LEGUMES

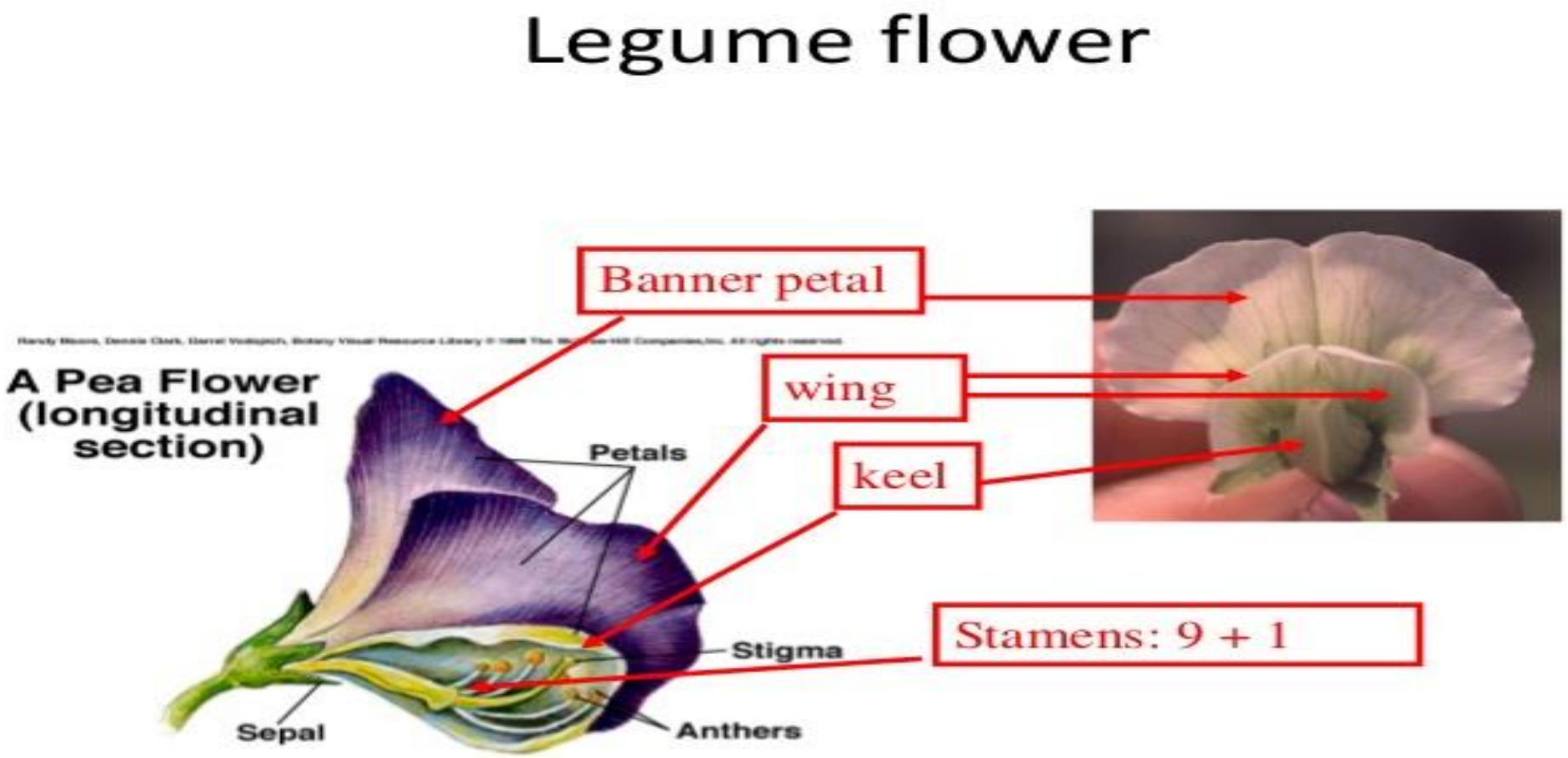
Legumes

- The legumes are all members of a single plant dicotyledonous plants family, the Fabaceae.
- Second most important family for humans.
- Beans, peas, lentils, soybeans, peanuts, alfalfa, clover, and more.
- Fabaceae is diverse and has about 16,000 species
- A combination of grain and pulses is seen in major civilization
  - Barley and lentils; rice and soybeans; corn and beans

Family characteristics

- Five-petalled irregular flower with bilateral symmetry
- Fruit is a legume (dry dehiscent fruit - two lines of dehiscence) with one row of seeds
- Seeds contain two large cotyledons

Legume flower



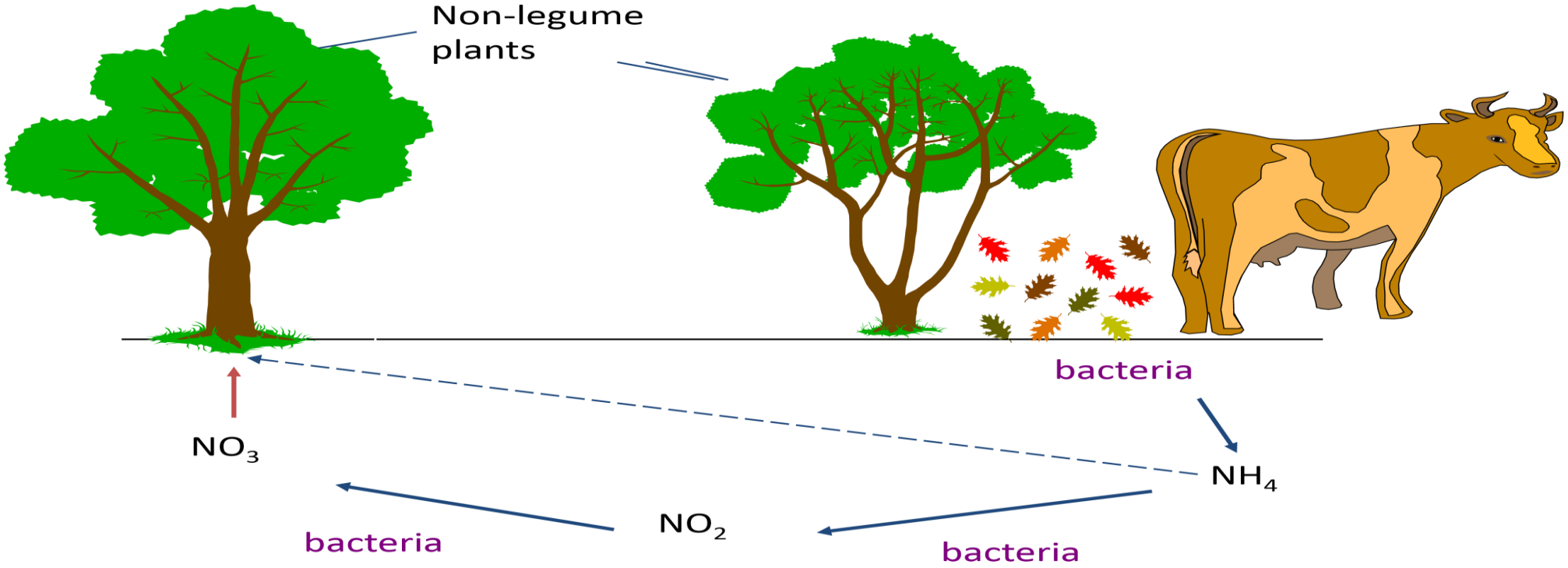
Legume fruits

Why legumes are important ?

- Legumes fix nitrogen
- Legumes rich in protein
- Legumes easily stored and harvested

Nitrogen cycle

- Nitrogen
  - essential elements for all living organisms
  - major component of amino acids, proteins, nucleic acids
- Nitrogen gas (N_2) about 79% of the air
  - most living organisms cannot use this form of nitrogen



Nitrogen compounds in soil

- Some plants take up ammonium directly
- Bacteria in the soil quickly convert ammonium to nitrite (NO_2) and then nitrate - (NO_3)
- Nitrate is the form of nitrogen usually absorbed by plants
- Fertilizer contain a mixture of both ammonium and nitrate

Nitrogen-fixing bacteria

- Certain bacteria and cyanobacteria have ability to reduce nitrogen (N_2) gas to ammonium NH_4^+
  - cells can convert NH_4^+ to compounds
  - called **nitrogen-fixation**
  - organisms are called nitrogen-fixing

Legumes and nitrogen-fixing bacteria

- High protein correlated with root nodules which contain **nitrogen-fixing bacteria**
  - convert atmospheric nitrogen to useful form
- Because of this legumes enrich the soil
  - Farmers often rotate legumes with crops that deplete soil nitrogen (soybean & corn)
  - "Green manure" crops ploughed sometimes
  - Reduces need for fertilizers - legumes can be cultivated worldwide - even in poor soils

Nitrogen fixation

- The roots of most legumes form associations with bacteria that can fix atmospheric nitrogen.
- These *Rhizobium* species live in nodules on the roots.
- They provide “free” fertilizer.
- Flowering plants cannot use atmospheric nitrogen but must absorb nitrate or ammonium nitrogen through the roots.

Nutrients

- Protein: CHO: fat: fiber are 20:70:8:4 percent.
- Protein: lack Met and cysteine and some sulfur containing amino acids
- CHO: raffinose and stachyose series. Hard to digest, flactulence. Alpha –galactosidase from *Aspergillas*.
- Fat has unsaturated fatty acids; hihgest in peanuts
- Non-protein amino acids
- Some have anti-nutritional factor
- Protease inhibitor
- Isoflavone
- Dissolve fiber

Legumes are frequently divided into two groups:

forage species like alfalfa, clover and vetch that are eaten by grazing herbivores

'grain' species, cultivated for their seeds, like various beans, peas, peanuts and lentils. This group are also known as "pulse" crops.

All have high protein content. All add nitrogen to the soil (90 million metric tons/yr).

Let's first consider beans...

- There are many types of beans, and taxonomic distinctions between them:
- Broad bean (*Vicia faba*)
- is an Old World species that originated in the Mediterranean area (or possibly Africa). It was cultivated 6000 YBP. Some of the health problems they can cause:
- favism – caused by the presence of vicine and convicine in them. Individuals who are deficient in the titre of the enzyme glucose 6 phosphate dehydrogenase (G6PDH) suffer from a hemolytic anemia these beans have high tyramine, and should be avoided when taking MAO (monoamine oxidase) inhibitors
- a health benefit – they are rich in L-dopa, which is used to treat Parkinson's disease

Broad bean flowers

Broad beans

- The fruit (the pod) is 15 – 25 cm long in modern food cultivars. Pods contain 3 – 8 seeds, each ~20 x 15 x 7.5 mm.
- Broad beans are eaten before complete maturity, while young and tender.

- Other dry beans (kidney, pinto, black, haricot) and some we consume with the enclosing carpel (green, string) are all varieties (cultivars) of a single species, *Phaseolus vulgaris* L.
- These beans are originally from the Americas and were first cultivated in MesoAmerica. They are a staple food.

- Nutritional content per 100g:
- carbohydrates 60 g
- dietary fiber 25 g
- lipids 1 g
- protein 24 g
- B5 (pantothenic acid) 0.8 mg (19% RDI)
- B9 (folic acid) 394 mg (99% RDI)
- Fe 8 mg (64%)
- Mg 140 mg (38%)
- There is one health concern (that normally doesn't apply): dry beans should be soaked, then boiled for at least 10 minutes. They (particularly red kidney beans) contain a lectin phytohaemagglutinin, which can cause severe gastric upset.
- What about flatulence? Caused by complex sugars that are removed by soaking.

- Compared to the dry beans, green and string beans provide less starch and protein, but more vitamins A and C.

Some uses:

- pinto beans – refried beans in Mexican foods
- white (haricot, navy) beans – Boston baked beans
- kidney beans – chili, Louisiana creole dishes, southern U.S. red beans and rice
- black (turtle) beans – burritos, feijoada (a national dish of Brazil)

- Lentils (*Lens culinaris*)
- Originate in the Near East, and one of the first crops domesticated there. They are second only to soybeans in protein content – 26%. As a result they are very important in vegetarian diets.
- The optical lens draws its name from the lentil, because the seed has a 'lens' shape.
- The largest producer is India, but Canada is both a significant producer and a large exporter. Of a world total production of 3.2 million metric tons, Canada (mostly Saskatchewan) produces about 520,000 tons, and exports around 400,000 tons.

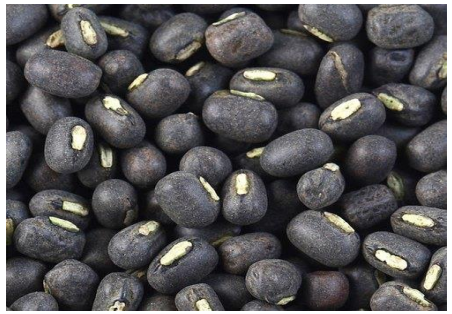
This is a map of lentil growing areas (area of origin in red):

- In India lentils are boiled to a thick stew-like consistency and mixed with oil and spices to make dal.
- In Ethiopia they are roasted then boiled to a very thick, stew-like consistency and mixed with berber sauce (long-cooked cayenne pepper, onions and water).
- In Europe and North America they are added to soups.

- Black-eyed peas (*Vigna unguiculata*), mung beans (*V. radiata*) and black gram (*V. mungo*)
- Black-eyed peas (*Vigna unguiculata*)
- Growing areas and uses:
- Black-eyed peas are originally native to Africa, but are now grown in southern Asia, Africa, the West Indies, and the southern U.S. Along with peanuts, George Washington Carver promoted cultivation of this bean.
- In the south the traditional dish is called “hoppin John”, and consists of black-eyed peas and pork (jowls, fatback or hocks). It is also traditionally served with greens (mustard or collard) and cornbread.
- In the West Indies, the traditional dish is rice and beans.

- Green Gram (*V. radiata*)
- This is grown as a pulse crop in Madhya Pradesh, Uttar Pradesh, Bihar, Rajasthan and Bengal. It is one of the very ancient legumes of India and is important crop. In India, it has been cultivated for atleast 3,000 years.
- Uses: The small oval seeds are highly nutricious and the green pods are also eaten. The seeds are eaten as a dal. It makes a good source of protein. The plants are used as cattle feed.
- Tender pods are consumed as vegetables. Mung is parched and made into a porridge. Often fried and used as a snack. Sprouted seeds are eaten and sometimes seedlings are candied. Decoction of seeds is give in beri-beri as a diuretic. Seeds are also used for vertigo. Mung extract is said to have curative properties in polyneuritis. The plants are also used for hay.

- Black Gram (*V. mungo*)
- A herb, cultivated as a pulse in Uttar Pradesh, Madhya Pradesh, Punjab and Bengal.
- Uses: The small oval black seeds are highly nutritious. It is good source of protein for vegeterians. The seeds are used in the form of dal. It is largely used by South Indians to make vada, idli, dosa etc. black gram is the main ingredient of these items. The plants are used as cattle fodder.
- This pulse is good source of phosphorous. It is the chief constituent of papad and also cooked as a vegetable. Fried and salted seeds are eaten snack. Pulse is used in rheumatism and nervous and hepatics dieseases. It is also used in dropsy, cephalagia as a diuretic. Root is narcotic and used for aching bones.



- Gram(*Cicer arietinum*)
- This is the most important pulsein India. It is native of South Europe, now commonly grown in Uttar Pradesh, Punjab, Maharashtra, Rajasthan, Bihar, Madhya Pradesh.
- Desi-type is a smaller seed with a rougher coat, and closely resembles archaeological evidence of origin. It is now grown in India, Ethiopia and Mexico, but originated in the fertile crescent (southeast Turkey). This type has a notably low glycemic index (particularly good for diabetics). In India it is ground as a coating flour and roasted as a snack.
- Kabuli-type is grown around the Mediterranean and Afganistan. This is the type used in the mid-East to make falafel and hummus.

- Uses: The gram is consumed in several ways. Dal is prepared by splitting the whole grain into two and removing the husk (the seed coat). This is one form in which gram is used in India. The flour of dal is known as besan. It is used in the preparation on unleavened bread and sweets. The whole grain is eaten raw, roasted, perched or boiled. Gram is also used as cattle feed. It makes a nutricious for horses.
- Germinated gram is also used as prophylactic against deficiency dieseases, scurvy in particular. Used also in textile sizing and adhesives. Gram is nutritive pulse and is used as a protein adjunct to starchy diets ; also contain a higher percentage of oil, 4-5%, than other pulses
- Chickpeas are a good source of zinc and protein. They are also very high in dietary fiber. They are low in fat, and most of the fat content is monounsaturated.

- Garden Pea(*Pisum sativum*)
- It is native of South Europe, but now cultivated chiefly in Punjab, Uttar Pradesh, Delhi and Himachal Pradesh. It is annual, glaucous, tendril-bearing, climbing or trailing herbs with white or coloured flowers and pendulous pods.
- Uses:
- The garden pea seads are eaten green or are used for canning. The seeds is also used for human consumption in the form of pea meal or split peas. The peas are used as pulses and they are good source of proteins. The plants are used for forage and green manuring.
- The peas are also available as canned, frozen and dehydrated peas. Peas have high content of proteins, that is upto 28% or more and also supply adequate quantities of vitamins an minerals and potassium and phosphorous. Pea oil when given parenterlly showed possibility of preventing pregnancy, the active principle being m-xylohydroquinone. The drug is non-toxic and has no side effects.

- Comparing dry split peas and fresh peas, there are clear differences in nutritional value (per 100 g):

	Green peas	split peas
• Carbohydrates	14.5 g	60 g
• Fiber	5.1 g	26.1 g
• Protein	5.4 g	25 g
• Vitamin C	40 mg (67%)	-----
• Vitamin B1	-----	0.7mg (54%)
• Pantothenic acid (B5)	-----	1.7 g (34%)
• Folic acid (B9)	-----	274µg (69%)

- Soybean (*Glycine max*)
- It is native of South-east Asia.Since many years, soybean is being grown in India. Yet only a few farmers grow it. The soybean can be grown in dries areas of the country where the rainfall is 35 inches or less. It can be grown at elevations upto 6,000 ft., above sea level especially in Assam, Orissa, West Bengal, Manipur, the Khashi and Naga Hills and the Kumaon hills of Uttar Pradesh. Several varieties have been found suitable for growing inthese country. Palmetto, Monetta, Clemson, Creole and Charlee are some of the good ones.

- Uses:
- Soybean is a very good food. The bean has a high oil content and the karnel is rich in protein. It also contains important minerals- calcium and phosphorous. It is rich in iron, potassium, magnesium and vitamins. Soybean oil is used for cooking and oil cake is used as cattle feed. Soybean oil are one of the vegetable sources for omega-3 fatty acids.
- Soybean flour or cooked bean is very good for diabetic patient. The flour is also used for making ice-cream and chocolate bar. Chapattis can be prepared with one part of soybean flour mixed with one part of wheat flour. Tasty biscuits and cakes can also be prepared from the flour.
- Soymilk and curd is also prepared from soybean which have a good taste and very nutritious. Soybean oil also used for paints and vernices and for soaps and food products. The beans are consumed as a vegetable, in salad and canned.
- Soybean meal and soybean proteinare used in adhesive, water paints leather finishes, textile sizes, insulating and wall-board coating, insecticidal spray and fire fighting compounds.

- Peanut (*Arachis hypogaea*)
- It is native of Brazil. It is widely grown in South India, Maharastra and Uttar Pradesh. North Gujarat is famous for peanut cultivation.
- Uses:
- The peanuts are used for roasting or sakting and for the preparation of peanut butter. Peanut are nutricious food. One pound of peanut yields 2,700 cal. The filtered, refined oil is used for cooking and in making margarine. Peanut oil is an important food oil. Oil cake is used as fodder. The protein in peanut is used in the manufacture of Ardil, a synthetic fibre. The vegetable ghee is made from the peanut oil after hydrogenation.
- The kernel are also used in various foods and confectioneries. Peanut flour is prepared by grinding the finest grades of peanut cake; it is used for supplementingth white floor. Some commercial products are groundnut milk, peanut ice-cream, peanut message oil for infantile paralysis. Hulls are used as fillers of fertilizer or graound into meal for insutaion blocks, floor sweeping compounds, bedding the stables etc. peanut oil finds someuse as a lubricant and blends with mineral oil have been developed.

- Raw peanuts are very nutritious. Contents (per 100 g) are:
- Carbohydrate 20.91 g
- dietary fiber 8.7 g
- protein 25.09 g
- fat (oil) 47.58 g
- 20% or more of RDIs of thiamin, riboflavin, niacin, pantothenic acid, folic acid, B6, Mg, P, Zinc, and less of many others
- Problems with peanuts:

peanuts are considered an incomplete protein, with relatively low amounts of the essential amino acids lysine, cystine and methionine

peanuts are also an unbalanced source of fat because they are devoid of required omega-3 fatty acids

peanuts may be contaminated with the mold *Aspergillus flavus* which produces aflatoxin, a carcinogen

Thank you