The grapevine

- the natural tendency of all plants: produce fruit that contain seeds
    - when not threatened: grow in a balance with just enough fruit to survive and expand size to the limitations of environ
    - in adverse conditions: increase the amount of fruit at the expense of growth to max survival rate
- permanent woody framework
    - produces fruit from wood grown last year thus growing conditions then determines quality/quantity of fruit: forward looking in vine husbandry - prune and nurture for the future
    - vines for planting new vineyards are always produced by taking hardwood cuttings from parent vines rather than seeds as pips/seeds do not grow true to type and each seed can turn into a new variety & many vine seeds are sterile
- Above ground structure
    - trunk & cane/spur
    - trunk: raise vine off ground, support fruiting wood, provide two-way conduit for nutrients and moisture to supply the plant from the soil and for carbonhydrates produced by plant to return to the roots
    - trunk in cane-pruned systems usu vertical with annual canes attached at top
    - trunk in spur-pruned systems extends into a T or inverted L with fruiting wood carried on spurs
    - buds contain plant matter turning into next year's shoots: the condition - heat/light and general well being and health of the vine will determine the quantity and quality of the crop to come; damp cool overcast conditions lead to smaller crops than warm dry conditions
    - distance between two leaf conditions determines the number of buds on a cane of a set length, irrelevant on spur-pruned vines as buds are carried on spurs which is an advantage of spur-pruning systems
    - in vigorous vines, side shoots will emerge from new buds and add to foliage, contributing to the problem of overcrowding
    - commercial vines are almost all hermaphrodites whose flowers carry male and female parts for pollination; single sex varieties (usu for table grape or drying) need pollinator varieties for pollen
- Below ground structure
    - root size depends on
        - own root or grafted
        - rootstock type
        - soil conditions:
            - shallow soils esp those overlaying impervious layer of rock of compacted soils impede root growth
            - sideway growth of root limited by neighboring vines
            - imbalanced nutrients/minerals retrict extensive root growth
        - water supply: waterlogged soils retrict growth
        - climate
    - roots' functions
        - anchor the plant in soil
        - provide a conduit for nutrients and moisture from the soil to the plant
        - store reserves of nutrients and moisture as a buffer against variations in supply
    - initial root activity is provided by minute root-hairs that turn into permanent roots which contribute to expansion of root system, the production of which is essential in the early growing season for vine to get into leaf quickly and extend the growing season
        - early budding almost always associated with a successful year as flowering is earlier and ripening takes place in better/warmer conditions?
- Clones
    - produced by selecting individual vines of certain characteristics (disease resistance, deep color, high yield, small berries), taking cuttings from those vines to plant and observe if any cuttings inherited desired traits - repeat until an exaggeration of the traits sought is produced
    - Pinot Noir subdivided into clones suitable for different climates, uses (dark skinned for red or lighter skinned for sparkling), higher yielding for basic or lower for better sites, upright habit (Pinot Droit), loose bunches (Mariafeld clones); ONIVINS lists 43 Pinot Noir clones permitted to be planted in French vineyards
    - Chardonnay clones for high acidity and little fruitiness eg in Chablis, Mendoza clones of small berries with tropical fruit; ONIVINS lists 28 Chardonnay clones for use in France; also stipulated in appellations which clones can be used: Champange CIVC lists 11 permitted Chardonnay

clones
    - Marketing advantage of clones over new bred varieties: new clones retain the name of the parent despite possible marked differences in flavor/quality, less consumer confusion
- Mass selection - selection massale
    - vineyard with a single clone could be of a uniformity of style and flavor: simple, 1-d, lack complexity of a multi-clone vineyard
    - before phylloxera
        - grubbing is rare (completely removed), rather:
        - layering used to replace vines: a method of filling in gaps in a vineyard by utilizing shoots from a neighboring vine
        - or growers take cuttings from the same/neighboring site and root in situ
        - so that prephylloxera vineyards usually consist of multiple grower selected clones from best vines in the region/vineyard
        - contribute to terrior expression and capture history of appellation
    - after phylloxera - today to plant a multi-clone vineyard: mass selection of source materials
        - grafting nurseries source scion (productive top half of a grafted plant) wood from a vineyard with a known history f producing good wines from which grafted vines can be produced
        - growers can also source wood from own/neighbor's sites and send to nursery for grafting
        - continue diversity of style and flavor in parent vineyard
        - wood sourced required testing for viruses
        - exists in new world too esp with well established vineyards, where grafting not necessary - Chile, parts of Australia, and where anti-phylloxera controls forbid the importation of plants or plant material "Vine Improvement Programs"
- Natural mutations - Chimeras
    - chimera/sport/bud sport: when plants produce a shoot, a leaf form, a flower or a fruit markedly dissimilar from norm
    - most commonly a different form of grapes - bigger/smaller/different shape/color - eg: teinturier grapes, Gamay/Grenache/Muscat/Pinot Noir/Blanc
        - if wood from from cane where abnormal bunches is propagated/subjected to clonal selection: a possible new variety
    - sometimes different growing habit: more upright, more compact, shoter internodes, distorted shoots/leaves
        - occassionally considered a new variety: eg Kernling, a mutation of the variety Kerner; Findling, a mutation of Muller-Thurgau
    - causes: virus infection
- Cross-breeding
    - new varieties made by crossing the male of one variety with the female of another: taking pollen from the male parts - anthers - of one variety and using it to pollinate the female part - ovary - of another, then plant out the seeds that result
    - uncertainty involves and no guarantee the desired traits will be passed on
    - actual mechanics simple as almost all commercial varieties are hermaphrodites:
        - anthers removed with tweezers then pollen from male variety dusted onto ovary
        - pollen can be harvested fresh or cold stored
        - from the 100s seedlings that grow, most disease resistant and strongest will be grown on/selected indoors forced to max growth in 1st year
        - once dormant hardwood cuttings are takine and a new plant produced from each fruiting eye, each then planted out and within 2 years produce fruit to be harvested then assessment on fruit quality
        - takes decades - 30-40 years - before a variety proves its (lack of) worth for commercial production
    - cross breeding in earlier years not organized and left to nature/chance: freely pollinated by growing mainly female varieties close to other pollen bearing varieties; Siegerrebe was bred this way, by Georg Scheu a noted German vine breeder in 1930s who cross bred by free pollination
    - successful varieties by cross breeding very few
        - Muller-Thurgau in 1882 by Prof Dr Hermann Muller at Geisenheim in Germany
            - once the most planted variety in Germany, still ~20% of total vine area
            - also widely planted in New Zealand in 50s, 60s, 70s before introduction of Chardonnay and Pinot Noir and Sauv Blanc
            - still found in climatically challenged regions
            - initially known as Riesling Syvalner, due to flavor/potential parentage

        - Rivaner in Luxembourg
        - parentage uncertain, records lost: many crossings of Riesling and Sylvaner/Silvaner attempted to recreate but no luck, now shown by DNA to be Riesling X Madeleine Royale (table grape developed in Loire in late 1800s)
    - Dornfelder, bred by August Herold 1955 at Weinsberg research station, 8% planting today after Riesling, Muller-Thurgau, Pinot Noir, 4th most planted
    - Scheurebe: Silvaner X Riesling
    - Bacchus: 3-way crossing of Silvaner X Riesling interbred with Muller-Thurgau
    - Pinotage: Pinot Noir X Cinsault
    - Tarrango: Touriga X Sultana
  - main problems: outcome uncertainty, long lead time for results and acceptance of new name
    - under modern naming procedures enforeced in EU, name can not reflect parentage to avoid public confusion
    - Ruby Cabernet (Cabernet Sauv X Carignan 1949) bears little resemblance to Cabernet Sauv would not be allowed today
    - names chosen for marketing appeals too, easy to pronounce
  - main reason/advantage: disease/virus resistance - grown with less/no chemical treatment
    - Catawba, Clinton, Concord, Delaware, Niagara, Norton: phylloxera resistant, and winter hardy
- Hybrids
  - Amercian and other non-European vines used as crossing partners with viniferas t produce hybrids
  - first developed in latter part of 19th century to develop varieties resistant to diseases and phylloxera
  - takes decades/generations
  - use in EU limited due to regulations that forbid non vinifera for quality wine - AC, DOC, DOCG, etc.
    - reason steeped in viticultural history: protection of mainly French appellations
  - cheaper to grow, productive in warm climate regions
  - categorized for low quality Table Wine - this regulation stopped further developement of hybrids, and planting declined
  - Prof. Dr Helmut Becker called it ‘viticultural racisim’ and convinced one day the benefit of disease resistance through natural plant breeding would be viewed positive
  - recent decades: renewed interest in producing naturally resistant varieties grown w/o chemical treatment
    - Regent, Phoenix are both complex interspecific crosses grown without spraying and produce very good wines
    - today > 25 varieties of modern disease-resistant interspecific crosses being grown around the world and organic/biodynamic growers are drawn
    - many have been officially classed by the German authorities as viniferas to overcome exclusion from Quality Wine Production after official state plant testing agency - Bundessortenamt - looked at the new hybrids to determine if they differ from pure vinifera varieties in any way other than disease resistance - growth habits, grape type, wine quality - and determined no intrinsic differences!
      - thus EU regulations circumvented by member states
      - took UK’s DEFRA (agri ministry) 5 years to adopt/accept the ruling so that Orion, Phoenix, Regent, Rondo can be made into English or Welsh Quality Wine
  - will never replace pure vinifera but a natural alternative to a blanket of chemical protection to produce a commercial crop
- DNA profiling
  - exposed Zinfandel as Primitivo or Crljenak or Tri?bag
  - Muller-Thurgau exact parentage
  - Cab Franc X Sauv Blanc = Cab Sauv
  - explains how Pinot has not only several very distinct forms - Pinot Auxerrois/Blanc/Gris/Noir/Meunier - but within each variety, dozens of clones
- Genetically modified grapevines
  - genetic modification through hybridisation not new
  - very limited in viticulture, limited to research, no commercial GM vines
  - GM vines trialled at
    - Geilweilerhof research station - Germany
      - Botrytis resistant vines

        - INRA - National Institute for Agricultural Research - France - Colmar - Alsace
            - fanleaf virus resistant vines
        - Stellenbosch University - Welgevallen Experimental Farm
        - all three belong to IGRP - The International Genomics Research Program whose goal is to understand… fundamental to… vital to…
        - traits of primary interests:
            - pathogen/abiotic stress resistant
            - quality traits for fruit and wine grapes
            - reproductive traits determining yield
    - aim at:
        - produce varieties that can grow w/o resources to chemicals thus protecting the environment, the public, and growers
    - consumer resistance and slow adoption even after research dev

Production of grapevines: specialist nurseries, store vines in a cold store until can be shipped for planting season, essentially two types: rooted cuttings, grafted grapevines

- Rooted cuttings
    - take out 250-300mm from a prant vine, place in a buttings bed to grow and develop a root structure, usually after 1-2 summer's growth
    - rooted cuttings then lifted, sorted, planted out in the vineyards
    - cheap, take vines from own/neighboring sites
    - risks in planting ungrafted cuttings where diseaes/viruses can be transmitted
    - in favorable climate conditions - warm, well drained soils, adequate water, weed free - cuttings can be rooted in situ, rarely done in practice though as it's less certain than planting a rooted structure
    - in phylloxera free zones, vineyards are planted with ungrafted cuttings but from nurseries where wood provenance and hygiene during all stages of highest order
    - in Australia, Vine Improvement Programs control production of vines in phylloxera-free areas
- Grafted grapevines
    - grafting a scion onto a rootstock
    - scion wood sourced from vineyards planted with vines tested for varietal purity and absence of viruses
        - mother gardens inspected routinely to identify abnormalities/viruses
        - wood pruned from vines, taken to nursery, cut into small pieces - 25mm long each bearing one fruit bud, disinfected, placed into cold storage until sale/grafting
        - scion wood oft distributed worldwide
    - rootstock wood sourced from rootstock vines grown by specialist growers mostly in southern France, northern Italy: these vineyards planted with generic material supplied by plant-breeding institudes that develop them
        - wood harvested in winter, taken to nursery, cut into 1.2m lengths, disinfected, placed into cold storage until sold to nurseries producing grafted vines
    - large nurseries may well grow both scions and rootstocks, others buy in both and focus on grafting
    - originally vines handgrafted by travelling workers esp Hungarians; today by machine the most common being Omega - joins two halves of the vines with an omega shaped jigsaw type of joint which holds the scion and rootstock together
    - scion and rootstock need to be matched in diameter to form a callus, fuse together
    - head dipped into low-temp paraffin wax - also contains a mild fungicide - to seal the graft immediately after
    - freshly grafted vine then placed upright into milk-crate sized callusing boxes - lower 3-quarters covered with moist and peat, which are then placed in plastic greenhouses with irrigation/warmth (soil warming cables, usually cover the graft with black polytene over soil to keep out weeds, capture moisture, and raise soil temp) until grafts harden, callusing starts, roots start to develop then after a few weeks plant out in a nursery field for the growing season: usually grafted in March/April and planted out in late May after frost risks, may be sprayed pesticides or irrigated during the remaining growing season
    - lifted once the 1st growing over as vines become dormant, inspected for strong grafts and abundant roots, trimmed for ease of handling, disinfected, bundled into 25s, put into a cold-store for sale usually within a year
    - losses in nursery bed can be high ~50% due to size mismatch, weak callus development, diseaes

Botrytis infecting grafts
    - **Field grafting** or **chip budding**
        - grafting single buds directly onto already planted rootstocks
        - rootstock wood already in a cuttings bed (for 1-2 years), then a rooted vineyard planted out into the vineyard in the correct position
        - once established - usu a year - the top of the growing vine is cut off and a single bud of the scion variety is chip budded onto the side of the established rootstock, then develop into a cropping plant
        - only in warm regions where natural rainfall is not sufficient or irrgiation not available and spring planted grafted vines might struggle to establish themselves, or where labor trained in this technique available
- Layering/provignage
    - not universally recommended
    - certainly happens as an individual vines (that died etc.) is replaced in a vineyard
    - a single vine is replaced by a taking a suitably positioned cane from a neighboring vine, laying down on the ground where the missing vine was, burying it under the soil - sometimes the cane cracks slightly and a stone placed on top to keep it in position
    - during the growing season the cracked cane will throw out roots and shoots emerge, which can be further trained up a support and in due course the new vine can be separated from its neighbor - done
    - routinely seen eg a Parral system vineyard in outside Mendoza where 50% vines replaced through layering
    - danger of layering in vineyards originally planted with grafted vines:
        - layered vines will be on their own roots so prone to phylloxera except when the vineyard is flood irrigated which kills phylloxera and counters soil salinity
        - layering inherits all attributes of the parent vine and the viruses they have
    - layering allows the life a vineyard to be indefinitely extended - of great antiquity, though not quite as old as it appears to be
- Repiquage
    - replant young vines in amongst existing older vines
    - lower avg age, usually discontinued once % newer vines exceeds that of original ones at which point then it's time for the whole vineyard to be grubbed and replanted
- Top-grafting/working
    - for changing varieties in a vineyard
    - take a mature cropping vine, grafting wood containing buds from another variety onto the top of the trunk, so then vine changed from one variety to another variety
    - usually done in Spring as vine is breaking into leaf
    - existing trunk cut off at ~500mm from ground, a split/cleft made in the top and insert 2 wood wedges of the new variety into the split - each piece of wood will bear 1-2 fruiting buds - the cleft is then bound up with plastic grafting tape, binding in the new pieces of wood, and protected with a paint containing fungicides to seal the wound and exclude diseases
    - once old trunk stops bleeding, new grafts will bond with older wood and fourish - will succeed as long as suckers from the original variety are rubbed off and windy conditions do not damage the new shoots
    - much quicker and cost-effective than uprooting/replanting
    - caveat: with relatively young healthy vines ~10-15 years with plenty of life left
    - can be used on both grafted and ungrafted vines
    - a variation: graft single buds into the side of the trunk, binding them into the side of the trunk in the same manner as the chip budding
    - Fun fact: in California following popular TV show The French Paradox in 1991 in which the longevity of the French was put down as a daily glass of red wine, demand for red wine esp Merlot - easy to produce/pronounce - shot up and casued a sudden spate of top-grafting with many acres of young Chardonnay converted to Merlot, which then converted to Pinot Noir after Sideways