

# Renaissance Science

Recovering ancient learning, producing new knowledge

Waseda University, SILS,  
Introduction to History and Philosophy of Science

# Recovered Texts

- ▶ In the 15th and 16th century, a new style of scholarship, generally called **humanism**, became prominent in Europe.
- ▶ Humanism advocated the study of ancient texts in their original languages on the basis of Greek and Latin philology (also Hebrew, Arabic, etc.).
- ▶ It advocated 'purging' technical works of any Arabic influences and using Greek and Latin terms instead.
- ▶ Humanists were often interested in pagan works that made metaphysical claims that were incompatible with Christianity.
- ▶ A number of ancient texts were 'rediscovered' – such as Plato's dialogues, Ptolemy's *Geography*, Dioscorides' *Medical Materials*, Lucretius' *On the Nature of Things*, Celsus' *On Medicine*, etc.



# New Translations

- ▶ In the Renaissance, scholars began a 'second wave' of translations, now mostly from Greek.
- ▶ This included many secular, mystical and pagan works<sup>1</sup> that had been previously neglected. First, mostly poetry and history, later science, medicine and mathematics.
  - ▶ The Hermetic Corpus, the Orphic poems
  - ▶ Greek and Roman historians (secular history)
  - ▶ Cicero's *Republic*
  - ▶ Galen's anatomical and physiological works
  - ▶ Aristarchus' *Sizes and Distances of the Sun and the Moon*
  - ▶ Archimedes' works in mathematics and mechanics
  - ▶ The Aristotelian *Mechanical Problems*
  - ▶ And so on...

---

<sup>1</sup> Often non-Christian, and sometimes incompatible with Christianity.

# Aratus' *Phaenomena*, 3rd c. BCE (ms early 15th c. CE)



# Materia Medica (ms late 14th c. CE)





# Aristotle's *De historia animalium* (MS 15th c. CE)



# Euclid's *Elements*, 1482 (First printing, Latin)





# Ptolemy's Tetrabiblos, 1484 (Latin)

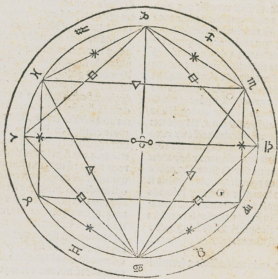
ed qm̄ eorū nōm̄ est occasio manifestā, et qm̄ biniūm qm̄ sunt p̄ has figurā illo in loco notari possunt in quo nobis ad hāc sciaz utilitate cōferretur hoc in loco reticendū fore decreuimus.

¶ Caplm. 14. in affinitatib⁹. 4. signoz et figuris.

**P**rima quidē partū circuli signoz inter se similitudinis affinitas ē que in figuris habet: et sicut partes inter quas vni⁹ est diametri lōgitudō: et que duobus rectis angulis subiectur, suntqz. 6. si-

gna et. 180. gradus. Et partes etiā inter quas est longitudo trina et q̄ vni⁹ rectū angulū ac eiusdē timentē circūdat: sunt 4. signa ac. 120. gradus. Partes quoqz inter q̄s est longitudo tetragona q̄ vni⁹ rectū angulū cōtinet: et sūt. 3. signa atqz gradus. 90. Nec nō et partes int̄ quas ē eragona lōgitudō q̄ vni⁹ recti anguli bis circūtenēt. et sūt duo signa ac grad⁹. 60. Occasiones aut̄ cur has solas lōgitudines et nō alias obseruare: ex hoc qd̄ subiegt̄ adiscem⁹. Illa occasio nes obseruandi longitudinē vni⁹ dia- metri per se manifestantur eo q̄ in ei⁹ oppositiōe fm̄ lineā rectā collocātur.

¶ Figura Spectrum.



Lūg duas maiores partes cōsiderauerim⁹ i q̄b⁹ erit diuēctia quātūctio partit̄ ac quātūctio totius et partit̄: hoc resti dūqz figurē cōstituet⁹. Per diuēctiā itaqz partit̄ erit ita: cū ad duos rectos angulos longitudinē assignauerim⁹ p̄portio nē que diametri est longitudo: ab eius medietate et tertia erit. i. medietas ē ip̄i longitudo tetragona. et ei⁹ tertia erit longitudo ipsius eragona. et bac aut̄ longitudo duplicata trina cōstituet longitudo. Per totū vō. partit̄qz diuēctiā fiet ita. cū a tetragona longitudine ad duas alias longitudines int̄ q̄s ip̄a cōstituit̄ p̄portioniē fecerim⁹: fueritqz vni⁹ p̄portio sesquialtera: alteri vō sesquitercia: cū assignauerim⁹ in quā p̄portioniē ab ea ad id qd̄ min⁹ ea fuerit. et cuius p̄portio ad eam sit sesquialtera eragona fiet: isti longitudo. cūqz ad mai⁹ ea p̄portioniē assignauerim⁹ et cuius p̄portio sit ei⁹ sesquialtera: trina longitudo cōstituet⁹. Istā itaqz affinitatē trina et eragona cōtinentes: appella uerē: eo q̄ et signis i genere cōtinentib⁹ cōstituit⁹: masculina nāqz vel fœmina sūt oīa. Que aut̄ ex diametro vel ex figura tetragona formant⁹: disconuenientes nominauerē: eo q̄ in cōtrarietate signozū in genere cōtinentiū semper inueniuntur.

¶ Caplm. 15. in sublimib⁹ et infimis q̄ precipientia et obedientia dicuntur.



Artes qd̄e quā vni longitudo ab aliquo vno codē qz p̄tecto. punctoz equinoctialit̄ est eadē: sublimis et infime nuncupā et sūt illē quāsi ascensionis et descensionis in ege temporib⁹ cō-

tingunt: eo q̄ in equalibus circūferentis circuloz paralleloz equinoctiali circulo ferunt. Istā a uē partium illē que in medio gñualis circuli formant⁹: sublimis dicunt⁹: et q̄ sūt i biemal circuli medio nomināt infime. ob hoc q̄ cū sol per gñualis circuli mediū p̄ogredis. dies noctib⁹ maiores esse cūc. Lū aut̄ biemalis circuli mediū erat illuminat⁹: dies noctib⁹ breuiorē esse demonstret.

¶ Caplm. 16. in signis se inuicē aspiciētib⁹ et sibi in fortitudinib⁹ equatis.



Scunt itē qd̄dā ē partes q̄ alijs partib⁹ in fortitudinib⁹ equat⁹: cū earū longitudo ab vno quolibet puncto ex duob⁹ p̄dictis tropicis: vna est et eadē: eo q̄ cū sol p̄ quēlibet istorū duozū punctoz periret: erit dies diei: noctisqz noctis equabit⁹: et tēpa horarū erit eadē: Aut̄ etiā q̄ hęc partes p̄p̄dicas occasiones se inuicē aspiciāt: et q̄ vnaqz earum ab eisdē orientis partib⁹ ascendat in orientē: et in eisdē partib⁹ in occidentē occubat.

¶ Caplm. 17. in signis sibi cōtradicientib⁹ et inter que nulla sit colligatio.



Artes quippe q̄ cōtradicientes et extraneas nuncupant illē sūt int̄ quas ex modoz p̄dictozū affinitatibus nulla cōtinent affinitas. i. nec sūt ex p̄dictis partib⁹: nec ex obediētib⁹: nec ex inuicē aspiciētib⁹ q̄ sunt infortitudinib⁹ ad inuicē equales: nec sunt ex his que per aliquā. 4. figurā p̄posita et aliqua debent ad inuicē affinitatē. i. per diametri

# Ptolemy's Geography, 1482, (Latin)





# Ptolemy's *Geography*, Venice 1511 (Latin)



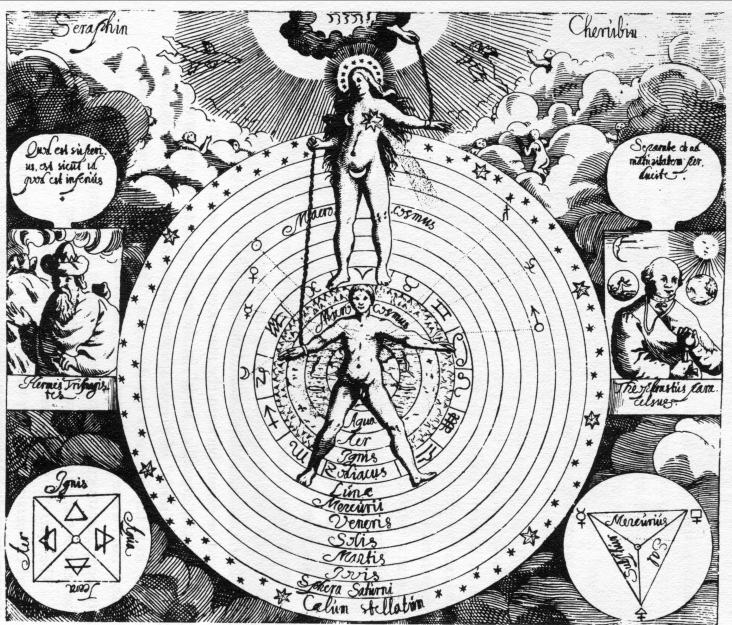
A cordiform projection by Jacobus Angelus and Bernardus Sylvanus.

# “Recovered” Knowledge

Renaissance scholars had a tendency to claim that their own work was the **recovery of ancient knowledge** – either pagan or patriarchal.

Examples: Hermeticism, Andreas Vesalius’ anatomical research (Galen), the mechanics of equilibrium or floating bodies (Euclid, Archimedes), William Harvey’s theory on the role of the heart (Aristotle), Nicolas Copernicus’ heliocentric hypothesis (Aristarchus, Pythagoras), François Viète’s analysis (Apollonius, Archimedes), etc.

# Schuetz (hermeticism), 1654



At the same time, they had a tendency to claim **radical breaks** with the past.

Examples: Paracelsus burning Galen's books, Francis Bacon's rejection of Aristotle, Vesalius' criticism of scholastic (medieval) anatomy, Harvey's criticism of Galen's physiology, Copernicus' rejection of Ptolemy, and so on.

This notion of *radical breaks* with past knowledge and scholarship also applied to humanistic and historical scholarship: Julius Caesar Scaliger (1540–1609) debunks the orphic poems and revises ancient chronology (contrary to Biblical history), Isaac Casaubon (1559–1614) debunks the hermetic corpus. And so on.

# New Technologies

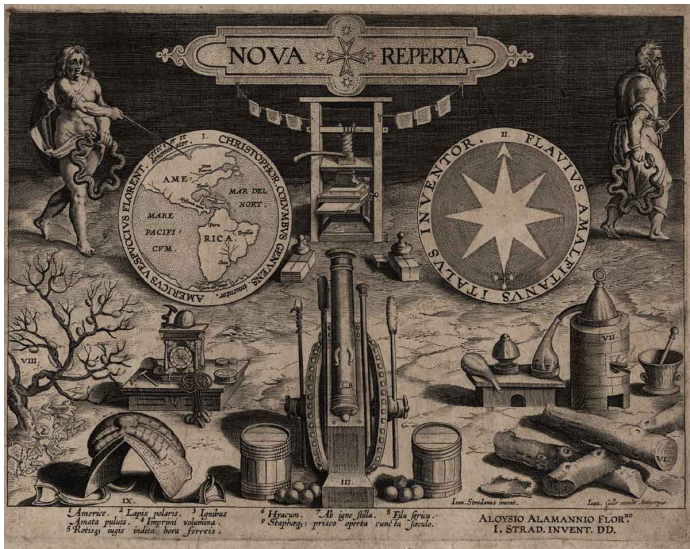
The period saw the increased use of old technologies and the development of new ones.

Bacon mentions the significance of the **magnetic compass** (13th c.), **gunpowder** (13th c.) and the **printing press** (early 15th c.). (Actually, all three of these were developed in China, but they were imported into Europe and put to uses that eventually contributed to changing the structure of society in Europe.)

New techniques of metallurgy, glass making, and other 'industrial' technologies.

Later, scientific instruments such as the telescope, microscope, barometer, thermometer, air pump, etc.

# Nova Reperta (1600), New Inventions/Discoveries



Frontispiece

# Nova Reperta (1600), Navigation





# Nova Reperta (1600), Gunnery





# Nova Reperta (1600), Printing



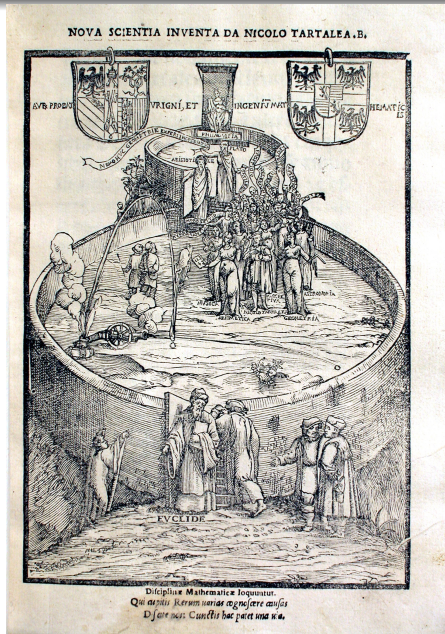
# Nova Reperta (1600), Eyeglasses



# *Nova Reperta* (1600), Distillation



# Tartaglia, *Nova Scientia*, 1606

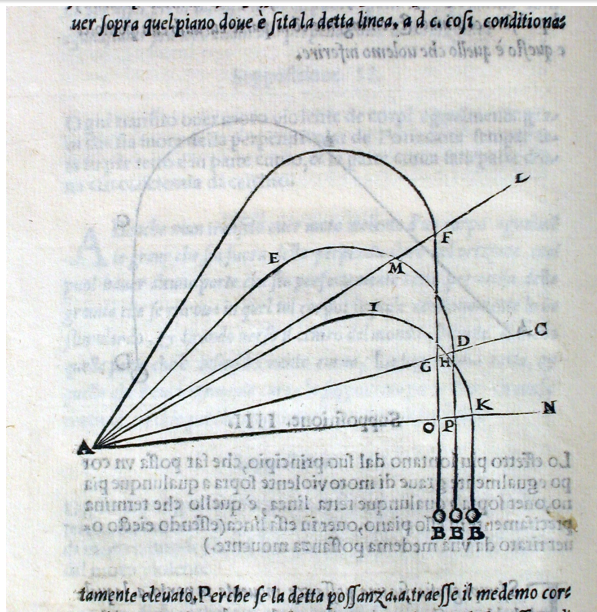


# Tartaglia, *Nova Scientia*, 1606





# Tartaglia, *Nova Scientia*, 1606



# Voyages of Discovery

The voyages to the Americas made it clear that the ancients could not have known everything.

The explorers brought back tales of unknown lands and civilizations, specimens and descriptions of new plants and animals, a few of the inhabitants, great wealth and new diseases.

These new plants, animals, and minerals did not have any place in the old taxonomies, and cast doubt on the various mystical and occult organizations of the macro- and microcosm that had been put forward.

# Martenellus, 1489







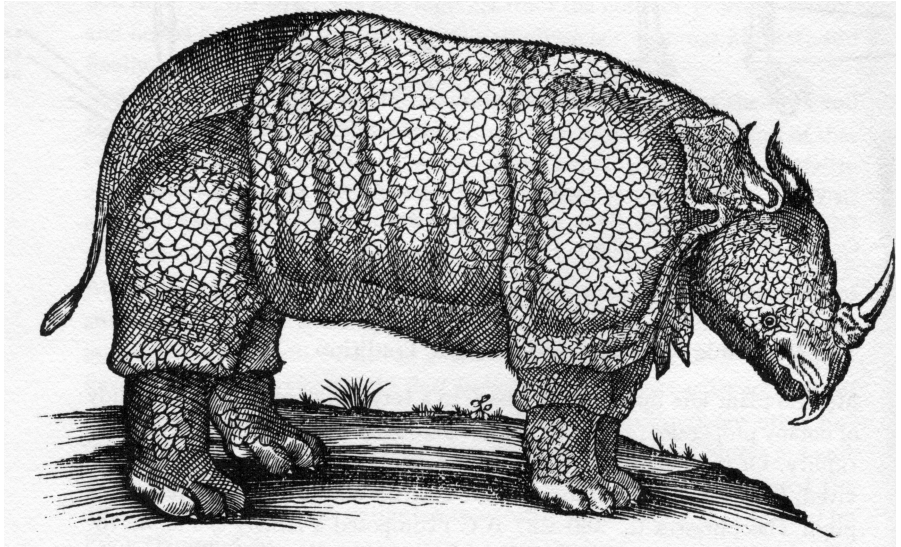
# Waldseemüller, 1507



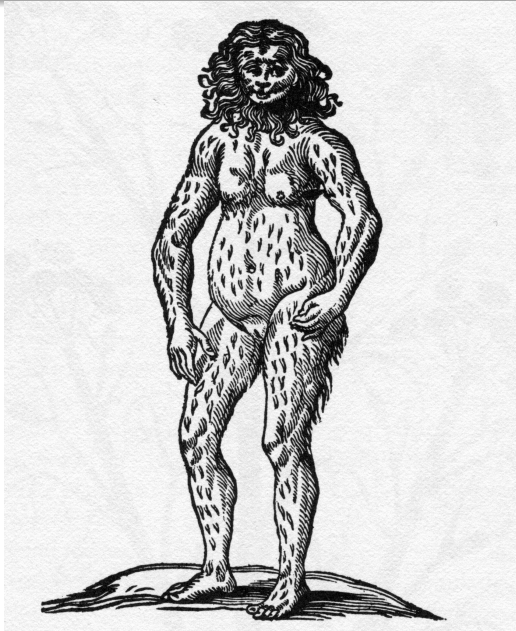
# Belon, Les observations de plusieurs singularitez et choses memorables, 1555 (a genette)



# Bundt (Buntius), 1658 (a rhinoceros)



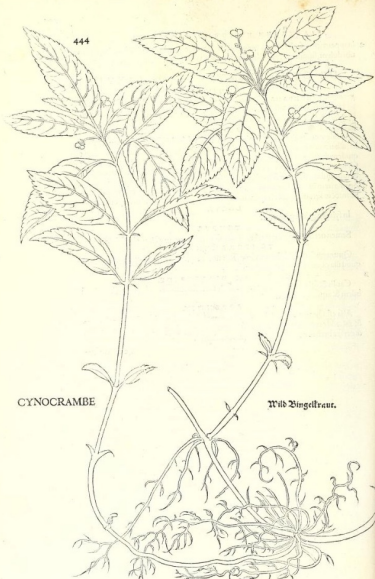
# Bundt, 1658 (an orangutan)





Just for comparison...





CYNOCRAMBE

Wild Vingelkraut.

## DE COLYTEA

## CAP. CLXVIII

445

A

### NOMINA.

**C**OLYTEA Græcis, Colytea & Colutea Latinis dicitur: à nullo tamen, quod sciam, ueterum, quàm à Theophrasto lib. ij. de plant. hist. cap. xvij. celebrata.

### GENERA.

Duo eius sunt genera. Vnum quod priuatum Colytea uocatur, officinis in eoigni Colytea. Germani welsch Linsen appellant. Alterum officinis cognitum & frequentius à medicis usurpatum, Mauritano sermone Sena nominatur. Germani ad eam alludentes appellationē, Genet nuncupant. Differunt autem inter se magnitudinem: siquidem primum genus maius est altero, uispete quod quadriennio, Theophrasto loco paulo antè citato teste, se in arborem efficit. Siliquæ etiam illius magis turgido spiritu distendantur. Sena uerò siliquas proferit lunatas, nec ita prætumidas. Semen deniq; Colyteæ rotundum, lentis obtinens similitudinem: Senæ autem oblongum, cordisq; humani instar acuminatum.

### FORMA.

Frutex est ramis exilibus, folio fecenigraci, flore geniste aut pili luteo, membr. Colyteæ duo folliculo, pellucente, prætumido, & ueluti quodam spiritu distendente turgido, ita ut digitis si prematur, crepitans dissiliat, in quo semen atrum, durum, lacum, lentis magnitudine, pili gustu, in ordinemq; digestum clauditur.

### LOCVS.

Satum utrunque in hortis prouenit.

### TEMPVS.

Floret Colytea Maio & Iunio mensibus, ac subinde in siliquis oblongis semen in proferit.

### TEMPERAMENTVM.

Arabes calidam in principio secundi, & siccam in primo ordine statuunt.

### VIRES. EX ACTVARIO.

Sene siliquosus quidam fructus à barbaris appellatur, qui citra noxam drachmæ pondusculo pectus, pituitam & bilem deiecit: post hos reliquos humores modè utiliter purgat, reoridam atramq; bilem, eiusq; suffusionem ex gallinaceo iure depellit. Vento capitis dolori, scabiei, comitialibus, impetigini succurrit. Sed fructus estis potius quàm triti farina propinatur. Interancorum obstructions tollit.

### APPENDIX.

Quum non forma tantum, imò etiam sapore duo hæc Colyteæ genera sibi similia sint, facili etiam hinc colligitur facultas inter se minimè differre. Quare utrumque citra molestanti atram bilem reoridamq; educit, caputq; ac cerebrum, & instrumenta sensuum à noxiis purgat humores. Quid multa? aduersus omnia uitia ab atra bile nata ualeat.

P DE CORO

Falsum & commentitium haud dubie est quicquid neoterici aliqui de Filicis femine fabulantur: Filix scilicet quod foliis nocte floreat, eademque mince pro hora cum defloruit maturum in terram semen ea sus caret. dat, ideoque nisi quispiam tunc affuerit, nec videri florem, nec colligi semen posse, tum quia incredibilia sunt, tum quod omnes, Theophrastus scilicet, Galenus, Dioscorides, Plinius, Perilem & sine semine dixerunt. Neque etiam medici vel Arabes vel Persae, ad magicas vanitates nati, seminis huius meminerunt. Quapropter omnia haec agyrtarum commenta esse videntur humane ignorantiae ad questum impudenter illudentium, quae certe vel vna hac ratione abunde satis confutari possunt, quod cuncta illa fieri & observari natali nocte diui Ioannis Baptiste praecipunt, cum natalis ea nox & solstitialis illa duodecim dierum numero nunc inter se distent.

## DE PEUCEDANO. CAP.

CCXXVIII.

## NOMINA.

**P**ΕΥΚΕΔΑΝΟΣ Græcis, Peucedanus Latinis, of Fœnicicinis et herbariis nostrae ætatis Fœniculus lus porcinus dicitur. Germanis Hartstrang, Seuufens nus. chel, oder Schuuefeluertz, (Gallus Peucedanus, ou queu porceau,) quod lachryma è radice nus vnde sulphuri aut thuri similis exudet. Peucedani autem dicta. nomē inuenit à pinu, quæ græcis πῖνα dicitur, cui Pinastel folio par est. Hinc posteriores latini Pinastellum lus.

S iij

cum

eum vocauerunt.

## FORMA.

Caulem emittit tenuem, macilentum, Fœniculo similem comam habet circa radicem copiosam & densam. Florem luteum, radicem foris nigram, intus albam, graui odore, crassam, liquore plenā. Hæ sanè omnes notæ, nulla prorsus reclamante, huic Officinæ quam pictam exhibemus herbe conueniunt. Officinæ, quæ non raro adulterinas pro genuinis vendunt herbas, Peucedanum ostendunt radice non succosa, sed lignosa, nec graui odore, sed incundo: unde de satis constare potest verum non esse.

## LOCVS.

Cignitur in montibus opacis, potissimum in monte prope Tubingam, cui olim arx imposita fuit, in itinere versus Rotenburgum sito.

## TEMPVS.

Floret Iulio & Augusto mensibus, atque deinceps semen producit. Radix foditur exitu autumnii.

## TEMPERAMENTVM.

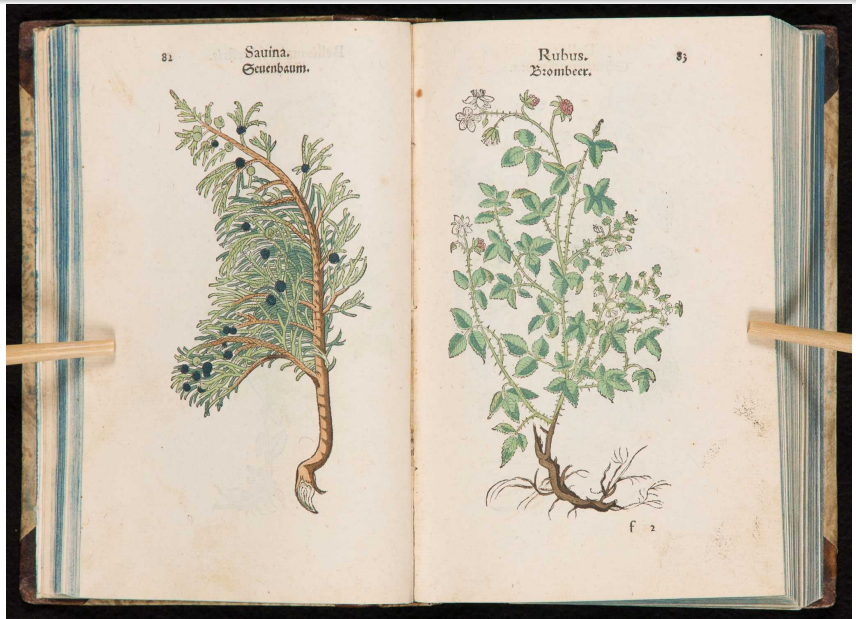
Calefacit ordine secundo iam completo: desiccatur verò tertio iam incipiente.

## VIRE. EX DIOSCORIDE.

Radice adhuc tenera Peucedani cultello incisa liquor effunditur, profluensque statim in umbra reponitur: in sole siquidem languescit. Facit cum coligitur capitis dolores & vertigines, nisi quis antea rosaceo nares præungat, & caput irrigat. Radix assata



# Fuchs, *Primi de stirpium historia* ..., 1549



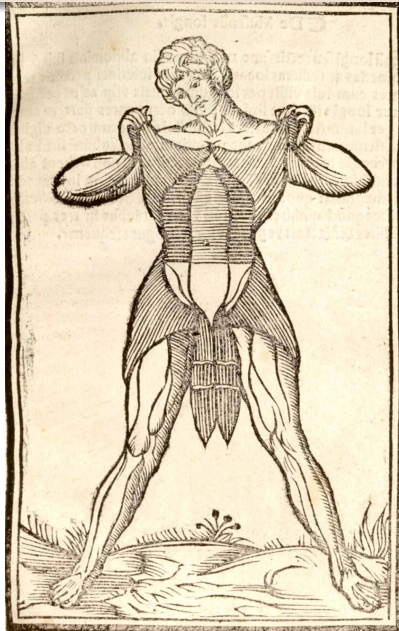
# Early Renaissance Anatomy

- ▶ Humanist scholars translated the most important anatomical texts of Galen (*On the Use of the Parts* (1500), *On the Natural Faculties* (1523), *On Anatomical Procedures* (1531)).
- ▶ The techniques of printed illustration made it possible to incorporate the new forms of art into anatomical textbooks.
- ▶ Printed books made it possible for physicians to be sure the illustrations they were publishing met their standards of accuracy.

Berengario, 1535, *In Anatomiam humani corporis*



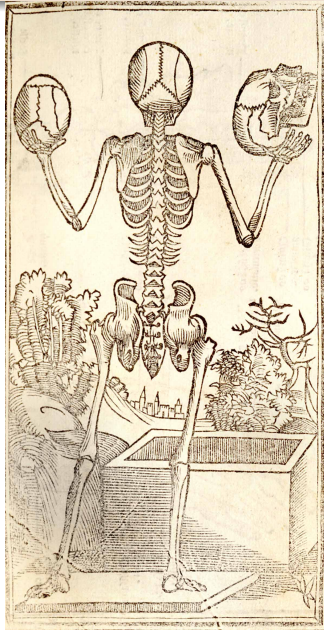
Berengario, 1535, *In Anatomiam humani corporis*



# Berengario, 1535, *In Anatomiam humani corporis*

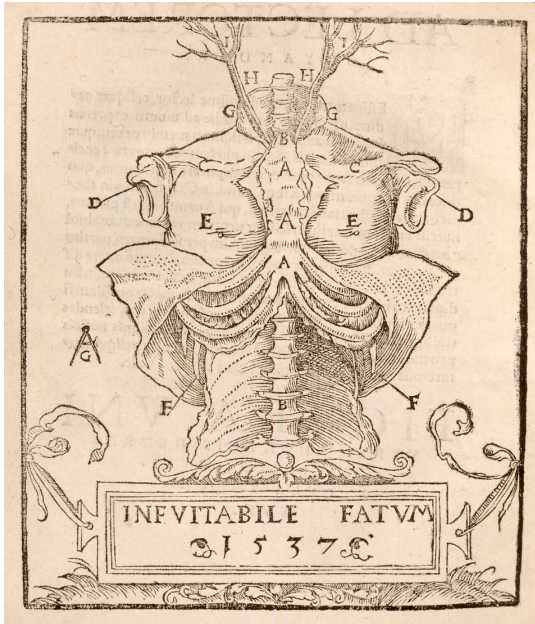


# Berengario, 1535, *In Anatomiam humani corporis*





# Eichmann (Dryander), 1537, *Anatimiae*



# Andreas Vesalius (1514–1564)

- ▶ Born in Belgium; educated in Louvain, Paris and Padua.
- ▶ At Paris, he studied with Johannes Guinter, a humanist scholar who specialized in Galen.
- ▶ Lecturer in surgery at Padua. Performed his own dissections. Established a school of eminent anatomists.
- ▶ He became famous for his work in anatomy and was appointed personal physician to Emperor Charles V.

# Andreas Vesalius (1514-1564)



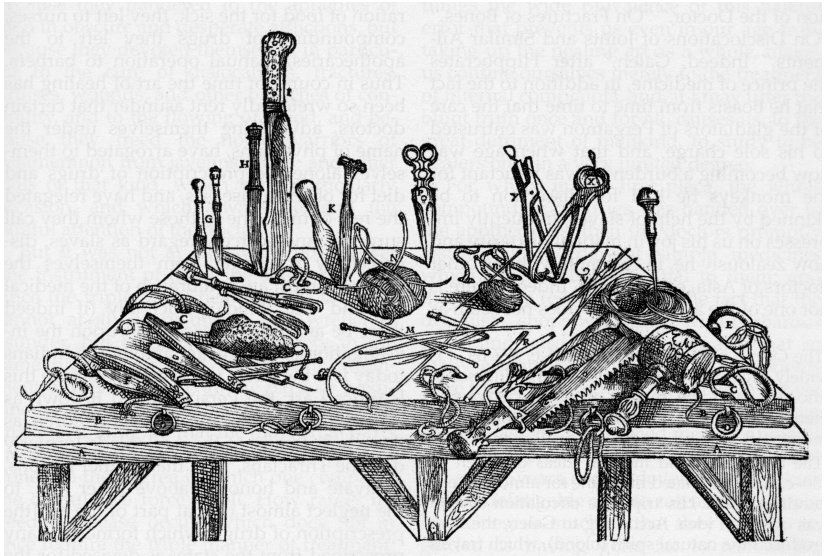
# The Fabric of the Human Body

- ▶ *De humani corporis fabrica*, Basel, 1543.
- ▶ The book is most famous for its illustrations, by Jan Stephen van Calcar.
- ▶ The text is strongly influenced by Galen.
  - ▶ Vesalius begins with a brief history of dissection.
- ▶ The text follows Galen's organization: skeleton, muscles, cardiovascular system, brain and nerves, abdominal organs, thoracic organs, etc.
- ▶ Although Vesalius noticed many minor mistakes that Galen had made, he maintained Galen's overall physiology.
  - ▶ For example, blood flow (circulation). He did, however, observe that the septum had no pores between the ventricles.

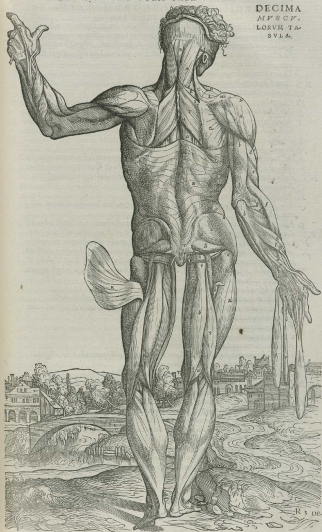
# *De humani corporis fabrica*, art by van Calcar



# *De humani corporis fabrica*, Tools of the trade



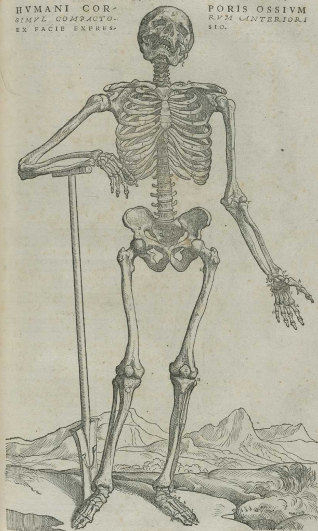




SEPTIMA  
MUSCULO-  
RUM TABV-  
LA.



DE HUMANI CORPQRE FABRICA LIBER I. 169  
HUMANI COR-  
PUS SIMPL. CONTACTO-  
EX FACIE EXPRES-  
PORIS OSSIVM  
RVM ANTERIORI  
SIO.



Movie on Harvey and the circulation of the blood...