tragacantha, from the *Aftragalus Tragacantha*. It is alfo abundant in the leaves of the *Malva rotundifolia*, or round leaved mallow; and in the feeds of quinces, &c. When the refinous principle, hereafter to be defcribed, is mixed with the gummous, it is called the *Gummi-refinous principle*, of which nature is the gum affa-fœtida which exudes from the *Ferula affa-fœtida*; gum galbanum, from the *Bubon galbanum*; alfo ammoniacum, fcammony, gomboge, euphorbium, myrrh, bdellium, opoponax, farcocolla, and ftorax, which exude from their refpective trees.

The antheræ of almoft every plant abound with the *Ceraceous* or *waxy principle*, and a great quantity is obtained from the fruit of the *Myrica cerifera*, *Croton cebifera*, and from laurel berries.

The

The ſtigmata of moſt flowers continually ſecrete the *Melleous principle* upon their ſurfaces; and in ſome plants, as the Fritellaria regia, &c. it even collects into drops. Chemiſtry demonſtrates, that this principle conſiſts of ſugar, diſſolved in mucilage; and balſams are found in the nectaria of ſome plants containing grains of cryſtallized ſugar.

If the roots, leaves, barks, &c. of ſeveral plants be put into ſpirit of wine, ſuffered to ſtand a few days, and the ſpirit then evaporated; the *Reſinous principle* is obtained. Sometimes it exudes ſpontaneouſly in the form of drops, from the bark of trees; as the gum maſtich, anime, olibanum, benzoe, elemi, ſandrach, guiacum, ladanum, tacamahacca, and ſanguis draconis, which are found adhering to the trunks of their reſpective trees.

If inciſions be made in the trunk of balſamiferous vegetables, as the *Copaifera officinalis*, *Amyris gileadenſis*, *Toluifera balſamum*, *Pinus balſamea*, &c. their ſeveral juices flow out; and not unfrequently ſpontaneouſly. By chemical analyſis theſe balſams are found to conſiſt of a peculiar reſin, diſſolved in ethereal oil.

By ſplitting the trunk of the camphor trees, *Laurus camphora* and *ſumatrenſis*, which grow in China, Japan, the iſles of Borneo, Sumatra, Ceylon, &c. very large and pure tears of *Camphor* are found between the barks, which are the moſt pure; but that in the ſhops is obtained from every part of the tree, by putting the branches, &c. into an iron alembic with water, covered over with a capital containing ropes of rice ſtraw, and thus expoſed to heat. The camphor in this manner is ſublimated in greyiſh grains, and theſe again unite into larger pieces. This *Principle* (which, in ſome of its properties, is nearly allied to volatile oils, but widely different from them in others, as is explained in chemiſtry) is alſo obtained in a ſmall quantity from the roots of the cinnamon tree, zedoary, thyme, roſemary, ſage, and many other labiated plants, either by decoction, or by diſtillation; from the fruit of the *Amomum repens*, called cardamoms; from the leaves of the roſemary plant, *Malaleuca leucadendra*, pepermint, marjoram, thyme, anemone, and fennel.

The *Saccharine principle* is detected by the taſte in many vegetables, eſpecially in dates, figs, ſiliquæ dulces, caſſia in the pod, raiſins, apples, quinces, plums, cherries, mulberries, currants, &c. but the plant in which it exiſts in the greateſt quantity, and from which it is obtained for economical purpoſes,

poſes, is the *Arundo ſaccharifera*, or ſugar cane, which is bruiſed between iron cylinders in the Weſt and Eaſt Indies, where it is cultivated; the juice, called Melaſſes, is then expreſſed, and by ſeveral operations made into ſugar. The trunks of the *Acer ſaccharifera* and *Fraxinus ornus* alſo afford this principle very largely; as is evident from the quantity of manna, which ſpontaneouſly flows every ſeaſon from their barks. It may likewiſe be obtained from carrots, parſnips, the roots of dandelion, ferns, liquorice, &c.

If deep inciſions be made in the leaves of the *Aloe ſocotorina*, or aloe plant, the *Bitter principle* flows profuſely from the inciſion, which inſpiſſated by the ſun, forms the aloes of the ſhops. It predominates in wormwood, quaſſia, gentian, colombo, ſimarouba bark, and the bitter apple.

If the leaves of the *Saponaria officinalis*, or ſoap-wort, be dried and powdered, it waſhes greaſy ſpots out of linen with water, and froths like ſoap. This *Saponaceous principle* is alſo found in the nuclei of the *Sapindus*, the roots of the *Cichorium*, *Scorzonera*, *Tragopogon*, *Bardana*, *China nodoſa*, *Sarſaparilla*, *Scabioſa ſucciſa*, *Carex arenaria*, *Ononis arvenſis*, and *Aſtragalus exſcapus*.

If

If the pericarpium of the *Papaver ſomniferum* be wounded, a juice flows from the inciſion, is inſpiſſated by the heat of the ſun (which in Turkey, where the plant is cultivated, is very powerful), and, when the poppy ceaſes to afford any more, is collected by the Turks for ſale. This *Narcotic principle* is called Opium in the poppy, and only reſides in the ſeed veſſel. That obtained in this country would appear to be as powerful as the opium imported from abroad, and may, by cultivation, be collected in conſiderable quantities. I wounded ſeveral poppies, laſt year, with the point of a needle, and each afforded a grain and a half, many three grains. If theſe punctures or inciſions were made in twenty different places of the ſame poppy, half a drachm would be collected; and as an acre of ground will produce many thouſand poppies, the quantity would be very conſiderable. The leaves of the Tobacco plant, Hemlock, *Lauro-ceraſus*, &c. afford a ſimilar principle; and thoſe of the *Stramonium*, *Hyoſciamus*, *Belladonna*, and *Lactuca*; the ſeeds of Coryander; and the ſtigmata of the *Crocus* alſo contain it in a leſs degree.

If the leaſt portion of the *Arum ſeguinum*, or dumb cane, be put on the tongue, the perſon will experience the moſt dreadful ſenſations on the part for ſeveral days after, ſo powerful is its *Acrid principle*. The *Arum maculatum*, or Cuckow pint, *Cochlearia armoracia*, or horſe radiſh, impart the ſame ſenſation, but far leſs powerfully. It reſides alſo in the root of the *Scilla maritima*, or ſquill, *Helleborus niger*, and *Veratrum album*; in the fruit of the *Momordica elaterium*; in the ſeed of the *Sinapis* and *Piper*; in the pericarpium and ſeeds of the *Capſicum annuum*; and, laſtly, in every part of the *Cicuta viroſa*, *Aconitum napellus* and *camarum*, all the *Euphorbia* or ſpurges, *Ranunculi* or butter cups, *Anemones* and *Clematides*.

The *Aſtringent principle* (which chemiſtry demonſtrates to conſiſt of the gallic acid, and the gummous principle) is found in a vaſt variety of vegetables, but more particularly in the *galls* of the Oak, the *inſpiſſated juice* of the *Mimoſa catechu*, called terra japonica, the *bark* of the fruit of the Pomegranate and Walnut, the cortex of the *Cinchona officinalis*, called Peruvian bark, that alſo of the *Quercus cerrix* and *robur*, *Betula alba*, *Æſculus hippocaſtanus*, *Ulmus campeſtris*, *Salix caprea*, *fragilis* and *pentandria*, *Fraxinus excelſior*, &c. &c. It reſides likewiſe in the *wood* of the *Cæſalpina braſilienſis* and *Hæmatoxylon campechiana*; the *root* of the *Tormentilla*

mentilla erecta; the *leaves* of the *Thea bohea*, *Betula alnus*, and *Arbutus uva urſi*; and in the *petals* of the *Roſa centiflora*, *gallica*, *canina*, and *Punica granatum*.

All vegetables afford the *Colouring principle*; it therefore muſt be very various. The art of dying depends upon the knowledge of this principle. If the ſtalk of the *Indigofera tinctoria*, or indigo plant, be macerated in water, it affords, by precipitating the fæculum, a beautiful blue colour, called Indigo. It may alſo be obtained from the *Iſatis tinctoria*, or common woad, *Lichen roccella* and *parellus*, and the *Croton tinctorius*. In the root of the *Rubia tinctorum*, or madder, *Anchuſa tinctoria*, or alkanet; and in the wood of the *Fernambucus* or *Cæſalpina veſicaria*, this principle is red. Laſtly, the *Carthamus tinctorius*, *Crocus ſativus*, *Serratula tinctoria*, *Amomum curcuma*, *Reſeda luteola*, *Trigonella fœnum græcum*, *Geniſta tinctoria*, and *Bixa arenella*, afford in the ſame manner, a yellow fæculum.

Chemiſtry, to which we are indebted for all our knowledge of the principles of plants, has of late made many curious and valuable acquiſitions in regard to the nature of the *Acid principle*, which, it has taught us, is various. From the vegetable kingdom are obtained the citric, malic,

malic, oxalic, tartaric, gallic, and benzoic acids. The citric acid is obtained from the fruit of the *Citrus medica* and *aurantium*, *Limonia acidiſſima*, *Berberis vulgaris*, *Punica granatum*, *Rubus idæus*, *Ribes rubra* and *groſſularia*, *Pinus ceraſus*, and *Vaccinum myrtillus*. The malic reſides in the fruit of the *Pyrus malus* and *cydonia*, *Fragaria veſca*, *Rubus chamæmorus*, *Vaccinium myrtillus*, and *Sambucus nigra*. The oxalic, in the leaves of the *Oxalis acetocella* and *corniculata*, *Geranium robertianum* and *acetoſum* ; in the root of the *Rhæum rhabarbarum*, *Bryonia alba*, and *Helleborus niger* ; the *Boletus ſuberoſus* alſo exudes an acidulous humour, which, inſpiſſated by the rays of the ſun, goes into very pure cryſtallized oxalic acid. The tartaric is found in the fruit of the *Tamarindus gallica*, and in the root of the *Rumex acetoſa*, and others. The gallic acid is detected in all aſtringent plants, combined with the gummous principle. Laſtly, the benzoic acid is obtained from gum benzoe and balſam of Peru, and lies concealed in the balſam of Tolu and in Storax.

The *Alcaline principle* of vegetables is of three kinds, namely, ammoniac, ſoda, and potaſh. The former reſides in ethereal oils, and moſt naſturcine plants ; for it is obtained dur-

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ing diftillation by the addition of the carbonate of potafh or fixed alkali. Soda is prefent in the afhes of all maritime plants; and Potafh is obtained from the afhes of plants not maritime.

The *Neutral* falts from the vegetable kingdom, are various. The *Hyofciamus*, *Borago*, *Nicotiana*, *Helianthus annuus*, *Mefembryanthemum cryftallinum*, *Millefolium*, and *Fumaria*, afford nitrate of potafh [a]. The *Tamarindus gallica*, the fulphat of foda [b]. The muriate of foda [c] is obtained from the *Salicornea herbacea*, from the leaves of the American tree called *Cerciba*, which abounds fo much with it, that one leaf is fufficient to falt a fallad. There are alfo plants of this nature growing in the Province of Jago, which is far diftant from the fea; and what is wonderful, not a particle of falt can be obtained from the foil, in which they grow. The cinders of many vegetables afford the fulphat of potafh [d].

The *Rhæum rhabarbarum* conceals the *Mediate faline principle*, for fulphat [e] and oxylat of lime are obtained from it; and the *Zea-mays*,

[a] Nitre. [b] Glaubers falt, or Sal Mirabile.
[c] Culinary or Sea falt. [d] Vitriolated Tartar.
[e] Gypfum.

or

or Indian corn, affords muriate, and nitrite of magneſia.

Laſtly, the *Extractive principle* is given out by all plants, which, with the ligneous principle, is as yet not ſufficiently known in chemiſtry.

THE EXTERNAL QUALITIES OF PLANTS.

To this head principally are referred the colour, taſte, ſmell, conſiſtence, and magnitude.

The COLOUR of plants ſeems to depend upon the colouring principle, the quantity of vital air, and light; and is proper to various parts of the ſame plant: thus if the exhalation of plants be prevented, and the light intercepted, the green colour of the plant is changed into a white.

The TASTE depends upon the different principles which conſtitute the humours of the plant, and is different not only in different plants, but in different parts of the ſame plant.

The SMELL alſo is of different natures, according to the part; and depends upon the volatile principle exhaling from the plant.

The CONSISTENCE of plants is various, as downy, membranous, carneous, arid, &c. which

are

are perceptible to the touch. Young plants are moſtly mucilaginous, but as they grow, become hard; yet many flouriſh in continual ſoftneſs, as the *Tremella*, and ſome are ſo hard as to ſink in water, as the Iron wood, which grows in the iſland of Ceylon.

When the ſimple fibres of a plant are aggrandized, as far as the nature and arrangement of its elements will admit, the fibre ceaſes to receive the nouriſhment deſtined for its increaſe; and the alimentary principles only replace what is diſſipated by the tranſpiration and ſecretions of the plant: every plant, therefore, has a preſcribed INCREASE or *meaſurement*. The *Ficus indica*, by reaſon of the ramifications ſent off, and concreted with the primitive trunk, inſenſibly acquires a conſiderable thickneſs, whoſe diametric ſection is twenty, or even thirty cubic feet. Laſtly, there are accounts given of ſome plants, ſcarcely viſible to the naked eye; and of trees, ſo large as to afford by their branches covering for two hundred men.

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THE NATIVE PLACE OR SITUATION OF PLANTS.

Plants from their ſituation have been divided into terrene, ſubterranean, aquatic, paraſitic, indigenous, and exotic.

The whole ſurface of the earth, the bottom of the ſea, and even ſubterranean paſſages, are furniſhed with plants.

THE USE OF PLANTS.

It is not intended to enter fully into the uſes of the vegetable kingdom, as it would far exceed the limits of the preſent publication, being alone ſufficient to form a volume ; it ſhall therefore be conſidered under three general heads, namely, Diet, Economy, and Medicine.

The vegetables which afford *diet* to man and beaſts are numerous ; indeed it would appear that every plant was intended to afford a nouriſhment, either to man, beaſt, or inſect ; for where is the plant by which the one or the other is not nouriſhed ? Thus, cereal, oleraceous, leguminous plants and fruits are collected for man, and by his induſtry converted into wholeſome food and pleaſant drinks. Thus, cattle feed upon grafs; birds eat with impunity, feeds, &c. which are deleterious to man; and thus alfo infects devour that which is refufed by the former.

The fubftances afforded by the vegetable kingdom, for *Economical purpofes*, are various. To hemp, flax, cotton, &c. we are indebted for clothing; and the Americans, and other lately difcovered nations, make cloth as fine as filk, by merely beating out and preparing the bark of the *Phormix tenax* and *Morus papyriferus*. To the oak-tree we are indebted for our fhips, by which we are enabled to crofs the ocean, and collect riches from every quarter of the globe: and in many places, even in the prefent day, perfect houfes are built of wood alone. Many nations have no fire but that which is made of wood, or foft plants, as turfs, &c. And laftly, the wooden utenfils in ufe in this, and every other country, are numerous.

Mankind have by experiments become acquainted with the *medicinal properties* of the far greater part of the vegetable kingdom, and have felected a confiderable number of the moft efficacious, which, by experience, are found to cure particular difeafes.

CHAP.

CHAP. III.

Of the natural Functions of Plants; namely, Abſorption of Nutriment—Nutrition—Growth or Increaſe—Secretion of the humours, and tranſpiration of Plants.

THE NATURAL FUNCTIONS OF PLANTS.

VEGETABLES have a very great analogy to animals, in regard to the functions by which they are nouriſhed and increaſed, and which, on that account, are called NATURAL. Under the head of natural functions, therefore, are conſidered the abſorption of nutriment, the nutrition, growth or increaſe, ſecretion of the humours, and the tranſpiration of plants.

THE ABSORPTION OF NUTRIMENT.

The oſcula of the abſorbent veſſels, on the ſurface of the plant, take up a nutritious juice, and convey it to the different parts.

The ſurface of a plant has two ſets of abſorbents, which conſtitute the ABSORBENT ORGAN of vegetables; the oſcula of the radicles of the roots, and thoſe on the ſurface of the leaves.

The *root* imbibes the nutritious juices from the earth, by means of its abſorbent oſcula, as long as it remains tender; but as ſoon as it becomes ligneous, it emits radicles on every ſide, which continue the abſorption, and convey it, firſt to the root, and then to the whole plant. Thus, if a plant, or tree, be tranſplanted, it ſucceeds with greater certainty, the more abſorbent radicles are preſerved with the root.

The *Leaves* abſorb humours from the air, in the ſame manner, as the radicles do from the earth, and convey them to the other parts of the plant, as will be ſufficiently obvious from the following obſervations.

Plants which grow tabid by the heat of the day, revive in the night-time by the dew, which

which cannot be attracted by any other organ than the leaves.

Leaves lying in the water, or on its ſurface, preſerve their greenneſs ; but immediately become yellow, if ſpread over with oil or varniſh, by which the abſorbent veſſels on the leaf are obſtructed.

The whole plant is enervated, if deprived of its leaves.

Laſtly, the *Cacti* and *Seda*, although they have very ſmall roots in proportion to their ſize, and grow on the drieſt hills, are very ſucculent.

The Leaves of plants, eſpecially their inferior ſurfaces, are furniſhed with innumerable villi ; theſe villi are their abſorbing veſſels.

By means of the abſorbent ſyſtem, the water is diſtributed to every part of the plant, and conſtitutes its principal aliment ; deprived of this univerſal fluid, the plant droops and dies, but by its influence is not only nouriſhed, and the veſſels of the whole fabric dilated, but it contributes greatly to irritate the languiſhing fibres, and thus to augment the vital power of the veſſels. By means of this ſyſtem of veſſels, the atmoſpheric air, which is eſſential to vegetation, is alſo abſorbed ; for plants *in vacuo* cannot be evolved from the ſeed, nor can they afterwards vegetate. This moſt probably is the reaſon why ſeeds buried very deep in the earth, do not vegetate, but die.

It appears from the following obſervations that the two airs, of which our atmoſphere is compounded, are abſolutely neceſſary to the nouriſhment of vegetables; I mean the vital air or oxygen, and the mephitic air or azot.

Plants placed in *vital air* grow larger, become more powerful, and are greener than in atmoſpheric. If the ſeeds of the *Phaſeolus, Piſum*, or *Lepidium* be put into ſilicious earth, and ſprinkled with water mixed with a ſmall portion of the oxygenated muriatic acid (for in no acid does oxygen ſo abound and ſo laxly adhere), they germinate much ſooner than if ſprinkled with pure water: but if ſeeds be immerſed in diluted muriatic acid, they become black and rugous, and never germinate.

In no kind of air, deprived of oxygen, do plants vegetate; for if they be placed in azotic or mephitic air, carbonic or fixed air, hydrogen or inflammable air, they become flaccid by the heat of the ſun, and gradually die away. In nitrous air plants become inactive in a few hours. From this it would appear, that the portion of vital air imparts a natural ſtimulus, which is highly neceſſary to excite the fibres,

and

and ſuſtain the vital ſtrength of the veſſels of plants. Laſtly, vital air, with the peculiar acidifiable baſes, generates the various acids which are found in plants.

The vegetable gluten of the fibres conſiſts of carbon, chemically combined with azot, as is explained in Chemiſtry: hence it follows that the azotic air is abſorbed by the plant; and thus it is that plants increaſe ſo rapidly in cemeteries, and other places where animals and vegetables putrefy in large quantities on the ground.

Carbonic air diſſolved in water, is alſo abſolutely neceſſary to the vegetation of the plant, in order to obtain their carbonic principle, which is a conſtituent part of the fibres, oil, mucilage, and other vegetable principles.

Plants appear to obtain their *caloric*, or matter of heat, from the ſurrounding atmoſpheric air; thus the ſhades of trees are ſo cool; and hence nothing is more healthy for almoſt all plants than tepid ſhowers, by which they obtain water together with this principle. Laſtly, ſeeds do not vegetate in the cold, and many plants die in it.

Light alſo contributes to the life of plants; for thoſe which vegetate in atmoſpheric air deprived of its light, as in the night and dark places, become pale and weak; but in the day-light, ſtrong and coloured. Thus the *Lactuca endivia*, tied up by the gardener, grows white internally and green externally; the *Aſparagus officinalis* covered with argillaceous earth becomes tender and white, and increaſes ſlowly; but if not covered, ſoon branches out, becomes firm and ſaturated with a green colour. The rays of light appear, likewiſe, to contribute to ſtimulate plants to exhale their ſuperfluous vital air, and the matter of light itſelf enters into the compoſition of plants with the various *gaſſes* or vapours they abſorb from the air.

From theſe obſervations, it will appear, that water and air form the principal nouriſhment of plants, and that their different modifications and reſpective actions on the irritable fibre, are advantageous or deſtructive to vegetable life.

THE NUTRITION OF PLANTS.

The nutrition of plants is one of the principal actions of the vegetable economy, and is defined, that operation, by means of which the abſorbed ſubſtance is converted or aſſimilated into alimentary matter.

The nouriſhment of animals is found to be compoſed of principles analogous to thoſe which

which enter into the nouriſhment of vegetables. It is true, the alimentary matter is leſs attenuated and leſs divided, when it enters into the interior of the former, than when into that of the latter. The animal by peculiar powers decompoſes all the nutritive ſubſtances in the *primæ viæ*, or ſtomach and inteſtines, into their elementary parts, which chemically unite and form proper alible ſubſtances to be abſorbed by the patulent oſcula. Nature performs the ſame operations in the earth, to ſupply vegetables ; for by the putrefaction of the various inorganic ſubſtances, their elementary principles are diſengaged and attracted by the mouths of the abſorbent radicles. Thus, vegetables, like animals, are nouriſhed by a ſimilar ſet of veſſels, which in the former are ſituated externally, but in the latter are placed internally in the inteſtines.

The organs of nutrition of vegetables (like thoſe of the circulation in animals) are the moſt active powers that nature has beſtowed upon them; for by their actions the aliment is converted into a peculiar fluid (totally different in its nature from what it was before its abſorption) called the ſap, which, in conſequence of this action, becomes endowed with the vital principle. This animated alimentary matter, univerſally diſtributed, ſerves for the nutrition, develope-

developement, and reproduction of vegetable ſubſtances, in which reſpect it is perfectly ſimilar to the blood of animals. It ſerves for nutrition, by its intimate penetration into every part of the plant, and for its developement by its ſoftening the parts, and rendering them ductile enough to admit of extenſion and increaſe.

The manner in which the different parts of plants receive the nutritious juice, has never as yet been ſatisfactorily demonſtrated. The following experiments, it is preſumed, may tend to throw ſome light upon the ſubject.

If a very ſucculent plant, as the *Sempervivum tectorum*, or common houſe-leek, the *Sedum telephium* or *acre*, when they begin to emit florigerous peduncles, be placed in a warm and perfectly dry place, after cutting the root; then not only the peduncles are obſerved increaſing, but the flowers alſo gradually unfold, and very often bear fruit. In the mean time, the inferior leaves gradually die away, and then the ſuperior, until they are all deprived of their nutritious juice, and nothing remains but the epidermis and a few parenchymatous veſſels.

The ſame phenomena are obſerved in the drying of plants (when uninjured) to be put into an herbarium.

Secondly, the inferior leaves of plants left in their

their native ſoil become arid when the flowers blow, and all the leaves gradually dry and fall, as ſoon as the fruit is quite ripe.

Thirdly, ſucculent plants in very dry places, and in very warm countries upon a defect of rain, appear to live in the ſummer months upon the nutritious juice of the leaves alone. The bulbs alſo of bulbous plants ſeem to prepare a nutritious juice for the ſtem, leaves, and flowers; for as ſoon as theſe parts are evolved, the bulbs waſte away.

Fourthly, plants without leaves, as the *Cacti* and *Cuſcuta*, conſiſt of a carneous ſubſtance, ſimilar to the parenchyma of leaves, which would appear to be their nouriſhment; for the juice in this, as it were, fleſhy ſubſtance is elaborated to ſupply the parts of fructification of the plant.

From theſe obſervations, it is evident, that chyme is carried through the abſorbent oſcula into the ſuccous veſſels, of which they are a continuation; and by the pneumato-chymiferous veſſels into the parenchyma of the leaves; there to be changed into a nutritious juice by the vital principle: and thus prepared, to be carried to all the other parts of the fructification, through their proper veſſels, and inſerted by the ſame power into all the fibres, or to ſerve for the various ſecretions.

In this mode then, all the parts of a plant are

are nouriſhed, the veſſels elongated, and the whole plant increaſed; and thus nutrition appears to be, the continued power of the *Formative niſus**, by which the plant was generated from the ſeed, and by which it is increaſed and preſerved by nutrition until it periſh.

The leaves of plants being thus ſupplied with parenchyma, which is the receptacle for the nutritious juice, may with propriety be conſidered as analogous to the *adipoſe paniculus* of animal bodies.

When the fruit of plants is ripe, nutrition and increaſe ceaſe, and the veſſels gradually become ligneous and impervious.

THE GROWTH OR INCREASE OF PLANTS.

Many ingenious theories have been invented with a view to explain the myſtery of the growth of organic bodies. When it is once well underſtood how a ſimple fibre increaſes and extends itſelf, it will be comprehended how a grain becomes a tree, and an egg produces an animal.

Experiments may be made to diſcover the laws, which organic bodies obſerve in their

* See Profeſſor Blumenbach's Treatiſe on Generation, tranſlated from the German by Dr. Crichton.

growth

growth or increafe; an exact fcale may be formed of their refpective extenfions; obfervations may be made on the interior ftructure of fuch bodies, and on the manner in which the organs feparate and diftribute their refpective juices; and the action of the veffels and the motion of the humours may be reduced to calculation. All this knowledge, though precious, does not fuffice to diffipate the darknefs which involves the mechanifm of increafe, by which is underftood, when applied to vegetables, the evolution of parts which conftitute the plant; for if the feed be obferved in the microfcope, it will appear that it has in miniature all the parts effential to form the future tree.

In order, therefore, to render this part of the phyfiology of vegetables as clear as its nature will admit, it is neceffary to examine the formation of the feed; to demonftrate the ufes of its different parts; and to accompany it from the time it begins to vegetate, until it arrive at a ftate of maturity.

The feed is compofed of two *effential* parts, namely, the cotyledon and corcule.

The *Cotyledon* is that farinaceous mafs, for the moft part feparable into two lobes.

The *Corcule* is a fufiform body immerfed in the vertex of the cotyledon. It may with propriety

priety (as will hereafter be explained) be confidered as the true embryo of the plant, and confifts of two parts, the plumule, bud or gem, and the roftel; the firft immerfed in the cotyledon, the other projecting from it, as is explained in the anatomy of the feed, page 10.

If the feed of the *Phafeolus* be put into water, after a fhort time it begins to fwell, and becomes turgid, on account of the water abforbed through the pores of the cuticle of the feed, which by the affiftance of the vital power diffolves the farinaceous matter in the cotyledon. The cuticle of the feed, incapable of further diftenfion, is then ruptured, and the corcule unfolds itfelf into the roftel and plumule. The roftel, which contains the rudiments of the root and its ramifications, foon pierces the earth, and is gradually prolonged into the root; and the plumule (which contains the rudiment of the future ftem, branches, leaves, flowers, &c.) advances flowly, and at length afcends through the earth.

As this little plant, as foon as it is evolved from the feed, wants organs and ftrength, by which it may attract its nourifhment, nature has placed a farinaceous matter in the cotyledon of the very feed, which is diffolved by the abforbed fluid into a nutritious mucilage, and

carried

carried by the veſſels of the cotyledon to the corcule of the plant for its firſt nouriſhment. Thus, if a ſeed have no *farina,* or if what it has be corrupted, it never becomes a plant.

When the farinaceous mucilage is conſumed, the cotyledons are changed into ſeminal leaves; conveying the nutritious juice to the new plant, until it has, at length, acquired ſufficient ſtrength to gather aliment from the earth by its own proper radicles; then, and not before, the ſeminal leaves, like the placenta in animals, are no longer neceſſary, and having exhauſted their nutritious juice, they become dry and fall off.

The analogy between the animal and vegetable, in this reſpect, is better illuſtrated in the tender almond, which encloſes a ropy ſubſtance, very ſimilar to the yellow of the egg, covered over with a veſicle; which veſicle is lubricated with a tranſparent liquor, ſimilar to the white. Thoſe who are acquainted with the formation of the ovula of animals, will immediately perceive this wonderful ſimilitude.

When, by a certain ſtimulus to the latent vital principle, vegetation commences, the veſſels may be ſeen ramifying on the interior of the lobes *.

* I have in contemplation the publication of ſome very beautiful

It is a very ſingular phenomenon, and as yet has never been explained, that the ſeed, placed in whatever direction in the earth, always turns itſelf ſo, that the roſtel, which forms the root, branches and radicles, grows downwards, and the plumule, which is to form the trunk, &c. proceeds upwards *.

Thus it appears that the ſame evolution which conducts an animal to that ſtate of perfection which is proper to it, accompanies a vegetable; which, like the animal, may alſo be detected in miniature in the ſeed or bud †.

Having thus demonſtrated the evolution of the ſeed, the growth of the root ſhall next be conſidered, and then that of the ſtem.

beautiful drawings from plants, illuſtrative of the various changes the ſeed undergoes before it arrives at a ſtate of maturity, and exhibiting the different coverings, veſſels, &c. &c. of vegetables.

* It is from this, and other very ſurpriſing phenomena hereafter to be mentioned, that ſeveral authors have offered many ingenious ſpeculations on the perceptivity of vegetables.

† The flowers of the Pear tree in bloom in the ſpring are viſible the preceding year. The ſagacity of ſome obſervers has pierced this cloud, and ſurpriſed nature occupied in preparing her future productions. Some have gone ſtill further in their reſearches, and have found in the bulbous roots of plants the rudiments of the future vegetable.

The

The root at firft advances more rapidly than the ftem; for an oak plant a foot and a half high has a root four feet in length. If the principal root be mutilated, the plant emits radicles in every direction; which always grow fafter than if the root had remained perfect. The radicles at firft do not receive any confiderable increafe; but foon after augment into a body almoft equal to the principal root, and then protrude new lateral radicles.

The roots are prolonged at the extreme apex, as will appear, if any root be coloured with varnifh in different places; and it is well known, that the radicles always fhoot out in that part where the earth is moft humid, fo that walls are frequently overturned by the power of the roots penetrating towards moift places.

The trunk of vegetables is expanded throughout its whole length, and not, like the root, at the apex only; for if the tender ftem of a plant, at the beginning of fpring, be coloured over with varnifh, and marked in different places, the marks will, after a few months, be obferved to have receded.

In *annual* plants the expanfion of the ftem in length continues until the explication of the flowers ; then the fibres of the ſtalk begin to be indurated, and at length gradually become dry.

In *perennial* plants the increaſe of the ſtem continues until the leaves fall in Autumn, whilſt a gem or bud ariſes in the apex, in which the rudiment of the new ſtem during winter increaſes ſlowly until the following ſpring ; when, caſting off its winter involucra, it continues the increaſe of the ſtem in the ſame way as the inferior part increaſed during the former years : for in that place where a bud is ſeated, a tumour extends, which is ſo continued with the new ſtem as ſcarcely to leave any veſtige.

The increaſe of the ſtem in breadth does not ariſe from the dilatation of the ligneous ſtrata, but from the generation of new ſtrata, which are annually depoſited by the veſſels of the bark. This is fully illuſtrated by the following experiments.

If the ring of the bark be torn from the trunk of a tree, and the ligneous cylinder of the naked part be perfectly ſurrounded with a leaf of tin, and the whole (after having replaced the cut-out ring of the bark) be covered with the tree plaſter ; then, upon cutting the tree

ſome

ſome years after, it will appear that the ligneous cylinder covered with tin has received no increaſe, and that the tin inſerted between the ligneous cylinder and the new ligneous ſtrata is complete. Theſe ligneous ſtrata appear to be generated from the cortex; for if metallic threads be inſerted obliquely into the cortex, they are after ſome years found in the wood itſelf, and not in the cortex.

Obſervation teaches, that the trunk of trees receives two ligneous ſtrata annually; but the thickneſs of theſe ſtrata is not every year the ſame; for it is greateſt when the tree is of a middle age, and the warmer the ſummer, the more ſlender the bark.

The bark would appear to be protruded by the vital power of the veſſels placed in the wood.

The generation of *branches* appears to be from the *corona*, or plexus of veſſels ſituated between the wood and medulla, from whence they proceed. A germ or bud produces a new branch, ſo that it may be ſaid to give birth to a new plant, which was ſhut up and laid concealed in that bud; for the branch contains every part eſſentially neceſſary to form a new plant, as is evident from cutting off a branch, and planting it, by which a perfect tree is produced.

The veſſels principally protrude where there is the leaſt reſiſtance in the bark, as in the axilla of the leaves, nodes, and joints; the ſame is obſerved of the branches of the root, and explains:

Why the propagation of plants does not ſucceed by the ſlip or branch, unleſs a node, joint, or germ, remain in them.

Why, if a branch of a tree (as yet adhering to it) be plaſtered round with earth or humid dung, there proceeds from it a root into the earth or dung.

Why the antients falſely attributed the generation of boughs to the medulla of the tree; for in trees deſtitute of pith, we ſee that no branches are produced.

The generation of *leaves* originates from the veſſels of the bark only; for, the bark being ſeparated from the wood, no connection of the leaves with the wood can be obſerved; and the bark alone, if put into water, produces leaves.

In the generation of *flowers*, the exterior bark, or epidermis, appears to proceed into the calyx, the alburnum into the corolla, and the ſeries of veſſels into the nectarium, ſtamina, and piſtils.

THE

THE SECRETION OF THE FLUIDS.

The ſimilitude between the animal and the vegetable kingdom is marked by many ſtriking characters, of which the ſeparation of the different humours is one; they being all ſecreted from the common maſs called the ſap, as the animal ſecretions are from the blood.

During the motion of the fluids in the plant, the nutritious part is, by the formative power of the *vis vitalis*, applied to all the ſolid parts of the plant; another part is depoſited, by peculiar ſecretory veſſels, in particular receptacles, or on particular parts; and the uſeleſs or ſuperfluous part is tranſpired through the leaves, or perhaps eliminated through the roots *. Thus the ethereal oil of the *Citrus aurantium* is ſecreted only into the veſicles of the bark of the fruit. In the *Laurus cinnamomum* it is ſecreted in the liber of the trunk, it being the only aromatic part of the whole plant. Thus,

* Humbold aſſures us, that vegetables ſecrete impurities or fæces through the extremities of their roots during the night, and thus derives the effect of fallowing, and the harmony which exiſts among plants. "Sic læditur," ſays he, "avena a ſerratula arvenſi, triticum ab erigero acri, linum "ab euphorbia peplo et ſcabioſa arvenſi, &c."

the unguinous oil of the almond is ſecreted in no other part of the tree; the ſame ſhould be obſerved of all the reſins, mucilages, ſaccharine, and other humours of plants, they being all ſecreted from the ſap by peculiar veſſels.

As theſe different fluids cannot be detected in the ground, nor in the atmoſphere, nor in the ſap of the plant, it is evident they are generated by a peculiar power in the ſecretory veſſels. By the ſpecific oſcillation of theſe veſſels, the vegetable chyme ſeems to be decompoſed into their elements, and theſe, at length, forming new unions, compoſed into new principles.

THE TRANSPIRATION OF PLANTS.

Plants emit from the ſurface of their leaves an exhalation, in the form of vapour, which is called the tranſpiration of plants. The truth of this fact is proved by their diminiſhed weight in the day; and by placing a glaſs bell over ſome mowed graſs in a field; in two minutes, although the ſeaſon be very warm and dry, the internal ſurface of the glaſs will be covered with a great number of aqueous drops.

That tranſpiration is chiefly carried on by the leaves, would appear from ſeveral experiments

ments hereafter to be mentioned ; indeed it is evident from their ſtructure being ſo very porous, and from trees deſtitute of leaves ſuffering no diminution of weight: whereas thoſe trees which are furniſhed with leaves, are very conſiderably diminiſhed in weight through the day.

It has been very ſatisfactorily proved by ſeveral writers, that the leaves are the principal organs of perſpiration: by ſome they have been conſidered alſo as the powers which elevate the ſap; but the prodigious force of the ſecretion of the weeping vine would ſeem to demonſtrate that the leaves are not the ſole powers which nature has here ſet to work ; and injections confirm this idea; for the coloured fluid elevates itſelf very high in branches deprived of leaves, and in a very cold ſeaſon.

The perſpiration of a plant by day exceeds that by night; and when a dew falls, it almoſt wholly ceaſes.

In the night time the leaves rather inhale than tranſpire.

The quantity of perſpired water in the day, is, in ſome plants, very conſiderable, as will appear from the following experiment.

In the month of July, commonly the warmeſt ſeaſon of the year, a large ſun-flower, three feet and a half high, was purpofely planted in a flower-pot when young. The pot was covered with thin millen lead, leaving only a fmall hole to preferve a communication with the external air, and another by which the plant might be occafionally fupplied with water. Into the firft hole was inferted a glafs tube nine inches long, and one fhorter, into the hole by which the water was introduced; and the latter was kept clofe ftopped with a cock, except when there was occafion to ufe it. The holes in the bottom of the pot were alfo ftopped up with corks, and all the crevices fhut with cement. Things being thus prepared, the pot and plant were weighed for fifteen feveral days; after which the plant was cut off clofe to the leaden plate, and the ftump well covered with cement. By weighing, it was found that there perfpired through the unglazed porous pot two ounces every twelve hours; which being allowed for in the daily weighing of the plant and pot, the greateft perfpiration, in a warm day, was found to be one pound fourteen ounces; the middle rate of perfpiration, one pound four ounces. The perfpiration of a dry warm night, without any fenfible dew, was about three ounces; but when there was any fenfible, though fmall,

dew,

dew, the perſpiration was nothing ; and when there was a great dew, or ſome little rain in the night, the plant and pot was increaſed in weight, two or three ounces.

Thus the quantity of water which plants in a flowering ſtate perſpire is very great. It is known by experiment, that one leaf of a tree within twenty-four hours perſpires ten grains, ſo that a tree which has 20,000 leaves perſpires within a day one pound. The ſingle ſtem of the Indian corn, *Zea mays*, perſpired in the ſame time ſeven ounces. A ſingle plant of the ſea cabbage, *Braſſica oleracea*, twenty-three ounces, and that of the *Heliotropium*, twenty-four ounces. Hence an acre of a field (which contains 30,240 ſquare feet) in which plants are ſo diſpoſed, that each be a foot diſtant from one another, would ſoon become a lake of water (provided there were no proviſions for its abſorption), allowing that every plant perſpires eighteen ounces.

Plants cannot draw in this great quantity of water from the ſummer rain only, for in many places it can be proved, that the rain is not in ſufficient quantity ; ſo that it is evident, that the rain which falls in the winter moiſtens the earth, and is retained until the ſummer, when, by means of the heat of the atmoſphere, it is abſorbed by myriads of radicles, and tranſpired by the plant.

Having thus eſtabliſhed that the leaves of vegetables are the principal organs of perſpiration, it is propoſed making ſome obſervations on the laws relative thereto.

The immediate action of the ſolar rays, greatly promotes tranſpiration; hence plants in ripening ſhould be expoſed to the ſolar rays, that they may the ſooner ripen by tranſpiration.

In winter there is ſcarcely any tranſpiration, nor in rainy weather, nor in humid air: but the greateſt degree of tranſpiration takes place in warm dry weather, and eſpecially when there is a dry wind.

An healthy plant perſpires more than a weak one, ſo that *they* labour under an error, who think that by watering plants in ſome diſeaſes, they aſſiſt them; for it makes them putrefy ſooner.

Exceſs or defect of tranſpiration, is hurtful to a plant; it ſhould in general be in proportion to the aliment.

As, in tranſplanting of trees, ſome branches of the root are unavoidably mutilated, and conſequently the abſorption of nutriment diminiſhed; it is neceſſary that the boughs an-

ſwering

ſwering to the deſtroyed roots, ſhould be reſcinded, in order to diminiſh the tranſpiration in proportion to the aliment.

The uſe of vegetable tranſpiration is to free the plant of its noxious and ſuperfluous humours.

CHAP.

CHAP. IV.

Of the Vital Functions; namely, the vitality, respiration, motion of the humours in the Veſſels, and the generation of heat of Plants.

THE VITALITY OF PLANTS.

LIFE may be ſaid to be that power in a living plant, by which it exiſts, and defends itſelf from putrefaction; hence the vitality of plants is of three kinds, namely, phyſical, phyſiological, and chemical.

The irritability of the veſſels, and other parts, conſtitutes the PHYSICAL VITALITY of vegetables. This irritability is dependent upon the vital principle, and produces in the vegetable the ſame eſſential effects, as the heart in the animal; preſiding over, and governing, the movement of the ſap. In conſequence of this vitality the cuttings of plants remain, for a long time after the motion of the humours has ceaſed, in a ſtate to commence it again.

The

The PHYSIOLOGICAL VITALITY, is that power, by which the fibres of the veſſels by an innate principle move themſelves, and propel the contained fluids.

The CHEMICAL VITALITY conſiſts in the power of defending the plant from putridity. This power appears to be in conſequence of the ſpecific attraction of the elements into certain conſtituent principles, according to the laws of vital affinity. It depends, however, upon the adhering vital principle, and is common to all the ſolid and fluid parts of the plant. During the preſence of this principle, a piece of wood lives for ages; but in its abſence, the elements again become obedient to the laws of vulgar chemical affinity, and enter into new combinations, by which they go into the products of putrefaction, or generate putrid vapour.

The *chemical* vitality remains much longer in plants than the *phyſical*, or *phyſiological*; for, even when the two laſt are deſtroyed, the chemical will remain perfect for ages; as is evident in the oak, and other hard woods.

To the *phyſiological* vitality is referred; the reſpiration of plants, the motion of the humours, and the generation of heat.

THE RESPIRATION OF PLANTS.

That action by which plants inspire and expire air, is termed the respiration of plants.

As the *leaves* perform the greater part of this function, they are not improperly called the *lungs* of plants.

The leaves continually inspire from the atmosphere, mephitic and carbonic air dissolved in the dew, especially in the night time; by which the transpiration of the aqueous vapour is diminished. Chemical analysis demonstrates, that not only the dew, but also the water in the clouds, contains carbonic acid.

In the same way as the leaves suck in aerated water from the atmosphere, so also do the roots from the ground.

Vegetables, in regard to expiration, differ very much; for the air which is expired varies not only in different plants, but also in different parts of the same plant, and depends upon the time of the day, the place, and a variety of other circumstances. Thus the leaves, and all the green parts of plants, exposed to the light of the day, expire pure vital air; in order to ascertain which, a plant need only be put into a glass vessel, filled with water, and exposed to the

the rays of the ſun. A number of air bladders will ſoon be ſeen occupying the ſurface of the leaves, which at length ariſe to the top of the veſſel; this air being collected, affords a free and commodious reſpirable element to animals, and candles burn in it very brilliantly. If this experiment be tried with the ſame leaves, in a dark place, or in a dark ſhade, or by night; the air which is obtained, extinguiſhes flame and ſuffocates animals, and, conſequently, is not vital air, but fixed air mixed with a little mephitic or azotic air, as chemiſtry explains.

The coloured parts of plants, as well as the root, bark, wood, flowers, fruits, and ſeeds, under certain circumſtances, (if even expoſed to the rays of the ſun) expire only fixed air.

The *Dictamnus albus*, or *Fraxinella*; moſt of the *Fungi*, but particularly the *Agaricus campeſtris* and *androſaceus*, and many of the *Byſſi*, expire inflammable air; for if they be ſhut up in a veſſel containing vital air, it becomes ſo vitiated as to be lighted with a candle.

If plants be put into inflammable air, and expoſed to the rays of the ſun, they emit pure vital air as long as they vegetate.

From what has been ſaid, it is evident, that the matter of light of the rays of the ſun, and inflammable air, act as *ſtimuli* on plants; and

draw

draw from them, as it were, by chemical affinity, pure *vital air*. Heat does not appear to contribute any thing, for the evolution of vital air is more powerful in the cold, than in heat.

All the parts of plants, from which no vital air can eſcape, and which abound with it, exhibit a white and variegated colour : as *Fungi*, the corollæ of plants, immature apples, barks, the bracteæ of the *Melampyrus nemoroſus*, the *Verrucariæ*, *Lichen miniatus* and *parietinus*, and all green plants in an obſcure ſituation, as Aſparagus covered with earth, &c.

A dead or diſeaſed plant exhales nothing, or only impure air; and it is wonderful that ſome healthy plants do the ſame, although expoſed to the ſolar rays ; as the *Ilex aquifolium*, *Prunus lauro-ceraſus*, *Mimoſa ſenſitiva*, and *Acer foliis variegatis*.

By inſpiration plants inhale their nutritious vapours ; and by expiration, they appear to free themſelves from thoſe which are ſuperfluous, leſt they be too much irritated by them. Theſe two operations conſtitute the *primary uſe* of the reſpiration of vegetables.

THE

THE MOTION OF THE FLUIDS IN THE VESSELS.

Two theories have been applied to the motion of the fluids in vegetables; the advocates of the one maintaining, that the vegetable ſap had a circulation analogous to the blood of animals; while others affirmed, that it only aſcends in the day, and deſcends again at night. In order, however, to prove the former, it would be neceſſary to demonſtrate in plants, as in animals, a centre from which the circulation begins, and to which it again returns; but no ſuch centre has ever been diſcovered by any naturaliſt.

As it has been proved that the roots and leaves attract a nutritious juice, and communicate it to the other parts of the plant; it is evident, that it muſt be carried upward and downward; and from ſeveral experiments, it appears, as ſatisfactorily proved as its nature will admit: that the humours, attracted by the leaves, deſcend at night, and thoſe by the root, aſcend by day; for the leaves by night inhale dew, and ſeldom perſpire vapour, and vice verſâ.

It does not appear improbable, although it is not proved by ocular demonſtration (which is the only way to aſcertain the fact), that a plant is conſtructed with ſpecial veſſels for the aſcending and deſcending juices *. This idea is to be conſidered as purely conjectural, but may at ſome future time be aſcertained.

The experiments which prove that the nutritious juice, taken in by the abſorbent veſſels of the radicles, aſcends through the veſſels into the leaves and flowers, are,

The *erection* of flaccid plants, if water be poured on the ground, or if the root only be put into water.

The *colouring* of flowers by putting plants into water impregnated with a colouring principle.

* If a vegetable be not ſupplied with theſe ſpecial veſſels for the aſcent and deſcent of the ſap, it muſt be performed in the ſame veſſels, which at one time muſt therefore raiſe, and at another depreſs it. What would, however, ſeem to ſtrengthen the opinion of its being thus moved, is, that nature has made no apparent proviſion whereby the ſap might be prevented from deſcending, in the very ſame veſſels through which it aſcends. In the veſſels of animals, whoſe office it is to return a fluid, there is an apparatus called VALVES, which effectually prevent the contained fluid from going back. Theſe valves are entirely wanting in the veſſels of vegetables.

Although

Although the aſcending ſuccous veſſels have been ſeen conveying the coloured fluid, it has never been carried ſo far as to enable one to detect whether the fluid was returned by the ſame or by ſpecial veſſels; yet I am very much inclined to favour the latter hypotheſis.

That the veſſels of plants are endowed with vital power and irritability, and after the manner of animal veſſels alternately diminiſhed and augmented in diameter, would appear,

1. From the aſcent of the contained fluid. For this could not be returned again by the capillary attraction of the radicles, or the heat rarefying the fluids, or the internal villoſity of the veſſels.
2. From the increaſed and diminiſhed motion of the veſſels, from various ſtimuli; for ſome increaſe the motion of the fluids, and others diminiſh it.

Without this contraction and dilatation *, the

* Von Marum was the firſt who decided this point, in a diſſertation he publiſhed at Groningen, on the motion of the fluids in plants, in which he ſays, "Videtur veriſimillimum, ipſis plantarum vaſis actionem quandam eſſe attribuendam, quæ abſorptos humores profundat verſus illam partem, quæ minorem offert reſiſtentiam; quænam autem ſit illa actio, inquirendum reſtat."

the very rapid circulation of the common juice or ſap of plants, could not take place. It is obſerved that the motion of the ſap varies in every plant: this depends upon the irritability of the veſſels; thus it is quickeſt in thoſe plants which are the moſt irritable, and vice verſâ.

The contraction of the veſſels is evident in moſt of the Euphorbia; thus, if a branch be cut when freſh, a milky juice will flow out, and continue for ſome time.

The cauſe of the contraction depends upon the irritability of the fibres compoſing the veſſels; hence it follows, that the efflux of the milky juice will not take place when the veſſels of the plant are deprived of that property: but this will be conſidered in its proper place.

The *ſtimuli* by which the irritable fibres are excited into motion, and diminiſhed and augmented in diameter, are; water, a requiſite degree of heat, vital air, light, electric matter,

" Diametro alternatim diminui aut augeri plantarum
" vaſa, et hac ratione contentos humores urgeri, ex una va-
" ſorum parte verſus alteram, requiri videtur.

" Utrum vero hæc vaſorum conſtrictio oriatur a vi quâ-
" dam contractili ipſis inſitâ, quæ a contractilitate vaſorum
" animalium non diverſa eſt, an vero ab aliâ quâdam vaſo-
" rum facultate derivanda, haud facile determinare licebit."

and

and artificial ſtimuli, as nitre, ſal ammoniac, ſulphur, &c. *

THE GENERATION OF HEAT.

Every plant, by its vital power, is poſſeſſed of a proper degree of heat, by which it vegetates, increaſes, and is enabled to reſiſt the cold and heat of the atmoſpheric air.

The power of reſiſting cold is very conſpicuous in the roots of ſome plants; thus thoſe of the *Betula alnus* are often incruſted the whole winter with ice, yet the tree blooms with vigour the following ſpring.

* A ſmall portion of nitre in water ſtimulates the Hyacinth, Narciſſus, and other bulbous plants, to germinate much ſooner than they otherwiſe would. Two portions of the Peppermint (Mentha Piperitida) were put, the one into a ſolution of nitre, the other into water: the firſt increaſed in weight three hundred and ſeventy-eight grains; the other only one hundred and forty-eight, in the ſame ſpace of time. A branch of the Betula alnus ſucked in $\frac{10}{12}$ of the liquor in which a ſmall quantity of ſal ammoniac was diſſolved; but in the ſame quantity of pure water, only $\frac{6}{12}$. The ſeeds of the Phaſeolus vulgaris, when put into ſulphur powdered and watered, after a ſhort time are obſerved to germinate; and their roots are firmer, and their increaſe greater, than thoſe planted in the ground, and watered with the ſame quantity of water.

If the *Avena* or oat, and the *Phaſeolus* or kidney-bean, be torn up with their leaves, and expoſed to a certain degree of cold (22°), the leaves die, but the roots, after a while, begin to vegetate abundantly.

If the green leaf of the Pine, or *Phaſeolus*, be put into the frozen juice of ſpinach or cabbage, it in a few minutes becomes thawed.

In the northern regions plants and fruits are diſcovered, upon which the froſt has no effect; and the woods with aceroſe trees are the moſt beautiful in thoſe countries.

In general it is obſerved that aceroſe trees, graſſes, and all plants filled with a tenacious juice, more eaſily eſcape the froſt than folious trees and thoſe plants which have an aqueous humour; thus tender plants, young ſprigs of trees, and flowers, are eaſily deſtroyed by ſudden cold in the autumn, or by cold late in the ſpring.

Some plants have the power of reſiſting the atmoſpheric heat. If in very warm weather the earth be touched with one hand, and the graſs with the other, the former will be found warm, and the latter cold. Thus, alſo, if water be expoſed in a glaſs placed in a bed of cucumbers, the water ſoon grows warm, but the cucumbers remain cold to the touch; and if one

be

be eaten, it cools the ſtomach like ice. The ſame thing is obſerved in fruits, while hanging on trees.

There is an account given of a Lake in the Iſland of Luſon, which is ſo warm as to kill ſwallows when flying over its ſurface ; and yet hiſtorians of undoubted veracity tell us, that the *Vitex agnus caſtus*, and two ſpecies of *Aſpalatus*, grow on its ſhores. The ſoil of the iſland of Tanna, about the Volcano, is 217 degrees of heat ; and yet plants are found there bearing fruit in great perfection.

The temperature of plants ariſes from the matter of heat abſorbed from the atmoſphere ; and hence it is, that the ſhades of all trees are ſo cooling.

Some plants have a great, and others but little power of *attracting* and of *retaining* the matter of heat.

In trees and plants which flouriſh in the winter, there ſeems to be a great quantity of *latent* or retained heat.

The heat of plants does not appear to *ariſe* from abſorbed and decompoſed water or vapour ; for although the matter of heat may be in combination with the portion of vital air contained in either, it is to be obſerved, that vital air is again exhaled in much larger quantities from the plant.

The beneficial effects of heat in plants are many. It supports the irritability of their fibres, by means of which all the functions are regularly performed, as the respiration, secretions, &c. renders their sap and other fluids more fit to penetrate and pass through the various vessels, and after the death of the plant occasions a dissolution and new combination of their component parts; as is evident when putrefaction commences.

CHAP.

CHAP. V.

Of the animal Actions in general—Of the Automatic Motion—Of the Sleep and Watching of Plants.

THE ANIMAL FUNCTIONS IN GENERAL.

THE motions of the leaves, and parts of the fructification, which are very ſimilar to thoſe of animal muſcles, conſtitute in vegetables the *animal functions:* to which are referred the automatic motion, ſleep, and watching of plants.

Plants are ſuppoſed to have no ſenſation, becauſe in the vegetable ſyſtem no nerves are detected: but is not ſenſation perceived in all the inteſtinal worms *, in which alſo nothing like nerves can be found?

THE

* This the author has proved in a work on the ANATOMY and PHYSIOLOGY of HUMAN INTESTINAL WORMS, ready for

THE AUTOMATIC MOTION OF PLANTS.

The contraction and relaxation of the leaves, or parts of the flower of a plant, from the application of a ſtimulus.

This contraction and relaxation cannot be conſidered as voluntary ; for plants are deſtitute of volition : nor can it ariſe from the influence of nerves; for, as it has been before obſerved, no ſuch inſtruments have as yet been detected in them.

It is evident, therefore, that it muſt ariſe from the IRRITABILITY of the fibres ; for every plant poſſeſſes, in a greater or leſs degree, this *principle of irritability* *.

The cauſe of the difference would appear to depend upon the capacity of the fibres to receive

for the preſs ; in which he has given an account of the TRICURIS, very lately diſcovered by him, which only inhabits the human body, and alſo plates of all the ſpecies of worms. There are likewiſe many inſects which are deſtitute of nerves, but which nevertheleſs ſhew evident marks of ſenſation.

* This principle has, by ſome writers, been conſidered to be OXYGEN ; there are, however, many objections to this opinion.

ceive the irritable principle: thus every plant has a degree of irritability peculiar to it, and hence one ſpecies is deprived of its irritability by external ſtimuli, when another will bear the ſame with impunity. Many plants alſo become gangrenous in the ſpring time, after a ſevere cold night, while others are not in the leaſt hurt. The *Phaſeolis vulgaris*, for inſtance, will be found dead under the above circumſtances, and the *Piſum ſativum* flouriſhing by its ſide.

A plant alſo poſſeſſes, at different times, more or leſs of the irritable principle, which would appear to depend upon various external ſtimuli, as will be explained hereafter. When it is abundant, it is called ACCUMULATED IRRITABILITY, and when deficient, EXHAUSTED IRRITABILITY *.

The irritable fibres of a plant would ſeem to have a connection or *ſympathy* with each other; for if a ſtimulus be applied to one fibre only, it is communicated to the reſt: but the

* The diſeaſes of plants are in the preſent day very little underſtood; but the doctrine of irritability, which every day is experiencing very rapid improvements, it is to be hoped, will eſtabliſh ſome rational ſyſtem, by which the pathology of the vegetable creation will be better underſtood, and the diſeaſes in a great meaſure remedied.

effect

effect is always the greateſt upon the fibres that immediately receive it, and much leſs upon thoſe which only act by ſympathy. Thus when a plant, whoſe contractions are viſible to the naked eye, as the *Mimoſa ſenſitiva* (hereafter to be deſcribed), is irritated by a ſtimulus, the whole plant is affected, but not in that degree as the part to which the ſtimulus was applied.

The irritable fibres of plants, like thoſe of animals, are deprived of their irritability in proportion to the frequency of the application of the ſtimulus; and conſequently the contraction of the fibre (which is totally dependent upon the principle of irritability) is diminiſhed in the ſame proportion: thus if the irritability be diminiſhed, the contractions are alſo; and if exhauſted, they totally ceaſe.

From theſe obſervations it is evident that the automatic motions of plants ariſe from the peculiar faſciculæ of irritable and muſcular fibres, which do not, like animal muſcles, become red, but are white.

In this manner the contraction of the parallel and faſciculated fibres of the ſtalk of the leaf of the *Hedyſarum gyrans*, *Mimoſa pudica*, *Oxalis ſenſitiva*, *Dionæa muſcipula*; the nodding of the filaments of the *Parnaſſia paluſtris* and *Ruta lalepenſis*,

lepensis take place, when the different ſtimuli irritate them to motion.

The HEDYSARUM GYRANS, or moving plant, is of the claſs *Diadelphia*, and order *Decandria*, and a native of the Eaſt Indies, where it is called *Burrum Chundalli*. It is a trifolious plant, and the lateral leaves are much ſmaller than thoſe at the end. The leaves in the day-time are continually moving up and down, and circularly. The circular motion appears to be performed by the twiſting of the fibres at the bottom of the ſtalk; and while the one leaf is riſing, its aſſociate is generally deſcending. The motion downwards is quicker and more irregular than the motion upwards, which is ſteady and uniform. If a branch of this plant be cut off, and put into water, the ſame motions continue in its leaves for the ſpace of twenty-four hours after. If from any obſtacle the motion of the leaves be retarded, upon the removal of that obſtacle it is reſumed with a greater degree of velocity. What is moſt remarkable in this plant, is, that the larger terminal leaves do not move, unleſs ſtimulated by the ſolar rays, on which account they ceaſe when the leaves are clouded; whereas the ſtipuliform leaves conſtantly move, and are interrupted by no ſtimulus. The motion of the

larger

larger terminal leaves is alſo increaſed in the night-time by a ſtimulus, at preſent unknown.

The MIMOSÆ are of the claſs *Monœcia*, and order *Polygamia*. Mimoſa ſignifies mimic, and is given to this genus on account of the irritability of the leaves, which, by their motion, mimic or imitate, as it were, the motion of animals. All the ſpecies are more or leſs irritable; but the following are the moſt ſo:

1. The MIMOSA SENSITIVA, or *common ſenſitive plant*, whoſe leaves and footſtalks recede from the touch, though not with the ſame facility as ſome of the following.
2. The MIMOSA PUDICA, or *baſhful ſenſitive plant*. By the leaſt touch the leaves inſtantaneouſly recede, contract, cloſe, and, together with the footſtalk, quickly decline downward, as if aſhamed of the approach of the hand.
3. The MIMOSA PERNAMBUCANA, or *ſlothful mimoſa*. The leaves of this ſpecies do not recede from the touch; but its *pinnæ* are a little contracted when ſmartly ſtruck: hence it is called ſlothful.
4. The MIMOSA ASPERATA, or *panama ſenſitive plant*. This ſpecies would form an

hedge

hedge or fence round a garden. The leaves are numerous, fmall, and winged, and, next to thofe of the *M. pudica*, are the moft irritable, contracting with the leaft touch, and remaining fo for many minutes after.

5. The MIMOSA VIVA, or *lively mimofa.* This is the fmalleft of the fenfitive plants, is furnifhed with creeping roots, and fpreads itfelf fo as to cover large fpots of ground. By running a ftick over the plant a perfon may write his name; and it will remain vifible for ten minutes.
6. The MIMOSA QUADRIVALVIS, which flightly recedes from the touch.
7. The M. PUNCTATA, and M. PLENA, are only fenfitive in the *foliola*, which are very fufceptible of any fubftance, or even of the air.

The contractions of the OXALIS SENSITIVA, are of the fame nature with thofe of the *Mimofa fenfitiva.*

The DIONÆA MUSCIPULA, or *Venus's fly-trap*, is of the clafs *Decandria*, and order *Monogynia.* It grows in America, about 35 degrees of N. Latitude, in wet, fhady places, and flowers in July and Auguft. The peculiarities of this plant are in the leaves, which at their

upper

upper joints are furniſhed with a particular apparatus, ſo that when an inſect alights upon it, the parts are irritated, the two lobes of the leaf riſe up, graſp it faſt, and by means of two rows of ſpines, which cloſe together like teeth, ſqueeze it to death. The lobes never open again while the dead animal continues within. Every part of this apparatus is beſmeared with a ſweet ſecretion, which attracts the unfortunate animal, and tempts it to taſte it. It is nevertheleſs certain, that the plant cannot diſtinguiſh an animal from a mineral ſubſtance; for if a piece of ſtraw, or a pin be introduced, it will be graſped full as firmly; nor will the lobes open while it remains. If the ſubſtance encloſed be gradually puſhed out, the lobes again expand themſelves; but if any force be uſed to open them, ſo ſtrong has nature formed the ſpring of the fibres, that one of the lobes generally ſnaps off rather than yield.

Automatic motion is alſo to be noticed in a great number of flowers; which motion is obſerved to take place at particular times. Some flowers, for inſtance thoſe of the *Reſeda luteola*, or Dyer's Weed, *Helianthus annuus*, and ſeveral others, conſtantly turn towards or againſt the ſun: others are influenced by certain ſtates of the air or ſky. Thus the

flowers

flowers of the Syngenefious plants fhut in cloudy, cold weather, and open when it is fe-rene and warm. The flowers of the erect campanulæ, in cold rainy weather, either nod or twift round their petals, left the pollen be wafhed away by the rain from the anthera, or the fmegma, or moifture, from the ftigma. Many flowers open in the morning, and clofe again in the evening: others open and fhut themfelves at certain and regular hours; as the Common Dandelion *(Leontodon taraxacum)*, which opens between five and fix in the morn-ing, and contracts between eight and nine in the evening; and the *Mefembryanthemum lingui-forme*, which opens between feven and eight, and fhuts about the third hour after noon *.

There is a connubial motion obferved in the parts fubfervient to generation, during the time the pollen is difcharging upon the ftigma; as will be explained in its place.

The STIMULI, which excite the irritable fibres of plants to motion, are mechanical irri-tation, light, heat, water, vital air, and electric fluid, when moderately applied.

* From a variety of fimilar circumftances, the immortal LINNÆUS divided flowers into the *Flores Meteorici, Æquinoc-tiales*, and *Tropici*; and formed the HOROLOGIUM FLORÆ. Vide Linnæi Philofoph. Botan. l. c.

The leaves of the *Mimofa pudica*, &c. contract by *touching* them; and thofe of the *Dionæa mufcipula* are irritated by the fly, and other fubftances, to fo powerful a contraction, as to retain the fubftance. Thefe and the like ftimuli may be confidered as acting *mechanically*; for a pin, a ftraw, or any other fubftance, will equally affect them.

The terminal leaves of the *Hedyfarum gyrans* are irritated to move by the rays of the fun; but when clouds intervene, the motion ceafes. The *Mimofa pudica*, if concealed for twenty-four hours in a dark place, is found to be much more irritable when expofed to the fun. Thefe actions, therefore, would appear to be from the ftimulus of *light* alone, as no other ftimulus produces the fame effect.

The motion of the leaves of the *Hedyfarum gyrans*, in its native foil, or when in a hot-houfe, is more vivid and ftronger than when furrounded by cold air. The ftamina of the *Berberis* are known to be lefs irritable when expofed to a northern wind, than thofe which lie concealed, and cannot be affected by the cold air; and all plants are excited to put forth their flowers by the ftimulus of *heat*, when applied proportionably to the irritability of the plant; under which circumftances heat

is

is known to effect the activity of the irritable fibres, and to facilitate vegetation in general *, as is obvious in hot-houfes, &c.

The flaccid ftamina of the *Berberis* alfo recover their former irritability, if the bough be cut and put into *water*. The *Mimofa pudica*, although in earth well watered, is in dry weather lefs irritable than when furrounded by humid air.

The power of *vital air* in ftimulating plants, is evident from this; that no kind of air deprived of oxygen, is favourable to vegetation; and that water mixed with the oxygenated muriatic acid, very much accelerates the germination of the feeds.

The leaves of the *Hedyfarum gyrans*, when in motion, are faid to gyrate more ftrongly by applying moderately the *electric fluid*; but if it be applied in too great a degree, the motion is deftroyed.

Laftly, the irritability of all plants is generally the greateft in the morning and noon, lefs during exceffive heat, and leaft in the evening.

* Thus Cicero appears to have confidered it as the vital principle; for he fays, " Omne vivum, five animal, five " terræ editum, vivit propter inclufum in eo calorem."

The STIMULI, which diminifh the irritability of the fibres, are excefs of heat, cold, light, mephitic air, electricity, and opium. Thus the ftamina of flowers in the morning move with more ftrength in moderately warm weather, than in *exceffive heat*; and the leaves of the *Mimofa fenfitiva*, expofed for a long time to the heat of the fun, cannot be agitated nor irritated into a gyrated motion.

During *fevere cold weather* the irritable fibres become rigid, dry, and hard; hence in the vegetable, as in the animal fibre, the irritability difappears. Thus the leaves of the *Hedyfarum gyrans*, and the ftamina of the *Berberis vulgaris*, are much lefs irritable when the north wind blows. Thus alfo many plants, as well as animals, become torpid, the organs of circulation and of nutrition perform their functions but languidly, and life itfelf appears fufpended.

Tender plants, too long expofed to the *light* of the fun, languifh. For this reafon gardeners defend young plants in the earth from the light of the fun; and thus feeds deprived of light, germinate fooner than if expofed to it.

The *Mimofa pudica* flowering in *vital air*, droops if put into *fixed* or *mephitic air*, and becomes lefs irritable; and if continued, dies (almoft in the fame manner as animals which are

are ſuffocated therein), and exhibits no ſigns of irritability. Moſt plants in general die if expoſed long in theſe airs. The leaves of many plants, very tenacious of their irritability, if put into water impregnated with the carbonic acid, become very ſoon deprived of it, and die *. Inflammable air kills plants; in nitrous air they become turbid in a few hours; and ſeeds placed in mephitic air, never germinate.

The *Murina*, and other animals ſeverely ſtruck by the *electric ſhock*, ſhew no ſigns of irritability, and cannot be moved by any ſtimulus: in the ſame manner the *Mimoſa ſenſitiva* and *pudica*, when ſeverely ſtruck by the electric power, cannot be excited to contract by any known ſtimulus: nor can the terminal leaves of the *Hedyſarum gyrans* be ſtimulated to motion, nor the wounded branches of the *Euphorbia* or *Carica* pour out any milky juice, if their irritability be deſtroyed by the ſame means.

* There are, however, ſeveral plants which grow and flouriſh in mephitic air; as the *Lichen verticillatus, aidelius, radiciformis*, and *pinnatus*, moſt of the *Byſſi*, the *Agaricus acephalus* and *aberuntius*, the *Boletus botryoides*, &c. and which, if put into any other air, die; but theſe are to be conſidered as exceptions, and do not lead to any general rule.

 The

The irritability of the *Hedyſarum gyrans*, and *Mimoſa pudica*, is gradually diminiſhed, and at length deſtroyed, by watering the earth in which they grow with a ſolution of *opium*.

Laſtly, the irritability of plants, like that of animals, when haraſſed by too frequent application of ſtimuli, becomes leſs powerful; and the moving parts of the plants already mentioned have, by being too frequently ſtimulated, their irritability totally deſtroyed. The ſame parts, when cut off from the plant, although not put into water, do not loſe their irritability for a conſiderable time; for the ſtamina of the *Berberis*, and leaves of the *Hedyſarum* and *Mimoſæ*, are obedient to a new ſtimulus for ſome time after.

THE SLEEP AND WATCHING OF PLANTS.

The cloſing of the petals and leaves of plants conſtitutes the ſleep; and the unfolding of the different parts, the watching of plants: hence moſt flowers ſhut themſelves at particular times, and again unfold them.

The reaſon why plants fold up and cloſe their petals generally in the evening and at night-

night-time, is, moſt probably, in conſequence of the uſual ſtimuli, heat and light, being at thoſe times abſent.

There are, nevertheleſs, many plants in which ſleep does not take place in the evening, &c. but which reſt even when expoſed to the ſtimuli juſt mentioned. Thus the *Solanum nigrum*, *Ranunculus repens*, &c. ſhut and cloſe their petals ſome hours in the day-time; the *Spiræa filipendula*, &c. in the middle of the day; the *Cactus grandiflora* opens its flowers at ſun-ſet, and folds them up in the morning: and the *Meſembryanthemum noctiflorum* is awake only during the night.

There are alſo ſeveral plants which diſcover the ſtate of reſt clearly by their external appearance: thus the *Alſine media* joins the upper ſides of its leaves; the *Ænothera mollis*, &c. fix them on the ſtalks; and in ſome the leaves are erect, and in others drooping.

If this remarkable phenomenon, ſleep, depend or be connected with the irritability of the plant, as from many experiments it appears to be, it follows, that, when the ſtate near to exhauſtion is preſent, it is neceſſary that the plant ſhould ſleep (be that time when it may), in order to re-accumulate its loſt irritability.

CHAP. VI.

Of the Sexual Functions of Plants in general—Of the Mellification of the Piſtil—Of the Connubium or Marriage of Plants—Of the Fecundation of the Seed—Of the Generation of an Hybride—And of the Parturition of Plants.

THE SEXUAL FUNCTIONS OF PLANTS IN GENERAL.

THE functions by which a plant produces another, and propagates to infinity, are called SEXUAL. To this head are referred, the mellification of the piſtil, the connubium or marriage of plants, the fecundation of the ſeed, the generation of an hybride, and the parturition of plants.

THE

THE MELLIFICATION OF THE PISTIL.

By this is underſtood, the ſecretion of a melleous juice, which, about the period of puberty, beſmears the ſurface of the ſtigma.

This ſecretion tranſudes from all the parts of the piſtil, but eſpecially from the ſtigma, the pores of which may be obſerved in the hyacynth, furniſhing the melleous fluid. In many plants this ſmegma fills the whole ſurface of the ſtigma, and the cavity of the ſtyle.

Chemical analyſis demonſtrates, that this ſecretion is a ſolution of ſugar in mucilage ; and in ſome balſamic flowers grains of pure cryſtallized ſugar are often detected in the nectarium.

It appears from experiment, that this juice is actually neceſſary to the fecundity of the germen ; thus, when, by the application of artificial heat, it is dried, the germen is not fecundated by the pollen of the male : for it is adapted by the nature of its viſcoſity to receive, detain, diſſolve, and carry the pollen through the cavity of the ſtyle to the germen, which is the OVARIUM of the plant.

The male flowers in general ſeparate no melleous

melleous juice, but merely pollen, for the purpose of impregnating the female, and which is alſo collected by the bees, who convert it into wax for their hives.

The honey of the female flowers is ſucked up by the ſame animal, and other inſects which have a proboſcis, and by them carried into their cells.

THE CONNUBIUM OR MARRIAGE OF PLANTS.

The exploſion of the pollen from the anthera upon the ſtigma, conſtitutes the marriage of plants; hence at the age of puberty the following phenomena take place.

The antheræ, when mature for marriage, on a ſudden break, and explode their pollen into the whole ambit of the flower.

The ſtigmata, when prepared for marriage, become turgid, with a viſcid melleous humour, which receives the exploded pollen. The antheræ, after the exploſion of the pollen, contract, become empty, and decay.

The ſtigmata are now obſerved covered with the pollen; ſoon after, with the ſtyle, they gradually become dry: and at length marcid, like the antheræ and ſtamina.

The

The *experiments* by which plants are known to celebrate marriage, and to fecundate the ſeeds from the exploſion of the pollen, are the following.

Firſt, Flowers that have ſtamina only, never produce ſeed.

Secondly, Flowers which have piſtils only, never fecundate unleſs the pollen be brought from the ſtamina of a neighbouring plant.

Thirdly, If, in a ſolitary tulip, the antheræ be taken away, or if the ſtigma be covered during the exploſion of the pollen, the ſeeds in the germen continue increaſing as uſual: but if thoſe ſeeds be put into the ground, they do not vegetate, but remain ſterile.

Fourthly, Monſtrous flowers, the ſtamina of which form petals, bear ſterile ſeeds: but if ſome of the ſtamina remain unchanged, then a few ſeeds only become fruitful.

Fifthly, The bilabiated ſtigmata of plants at the age of puberty, are ſeen unfolding themſelves, and remain ſo for ſome days in expectation of the pollen; and if the male be not preſent, they become marcid.

Sixthly, Plants which have female flowers only, are never fruitful, unleſs its male plant be in the vicinity, or the pollen be ſprinkled over it. Thus the great PALM TREE in the garden of the

the Royal Academy at Berlin flowered, and bore fruit, for thirty years; but the fruit never ripened, nor did the feeds when planted vegetate: the plant being a female. There happened, however, to be at that time a male Palm-tree in the garden of Leipfic, twenty German miles from Berlin: a branch was procured when in full bloom, which was fufpended over the female plant. The experiment fucceeded; the female-tree produced more than an hundred perfectly ripe fruit, from which many young Palm-trees were generated. The experiment was again repeated the following year, and the female-tree bore above two thoufand ripe fruit.

The female KIGGELARIA plant flowered every year for fifty years, but never bore any fruit. At length the male-tree was procured, and planted fifty paces from it. The flowers fecundated the firft year, and at prefent there is a progeny from the feed. The CLUTIA PULCHELLA affords a fimilar example.

The MODE, however, of fecundation is different in refpect to the fituation of the ftamina and piftils of the plant.

In *hermaphrodite flowers*, the explofion of the pollen to the ftigma is very eafy, as the parts of generation are in the fame flowers.

In

In *erect flowers*, the ſtamina, for the moſt part, are very long, and the piſtils very ſhort; ſo that the exploded pollen may eaſily ſettle upon the ſtigma.

In *pendulous flowers*, the piſtils are moſtly long, and the ſtamina very ſhort; ſo that the pollen, when diſcharged from the antheræ, may fall upon the piſtils.

In *erect flowers* with *ſhort* ſtamina and *longer* piſtils, it is obſerved, that the ſtyle at the period of marriage curves itſelf downwards, and offers its ſtigma to the antheræ for the reception of the pollen; after fecundation, the ſtyle again erects itſelf: of this the *nigelli* afford a very ſtriking example.

In *erect flowers*, whoſe ſtamina are placed *horizontally*, as in umbelliferous flowers, the *Ruta hortenſis* and *Parnaſſia*; the ſtamina ſo erect themſelves, that daily one or other of the antheræ copulate with the ſtigma, and the exploſion of the pollen having taken place, the ſtamina again return into their natural horizontal ſituations. In the *Ruta hortenſis* ſometimes two antheræ adhere at the ſame time to the piſtil. In the *Parnaſſia*, the ſtamina, one after another, ſo apply themſelves to the ſtigma, that the coition laſts for ſeveral days.

In

In flowers of the claſs Syngeneſia, the ſtigma paſſes through the tube coaleſced with the anthera; and the exploſion of the pollen takes place *ſub tranſitu.*

In Monœcious plants, whoſe ſtamina and piſtils are ſituated in different flowers of the ſame plant; and in Diœcious plants, whoſe ſtamina and piſtils are placed in two ſeparate plants; the tranſlation of the pollen to the female flower is truſted to the wind and inſects. The maſculine flowers of ſome Diœcious plants yield ſo great a quantity of pollen, that it is conveyed by the wind to different places, and is often found (in countries where the trees are abundant) in lakes upon the ſurface of the water, ſo thick, that it has excited an idea among the country people of ſulphureous rain from heaven.

Diœcious plants flouriſh before the eruption of the leaves, leſt they ſhould drive away the pollen from the ſtigma of the flowers. The *Fagus Caſtanea*, however, protrudes the leaves before the flowers, but has a remarkable number of male flowers in compariſon of the number of female.

Aquatic hermaphrodite plants, at the time of fecundation, erect their flowers above the ſurface

face of the water, left the pollen of the 'anthera, and the melleous smegma of the stigma, be washed away.

The celebration of the connubium in aquatic plants is most wonderful in the VALISNERIA DIOECA. At the period of puberty the female plant erects its flowers, by a very long spiral peduncle, above the surface of the water. At the same time the male flowers, of their own accord, are broken from the masculine plants (by the peduncle, which is short), and swim on the surface of the water; the flowers now open, and are driven by the winds to the female flowers, and then, but not before, explode the pollen upon them. The impregnation of the flowers being finished, the spiral peduncle, with the female impregnated flower, withdraws again to the bottom of the water.

The *Nymphææ, Potamogitons*, and other aquatics, be the water in which they grow ever so deep, send up their flower stems until they reach the surface; when the flower is developed for the purpose of generation.

Lastly, in Cryptogamia plants the propagation is not to be observed, but takes place in the parts of the fructification lying concealed in the leaves.

THE

THE FECUNDATION OF THE SEED.

The impregnation of the ſeed concealed in the germen, by means of the pollen of the anthera acting upon them.

The ſeed while in the germen, and not as yet impregnated, contains a *peculiar* fluid; and each atom of the pollen is alſo furniſhed with a ſimilar prolific vapour. See the ſtructure of the ſeed and pollen.

The pollen being ſprinkled upon the ſtigma, is there detained by its viſcous humour, and, when chemically diſſolved, gradually deſcends through the veſſels of the ſtyle, and impregnates the contained ſeeds with the VITAL PRINCIPLE.

The vegetable embryo appears to be formed from the mixture of the pollen with the liquid in the ſeed, by means of the formative ſtimulus, unknown to us, but which is the ſame as in animals; for the albuminous liquor contained in the ovula of the ovarium, is impregnated by the AURA of the *ſemen virile.*

Hybride plants and animals ſhow that embryos do not pre-exiſt in the ſeeds of vegetables and the ovula of animals; but in what manner

manner the paternal parts of ſuch a plant or animal pre-exiſt in the animal ovum, or in the vegetable ſeed, before copulation with the male, is a ſubject to be aſcertained.

It is not neceſſary to the fecundation of the ſeeds, that all the piſtils of a flower ſhould be impregnated: it is ſufficient if the pollen be ſpread over one; for I have deſtroyed all the piſtils, except one, in the ſame flower, and yet moſt of the ſeeds have fecundated.

Nor is it neceſſary that the pollen of all the antheræ ſhould be ſpread over the ſtigmata; for the *Hybiſcus Syriacus* has ſome thouſand grains of pollen in one anthera, and yet all its ſeeds are fertile, if beſmeared with only fifty or ſixty: but under twenty, its ſeeds are ſterile.

Thus it would appear, from theſe obſervations, that nature has provided ſo prodigious a quantity of flowers, and number of piſtils, that the fecundation of the ſeed ſhould never fail.

THE GENERATION OF AN HYBRIDE PLANT.

A plant from an union of two different ſpecies of one genus, is called an Hybride; and retains fome peculiarities from both fpecies of its parental plants.

If the NICOTIANA RUSTICA be deprived of its ftamina, and its piftils fprinkled with the pollen of the NICOTIANA PANICULATA, it produces feeds which afford the NICOTIANA HYBRIDA; which neither refembles the *ruftica* nor the *paniculata*, but has a few of the characters of each. Thus the *ruftica* has ovated leaves, and fhort and greenifh yellow corollæ; the *paniculata* is furnifhed with lanceolated leaves, longer corollæ, of a yellowifh green colour, and has a very long ftem; but the HYBRIDA maintains a medium in all thefe refpects.

Hybridation fucceeds equally well with other plants.

Experiments have afcertained, that this phenomenon only takes place between different fpecies of the fame genus, but not in different genera of plants.

The feeds of an hybride plant increafe like thofe of another plant, but when put into the ground do not propagate: hence it is that no new fpecies of plants can be produced.

From thefe facts it is known of how much importance it is, that gardeners fhould place plants of a different fpecies, which have the

fame

ſame period of floreſcence, remote from one another; leſt, by the confuſion or mixture of the pollen, the ſeeds be rendered unfit for further propagation.

MONSTERS may be generated in plants as well as in animals; but theſe would appear to originate not only from an error in the *formative niſus*, but alſo from heat, cold, the ſun, nature of the climate, inſects, and other cauſes as yet unknown.

THE PARTURITION OF PLANTS.

The ſpontaneous delapſe of the ſeed from the plant, is called the parturition of plants.

As ſoon as the ſeeds are perfected and matured, the pericarpia burſt, and let them out.

The peduncles of fruits, when the ſeeds are matured, become dry; that the fruit, by its own weight, or the ſlighteſt agitation, or by the wind, may fall from the tree.

The very frequent abortions, whether of flowers or immature fruits, ſeem to be in conſequence of a law in the economy of the plant; for ſome fructiferous trees produce a ſtupendous quantity of flowers: on which account it is neceſſary that many of them ſhould fall, or be deſtroyed by the wind, cold, dryneſs, inſects, ſhowers, &c. before they are far advanced towards maturity, leſt the boughs of the tree be broken by their weight, or the tree too much exhauſted of its nutritious juices.

The number of ſeeds which ſome plants naturally yield, is beyond all conception. The *Zea mays* alone produces three thouſand; the *Helianthus annuus*, four thouſand; the *Papaver ſomniferum*, thirty thouſand; the *Nicotiana tabacum*, forty thouſand.

The ſeeds thus matured are diſſeminated on the ſurface of the earth, either by the elaſticity of their capſules, or they fly of their own accord, or faſten to other ſubſtances by a peculiar apparatus, or are ſwallowed and not digeſted, but depoſited with the excrement of the animal.

Thus the capſules of the *Impatiens balſamina*, when they rupture, throw their ſeeds to a very great diſtance; thus the ſeeds of the *Arctium lappa* faſten to the wool of ſheep and the clothing of animals, and are conveyed to a diſtance; thus the ſeeds of *Moſſes* and *Fungi* (which are ſo minute as to be almoſt inviſible to the naked eye) and all ſeeds furniſhed with a plumous or pilous appendix, or an inflated calyx or pericarpium, or a kind of tail or wing; fly about from place to place, and are depoſited

ſited on high towers, and in diſtant countries. Laſtly, thus the ſeeds of the *Loranthus europeus*, and *Viſcum album*, are depoſited in the trunks of trees with the excrement of birds, the ſeeds of the *Liguſtrum* by the fox, &c. Hence, by manuring a field with the freſh dung of animals, innumerable weeds ſpring up, which did not exiſt there before.

The ſeed, by one of theſe methods depoſited in the earth, evolves at the proper ſeaſon, when the ſtimuli to vegetation are preſent, into its primordial parts : the nutritious juice is attracted from the earth by the abſorbing veſſels in the *hilum*, and the pulp of the ſeed ſwells, ruptures, and gradually throws off its *arillus*.

The Formative nisus, or power of vegetation, thus called into action, expands the pulp of the ſeed into the cotyledons (when preſent) and corcule ; and the former, like the placenta of animals, prepare a nutritious juice for the nutrition of the corcule.

The corcule, by the ſame power, ſhoots upwards into the plumule, which conſtitutes the ſtem, and downwards into the roſtel, which is prolonged, partly into the root and partly into the baſis of the ſtem, elevating the cotyledons without the earth.

In this manner the developement of the plant commences. The little plant, having acquired ſtrength enough in its radicles and leaves, abſorbs by their means its nutrition from the earth and air; the cotyledons then become dry, and fall off. See *growth* and *increaſe* of plants.

CHAP.

CHAP. VII.

Of the Age, natural Death, and Putrefaction of Vegetables.

THE AGE OF PLANTS.

THE continuance of life in plants is various; they are however divided from their duration, into annual, biennial, and perennial.

Some trees and fruits arrive not only to a great but ſtupendous age: thus the Cedars of Lebanon have exiſted for two thouſand years. In this country the Oak is the moſt durable.

The age of ſome trees may be aſcertained by the number of ligneous annuli: it is however very difficult to diſtinguiſh theſe in many; and in others totally impoſſible.

The life of vegetables, like that of animals, is divided into the ſame periods, and is alſo diverſified by continual change: thus infancy is marked by the characters of weakneſs and tendernefs; youth acquires beauty and fize, the veffels attract and convey their juices; and the full growth is crowned with the robuft fibre, and full exercife of all its functions; the fruit therefore ripens, but as old age advances the veffels begin gradually to harden and lofe their tone, the plant droops, the juices move no longer with equal celerity as in youth, the vital power ceafes, they ftagnate and corrupt, and the tottering plant is at length decompofed into its priftine principles.

THE NATURAL DEATH OF PLANTS.

By a law of nature all organized fubftances have a conftant tendency to diffolution; and when the vital principle ceafes of its own accord, a plant is faid to die a natural death.

In perennial plants and fruit trees, and thofe which are not ever-green, the parts of the fructification only, and the leaves die every year, but are renewed the fucceeding one.

VEGETABLE PUTREFACTION.

When plants are deprived of their vitality, they foon become putrid, and exhibit feveral very curious phenomena, many of which are peculiar

peculiar to them, and many alſo common to the animal kingdom.

The conſideration of theſe is foreign to the preſent publication, and belongs particularly to the province of the chemiſt: we ſhall therefore conclude with obſerving, that the earth is continually manured by the putrefaction of dead vegetables, ſo that the ELEMENTS, diſengaged by ſpontaneous decompoſition, become again obedient to the common laws of chemical affinity; enter into new COMBINATIONS; form new principles; and at length, prepare new food for living plants, which conſtitutes the primary uſe of vegetable putrefaction.

THE

ANALOGY

BETWEEN

ANIMALS AND VEGETABLES.

———————————" behold the chain of love
" Combining all below and all above.
" See plaſtic nature working to this end,
" The ſingle atoms each to other tend;
" Attract, attracted to, the next in place
" Form'd and impell'd its neighbour to embrace.
" See matter next, with various life endu'd,
" Preſs to one center ſtill, the gen'ral good;
" See dying vegetables life ſuſtain,
" And life diſſolving, vegetate again!!"

POPE.

Of the Analogy between the Animal and the Vegetable.

TO discover the similitude that exists between the animal and vegetable kingdoms, does not require a very minute investigation: for such is the external structure and internal organization of both (as may be observed throughout the present publication) as to afford, in every respect, a very striking analogy, even to a superficial observer.

Nor do the laws by which their lives are regulated, and their various functions performed, appear to differ in many respects. In short, the analogy may be carried to such a degree of perfection, that the philosopher would be unable to distinguish the two, were sensibility and the locomotive faculty laid aside.

CHAP. I.

OF VEGETABLES IN GENERAL.

A PLANT is composed of three parts,

Solids,
Fluids, and a
Vital principle.

The SOLIDS are formed of simple fibres.

The *simple fibres* constitute the hard and soft parts, as the wood, bark, leaves, &c.

The FLUIDS are divided into,

1. Those which have not entirely acquired the nature of the vegetable, as the *chyme*, *chyle*, &c.
2. Those which have partaken of the nature of the vegetable,

OF ANIMALS IN GENERAL.

An ANIMAL is composed of three parts,

Solids,
Fluids, and a
Vital principle.

The SOLIDS are composed of simple fibres.

The *simple fibres* form the hard and soft parts, as the bones, cartilages, muscles, &c.

The FLUIDS are divided into,

1. Those which have not entirely put on an animal nature, as the *chyme*, *chyle*, &c.
2. Those which have partaken of the nature of the animal,

vegetable, as the *ſap*, &c.

3. Thoſe which are ſecreted from the ſap, as the proper juices, &c.

From the chyme which is abſorbed from the earth and the ſurface of the plant, the chyle is elaborated, which is propelled into the ſuccous veſſels, and conſtitutes the SAP.

The VITAL PRINCIPLE exiſts in every part of the plant, and conſtitutes its life.

When this *principle* thus univerſally diffuſed ceaſes to operate, the plant dies.

PLANTS that propagate their ſpecies by ſeeds, which, at a proper ſeaſon, vegetate, and produce young plants, are called *Oviparous*.

PLANTS, that ſend forth buds or radicles to be ſeparated from the parent plant at a proper period, and which then become perfect vegetables, are termed *Viviparous*.

animal, as the *blood*, &c.

3. Thoſe which are ſecreted from the blood, as the perſpiration, &c.

From the chyme abſorbed from the inteſtines, and the lymph from the ſurface of the body, the chyle is produced; which is at length carried into the blood-veſſels, where it forms the BLOOD.

The VITAL PRINCIPLE reſides in every part of the animal, and conſtitutes its life.

When this *principle* thus univerſally diffuſed ceaſes to operate, the animal dies.

ANIMALS that lay eggs, which, at a proper ſeaſon, are hatched, and bring forth young animals, are called *Oviparous*.

Animals which bring forth their young alive, and not encloſed in a ſhell, are termed *Viviparous*.

From

From what has been advanced in this chapter, the following PRINCIPLES are deduced

I.

That animals and vegetables, are alike compofed of *three effential* parts, namely, folids, fluids, and a vital principle.

II.

That the *barks* and *leaves* of plants are to the vegetable, what the *hard* and *foft* parts, are to the animal.

III.

That the *chyme*, *chyle*, *fap*, and the *fecreted* juices of the plant are to it, what the *chyme*, *chyle*, *blood*, and the *fluids feparated* from it, are to the animal.

IV.

That the *vital principle* is of the fame nature in both, and appears to be governed by *fimilar* laws.

V.

That plants like animals are *oviparous* and *viviparous*.

CHAP.

CHAP. II.

Of the Seed.

The ſeed, when vivified by the pollen of the male, is capable of producing a plant.

The ſeed, thus impregnated, is an organized body, incloſing under various coverings more or leſs thick, the plant in miniature.

A glutinous, ſpongy ſubſtance, of a whitiſh colour, and more or leſs fluid in conſiſtence, forms the internal ſtructure of the ſeed. In this ſubſtance are found very ſmall veſſels, ariſing from every part, and running in every direction.

The ſeed, when put into the earth, by means of its vital principle, ſwells ; the action of the veſſels is induced ; heat is generated, and it becomes a living plant. The delicate, ſpongy ſubſtance ſupplies the veſſels with a fluid, which is

conveyed

Of the Egg.

The egg, when vivified by the ſpermatic aura of the male, is capable of producing an animal.

The egg, thus impregnated, is an organized body, containing under various tunics, thicker or thinner, the animal in miniature.

A ropy, gelatinous liquid, more or leſs fluid in conſiſtence, occupies its inſide, and ſmall veſſels are ſeen ſpreading around it in every direction.

The egg, when warmed by nature or by art, by means of its vital principle, is ſtimulated to action; the veſſels begin to contract and dilate, the animal becomes a living creature, and is ſupplied with a nutritious fluid from

the

conveyed to the embryo for its nouriſhment.

The plant in this manner begins to be developed, and gradually and inſenſibly increaſes in ſize. The coverings, unable to reſiſt the preſſure, give way, and the radicle having penetrated the ſmall orifice or hylum, the ſhell at length ſplits in two. The root then pierces into the earth, and abſorbs from thence a more copious nouriſhment. The young plant now begins to riſe to the ſurface of the earth ; the leaves unfold themſelves, and, ſtrengthened by the nouriſhment the radicles ſupply, it pierces through the earth, and advances into the air, ſupplied with every part in miniature.

the gelatinous ſubſtance it contains.

The animal thus becomes inſenſibly and gradually increaſed in ſize, the different parts are unfolded, and at length it occupies the whole of the egg, having exhauſted its nutritious ſubſtance. Nature has by this time furniſhed it with inſtruments, by which it breaks the ſurrounding ſhell, and in a little time ſets itſelf at liberty. The animal is now produced, enjoys a new life, and has, concealed in miniature, every part it at any future period may expoſe.

CHAP. III.

Of the Bud.

The bud lies concealed in the body of the tree, between the barks.

In

Of the Fœtus.

The fœtus lies hid in the body of the animal, within the uterus.

At

In the beginning it is extremely ſmall, and covered (in a ſimilar manner to the ſeed) with the bark of the tree.	At firſt it is extremely minute, and is incloſed in membranes in a ſimilar manner to an egg.
It then ſends forth very delicate and ſmall veſſels, which inoſculate with thoſe of the trunk, and abſorb from them the ſap, which it conveys to every part for its nouriſhment.	In a ſhort time it attaches itſelf to the mother by means of the ſmall veſſels of the placenta, which abſorb the blood, and convey it to the child for its nouriſhment.
When arrived at a certain ſize within the trunk, it penetrates and protrudes through the bark into the air.	When all the neceſſary parts are developed, and the fœtus has acquired a certain bulk, it brings on labour, and an animal is born.
At its firſt appearance it puſhes the coverings before it, but ſoon ruptures them.	At the beginning of labour the membranes protrude, but are ſoon broken.
The bud then unfolds itſelf, and in a little time exhibits the perfect plant in miniature; and derives its nouriſhment from the tree until it be torn or cut off, and placed in the ground.	The young animal is, at this time, unable to ſeek for food itſelf; the mother, therefore, either gives it herſelf, or procures ſome for it.

From what has been ſaid in the two preceding chapters, the PRINCIPLES which follow are deduced.

I.

That the mucilaginous gluten in the cotyledon of the ſeed, is to the *vegetable* the ſame as the gelatinous fluid in the egg is to the *animal*.

II.

That the veſſels of the cotyledon of the ſeed, are for the ſame purpoſe as thoſe of the cotyledons and placentæ of animals.

III.

That both the ſeed and egg produce the plant and animal by a developement of pre-exiſting parts.

IV.

That the root is to the plant what the inteſtines are to the animal.

V.

That the ſeed is to the vegetable that which the egg is to the animal.

VI.

That the bud of the vegetable is to it, what the fœtus is to the animal.

VII.

VII.

That the bark of a tree is to the bud, what the uterus of the animal is to the fœtus.

VIII.

That the veſſels of the bud which inoſculate with the trunk of the tree, are to the bud what thoſe of the placenta and cotyledons are to animals.

IX.

That the protruſion of the bud through the barks of the tree is the birth of a plant, and is to the vegetable what labour is to animals.

CHAP. IV.

Of the Nutrition of a Plant.

A plant is nouriſhed by means of the abſorbent veſſels of the root and thoſe of the leaves, imbibing a prepared chyme, &c. which is conveyed by them into the ſuccous veſſels, to be aſſimilated into ſap.

Of the Nutrition of an Animal.

The animal is nouriſhed by means of the abſorbent veſſels of the inteſtines and thoſe on the ſurface of the body, which abſorb a prepared chyme, &c. and convey it into the blood veſſels, to be converted into blood.

The abſorbent oſcula of the leaves continually take in air from the atmoſphere, which, by a kind of chemical proceſs, imparts to the ſap its eſſential principles, which were deſtroyed; and the ſuperfluous, noxious, and diſengaged parts, are again expired.	The pores of the veſſels on the ſurface of the air-cells continually tranſmit from the inſpired air, by a kind of chemical attraction, that which the blood is in want of; and the noxious and diſengaged parts are again expired.
The ſap is conveyed, by means of the irritability of its proper veſſels, to every part of the plant, for its developement and increaſe, and to ſerve for the various ſecretions and depoſitions; by means of which every part is formed by the continued impulſe of the Formative Niſus.	The blood is conveyed, by means of the irritability of the veſſels, to every part of the animal, for its growth and increaſe, and to ſerve for the various ſecretions and depoſitions; in conſequence of which every part is formed by the continued effort of the Formative Niſus.

The PRINCIPLES to be deduced from *this* chapter, are,

I.

That the plant is nouriſhed by a *ſimilar* ſet of veſſels to thoſe which nouriſh animals.

That

II.

That the *ſuccous* veſſels are to the plant, what the *blood* veſſels are to the animal.

III.

That the *leaves* of plants are to them what the *lungs* are to animals.

IV.

That plants, like animals, have their *proper* juices or *ſecretions* ſeparated from a COMMON MASS; called the ſap in the former, and the blood in the latter.

V.

That the SAP is to the vegetable, what the BLOOD is to the animal.

VI.

That the *motion* of the ſap in the vegetable, is to it what the *circulation* of the blood is to the animal.

CHAP. V.

Of the Growth of the Vegetable.	*Of the Growth of the Animal.*
A plant grows, and is increafed by the gradual and infenfible unfolding and extending of its parts.	The animal grows, and is increafed by the continual developement and extenfion of its parts.
This extenfion is followed by a proper degree of confiftence, contracted by the fibres.	This extenfion is always fucceeded by a peculiar degree of confiftence, proper to the fibres of the part.
The extenfion diminifhes as the hardnefs increafes, and entirely ceafes when the proper degree of confiftence and the prefcribed meafurement is affected.	Firmnefs of the part increafes as the extenfion diminifhes; and when the degree of confiftence and the prefcribed fize is effected, the extenfion totally ceafes.
The feed and the bud are at firft perfectly foft, and nothing ligneous can be detected; but at length the tender fibres become hard, and acquire the proper degree of firmnefs peculiar to the fpecies. Thus hard wood, carneous fubftance, and parenchyma, are produced.	The egg and the fœtus are originally perfectly foft, and contain nothing like bone or cartilage; but as the tender fibres increafe, they become firm, and give to each part its peculiar degree of hardnefs. Thus bones, cartilages, mufcles, &c. are produced.

From

From the preceding chapter the *following* PRINCIPLES are inferred.

I.

That the plant, like the animal, is produced from pre-exifting parts.

II.

That the growth of both depends upon the extenfion of the fibres.

III.

That when the prefcribed fize is attained, increafe ceafes.

IV.

That the effential parts of the plant exifted in the feed or bud, in the like manner as thofe of the animal exifted in the egg or the fœtus.

CHAP. VI.

Of the Fecundation of the Plant.

The very fubtile, elaftic *Vapour*, contained in the farina or pollen of the anthera,

Of the Fecundation of the Animal.

The very fubtile, elaftic *Aura*, contained in the femen of the male, is the principle

anthera, is the principle which fertilizes the plant.	principle which fertilizes the animal.
The parts ſubſervient to the formation of this vapour, are called the male parts of the flower or *Stamina.*	The parts immediately engaged in the formation of the Semen, are called the male parts of generation.
Each Stamen is compoſed of	They conſiſt of
The *Filament* and The *Anthera.*	The *Teſtis* and The *Veſiculæ ſeminales.*
The veſſels of the filament prepare a fluid, and convert it into the farina or pollen; which is then propelled through very minute ducts into the anthera.	The veſſels of the teſtis prepare the ſemen, and convey it through the vas deferens into the veſiculæ ſeminales.
The *Anthera* receives and matures the farina, for the purpoſe of fertilizing, by the act of impregnation, the tender and concealed ſeed.	The *Veſiculæ ſeminales* receive and retain the ſemen for fertilizing, by the act of impregnation, the tender and concealed ovum.
The female parts of the flower are termed the piſtils.	The female parts of generation are,
Each piſtil is compoſed of	
The Germen, or pericarpium,	The Ovarium, The Uterus, and
The	Its

The Style, and The Stigma.	Its appendages.
The Germen or pericarpium contains the tender ſeeds.	The Ovarium contains within it the unimpregnated ovum.
The Style conveys the elaſtic vapour of the pollen through its cavity into the germen, where it fecundates the *ſeeds*.	The Uterus and Fallopian tubes convey the Spermatic aura of the Semen through their cavities to the ovarium, where it fecundates the *Ovum*.
The Stigma attracts and receives the pollen, exploded upon it by the rupturing of the anthera.	The Vagina and Uterus retain the ſemen tranſmitted into it from the veſiculæ ſeminales.

From this wonderful proceſs of fertilization, the *following* PRINCIPLES are deduced.

I.

That the *Subtile vapour* of the pollen is to the vegetable, what the *Spermatic aura* is to the animal.

II.

That the *male* parts of the flower are to the vegetable, what *thoſe* of the animal are to it.

III.

That the *veſſels* of the filament of the plant, like

like *thoſe* of the teſtis of the animal, *prepare* the prolific vapour.

IV.

That the *antheræ* of the vegetable are to it, what the *veſiculæ ſeminales* are to the animal.

V.

That the piſtil is to the vegetable, what the uterus and ovarium are to the animal.

VI.

That the germen is to the vegetable, what the ovarium is to the animal.

VII.

That the pericarpium and uterus are for ſimilar purpoſes in their reſpective kingdoms, viz. to bring to perfection their young.

CHAP. VII.

Of the Death of Vegetables.

A plant, after having eſcaped a variety of diſeaſes, to which, from its organization,

Of the Death of Animals.

An animal, after having eſcaped a variety of diſeaſes, to which, from its organization, it is liable, cannot avoid the effects of age. The vital principle ceafes to operate: the irritability (upon which the various functions depended) being thus inevitably deftroyed, the plant dies; or, in other words, its elements are gradually decompofed and difengaged; in which ftate they remain but a fhort time; for the great *chemical elaboratory of nature*, ever employed, unites them into frefh principles, to fulfil her immenfe defign.

organization, it is continually expofed, cannot efcape the effects of old age. The vital principle ceafes to operate: the irritability (upon which all its functions depended) being thereby inevitably deftroyed, the animal dies; or, in other words, the elements thus recover their former ftate, and become again obedient to the laws of chemical affinity; by which new principles are generated, and new beings formed.

The PRINCIPLES to be deduced from *this* chapter, are,

I.

That the *death* of a plant is of a *fimilar* nature to that of an animal.

II.

That *both* are alike fubject to *Death*.

III.

That the functions of the vegetable, like thofe thoſe of the animal, are dependent upon the *irritable principle*.

IV.

That the IRRITABLE PRINCIPLE of both is dependent upon, and governed by, the VITAL PRINCIPLE.

V.

That the death of the vegetable and of the animal is *conſtituted* by the *ceſſation* of the action of the vital principle.

VI.

That the vital principle having ceaſed to operate in the animal and vegetable, they are no longer ſubject to the laws of vital affinity.

VII.

That vegetable and animal ſubſtances then become obedient to the laws of chemical affinity.

VIII.

That the animal and vegetable, when deprived of their vital principle, do not periſh, but only loſe their organic ſtructure, by the continual *circulation* of their ELEMENTS; the deſtruction of ONE becoming the generating cauſe of ANOTHER.

CON-

CONCLUSION.

THUS the analogy between animals and vegetables has been purfued, *in a general way*, from their birth to their death.

The fources of comparifon that might have been brought forward are innumerable, and the extent to which it might have been carried is almoft incredible ; but as the great aim throughout the whole has been perfpicuity, brevity was preferred to prolix defcription.

This imperfect fketch is, therefore, to be confidered as an attempt to elucidate, in an elementary manner, a few of thofe laws which nature has fo beauteoufly difplayed, and invariably adhered to, throughout her univerfe. The contemplation of her fecret operations, the admirable fimplicity confpicuous amidft her empire (for nature is extraneous to that which is complex), have in every the remoteft ages of mankind employed the genius of the philofophic mind. Monarchs themfelves, retired from the weight of regal power, have culled the luxuriant plant to explore the periodical polity of the vegetable tribe ; and even at the earlieft dawn of fcience, the inveftigation

tion of this part of creation primarily attracted the enraptured imagination of the muse.

"Such themes as these the rural MARO sung."

But how incompetent is human effort to portray the beauties of this sublime subject! How inadequate the most descriptive talent to approximate to our view the vegetative profusions contained within the recess of nature! How limited have been our public researches! How contracted the knowledge which has been as yet obtained! What an incomprehensive store remains yet concealed, impenetrable to mortal view! The rude figures drawn on a wall by the hand of a child, do not so widely differ from the most finished performance of a RUBENS.

Should, however, this concentrated view meet the approbation of the learned, it is proposed to submit the similitude to a more minute inquiry; to draw the parallel between the different orders, and thereby to pursue the examination from the more perfect and evident species of animals and vegetables, to those which are less perfect and less conspicuous; and thus to investigate organized nature, and endeavour to establish general rules concerning her operations.

These

Theſe purſuits point out the infinite number of modifications the elements continually undergo; demonſtrate the grandeur of their origin, and exalt the mind to the contemplative admiration of that BEING, whoſe wiſdom directs and agitates the whole.

Myſterious round! what ſkill, what force divine,
Deep felt, in theſe appear! a ſimple train,
Yet ſo delightful mix'd with ſuch kind art,
Such beauty and beneficence combin'd,
Shade, unperceiv'd, ſo ſofting into ſhade,
And all ſo forming an harmonious whole,
That as they ſtill ſucceed they raviſh ſtill.

THOMSON.

THE END.