

SPIDER SILK

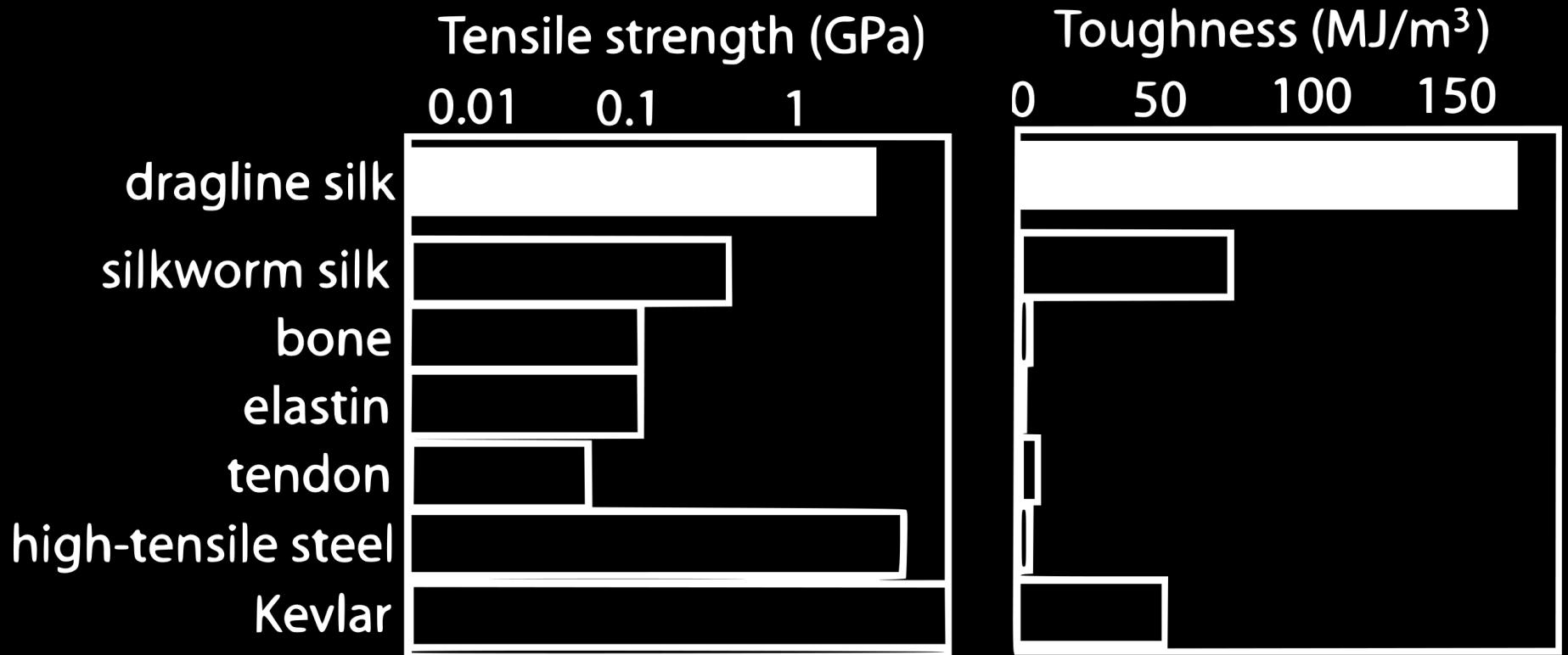


and the glands
that produce it

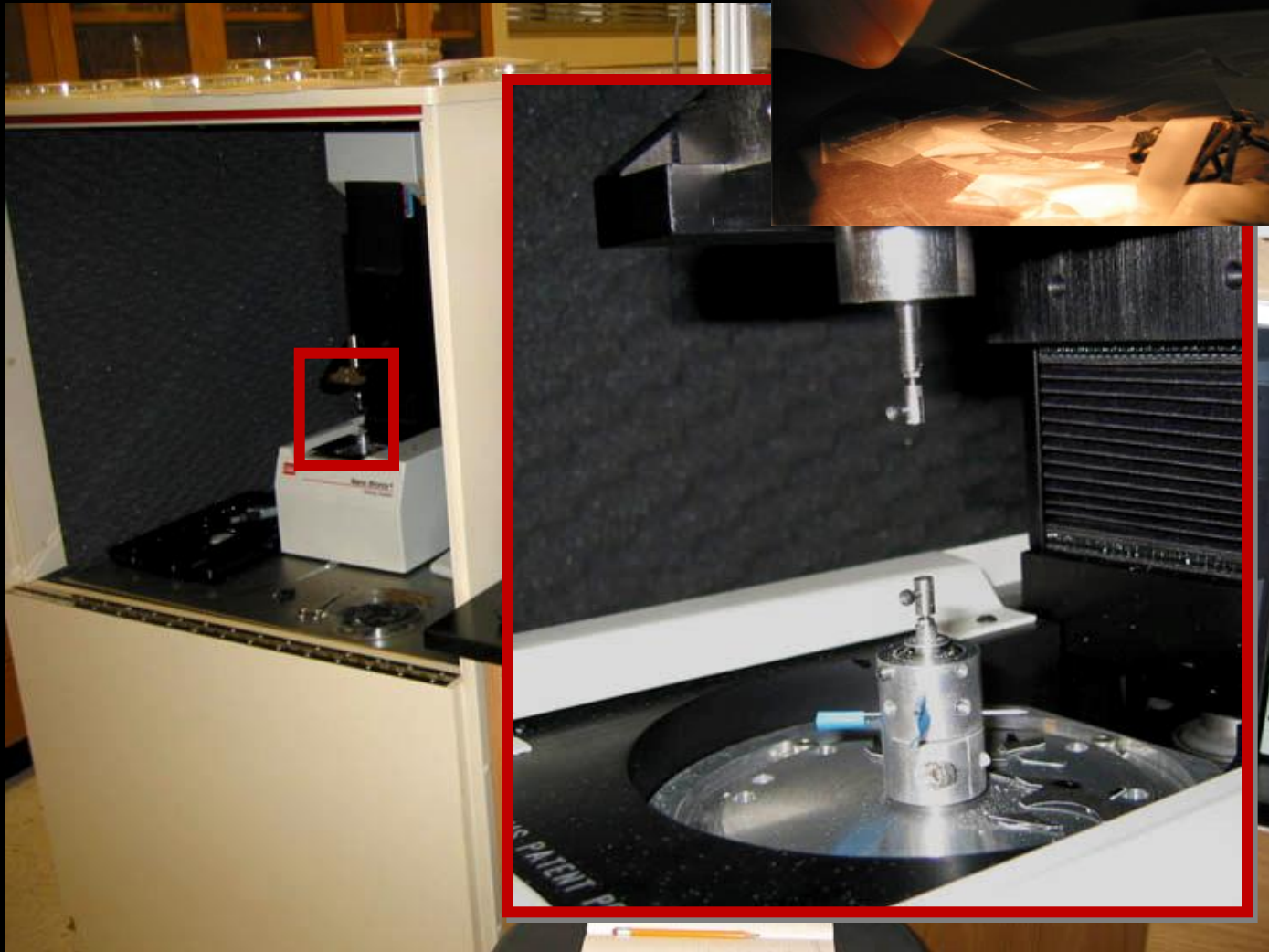
MILAN ŘEZÁČ

Crop Research Institute, Prague

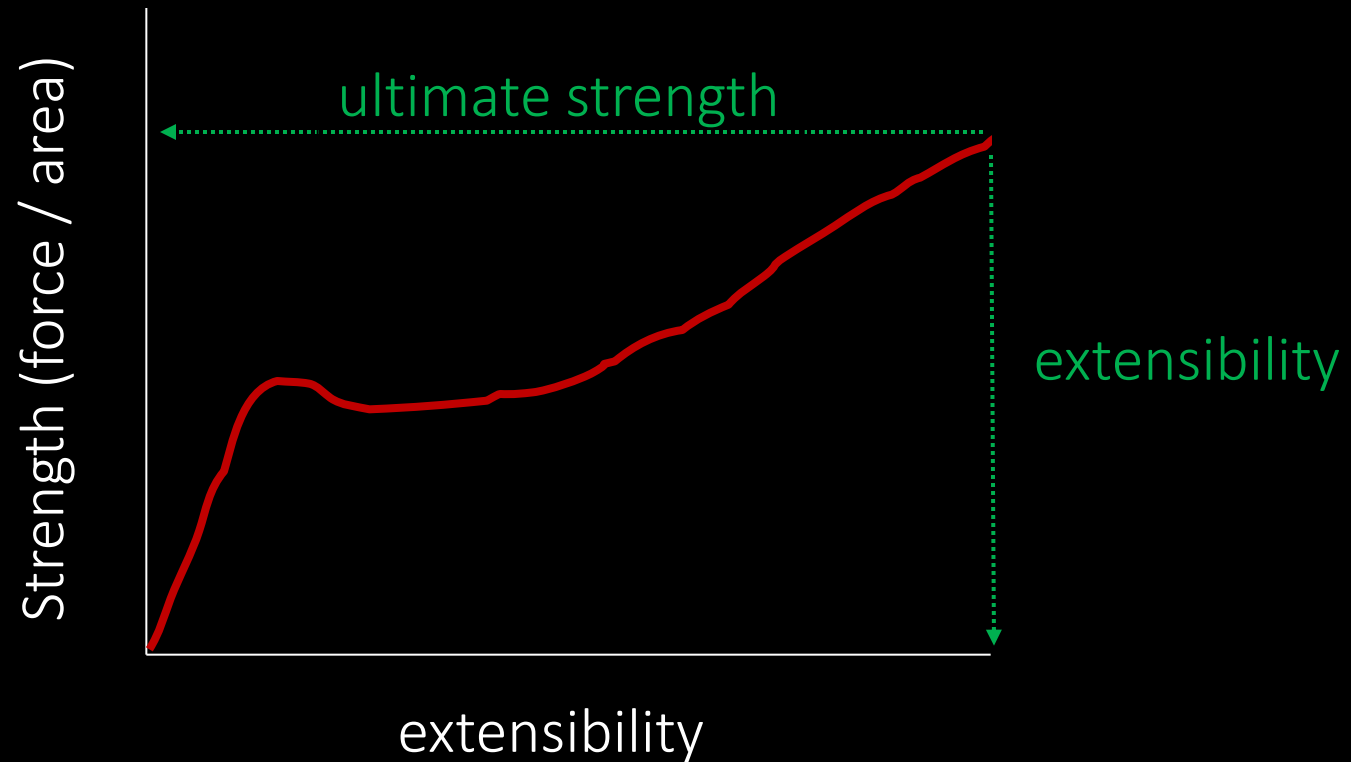
Spider silk is a biological 'supermaterial'



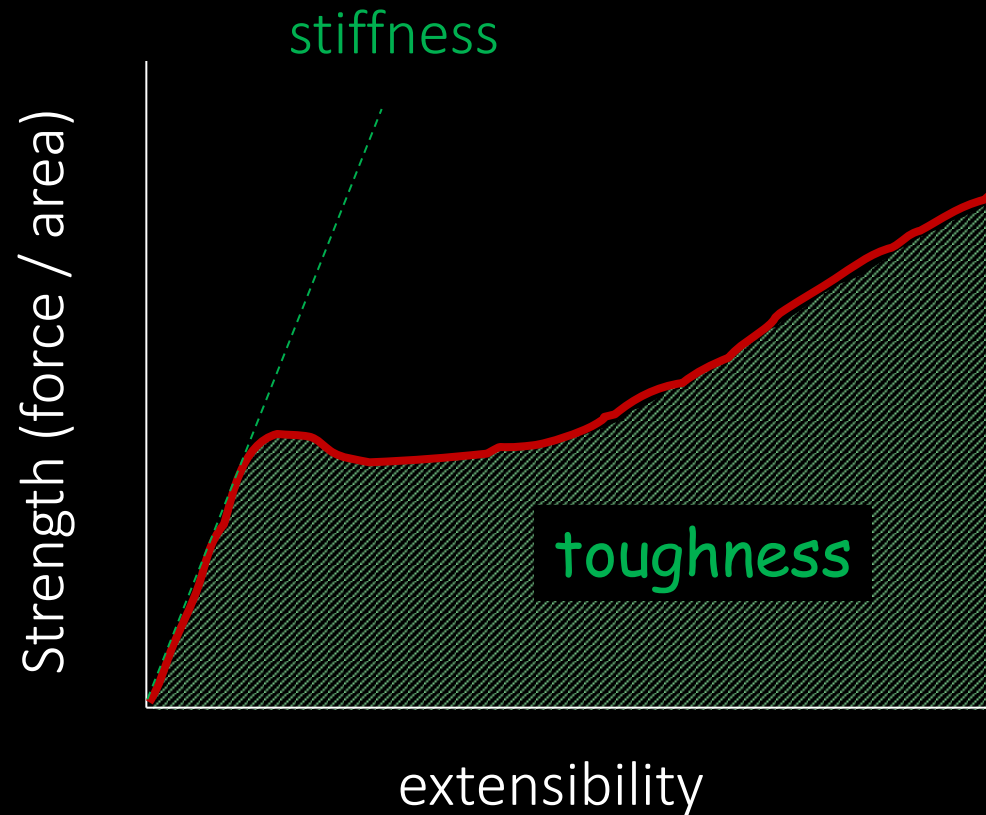
Characterizing silk: Nano Bionix tensile tester



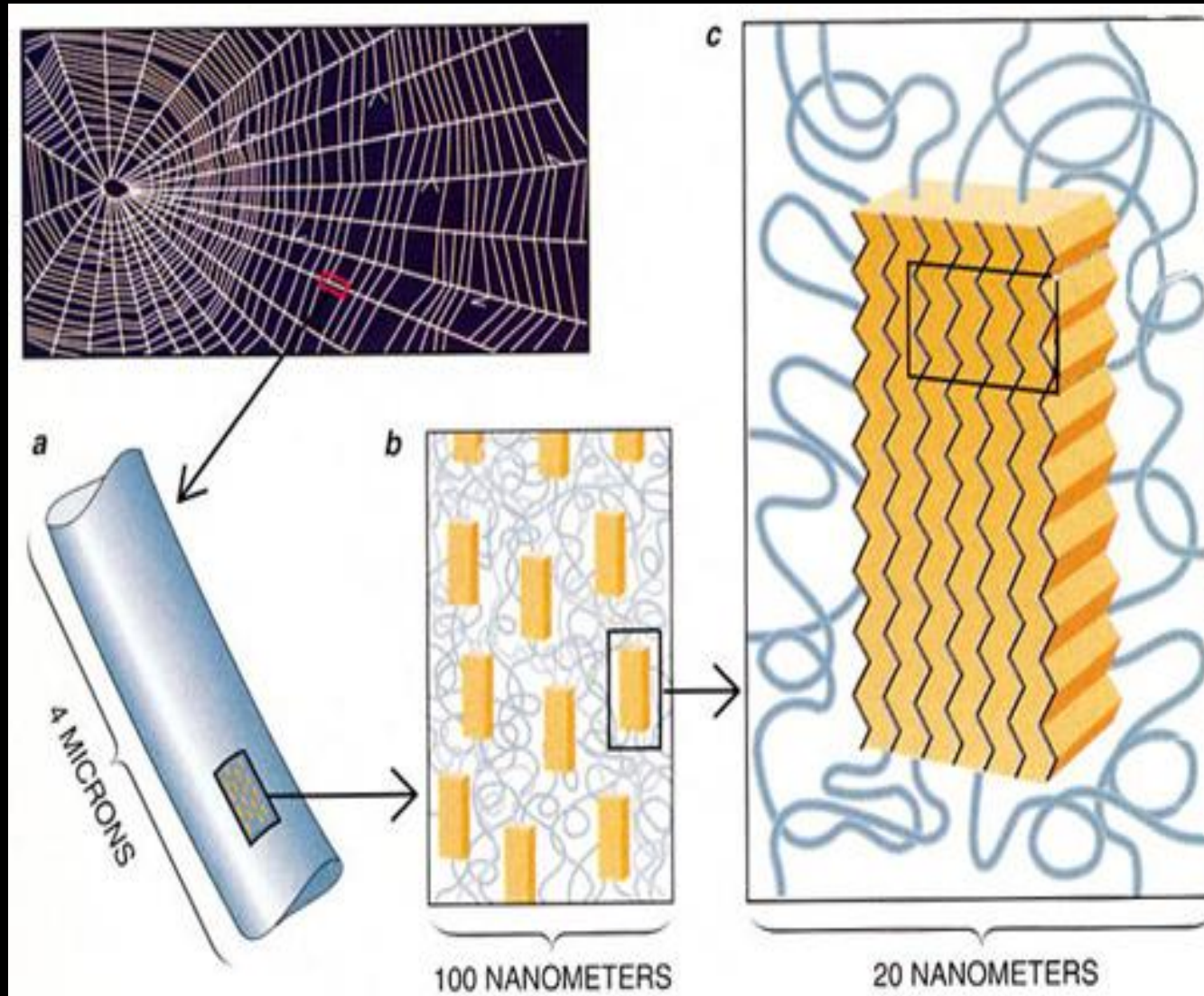
Silks are viscoelastic polymers



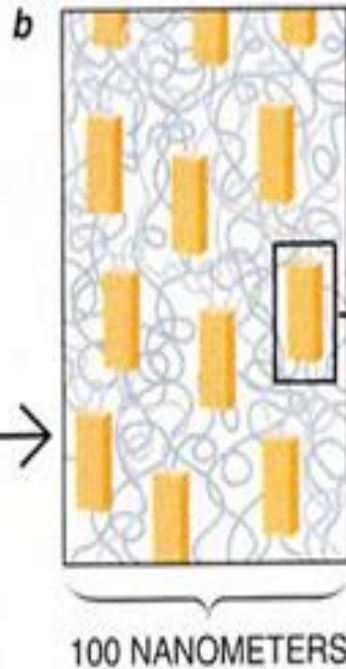
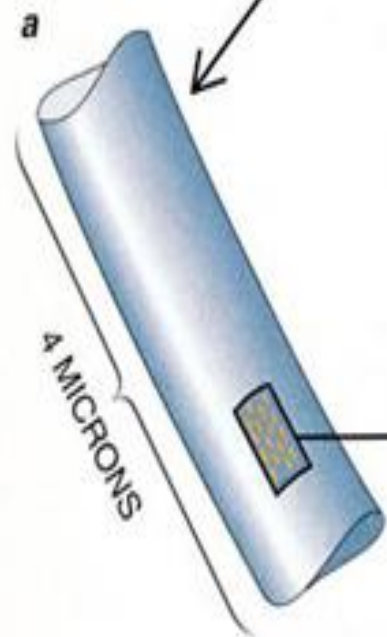
Silks are viscoelastic polymers



Silk proteins contain repetitive motifs



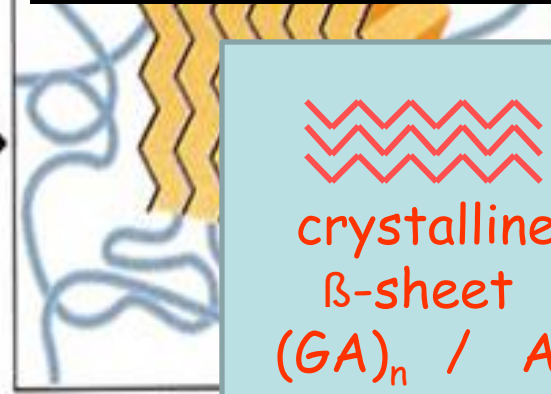
Silk proteins contain repetitive motifs




c

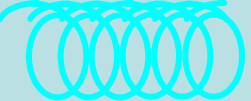
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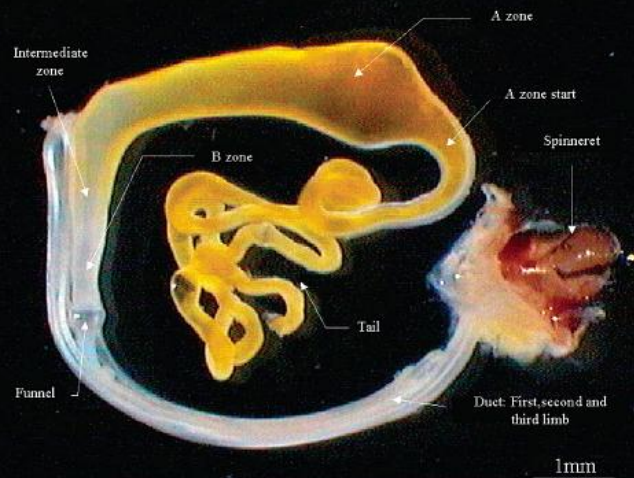
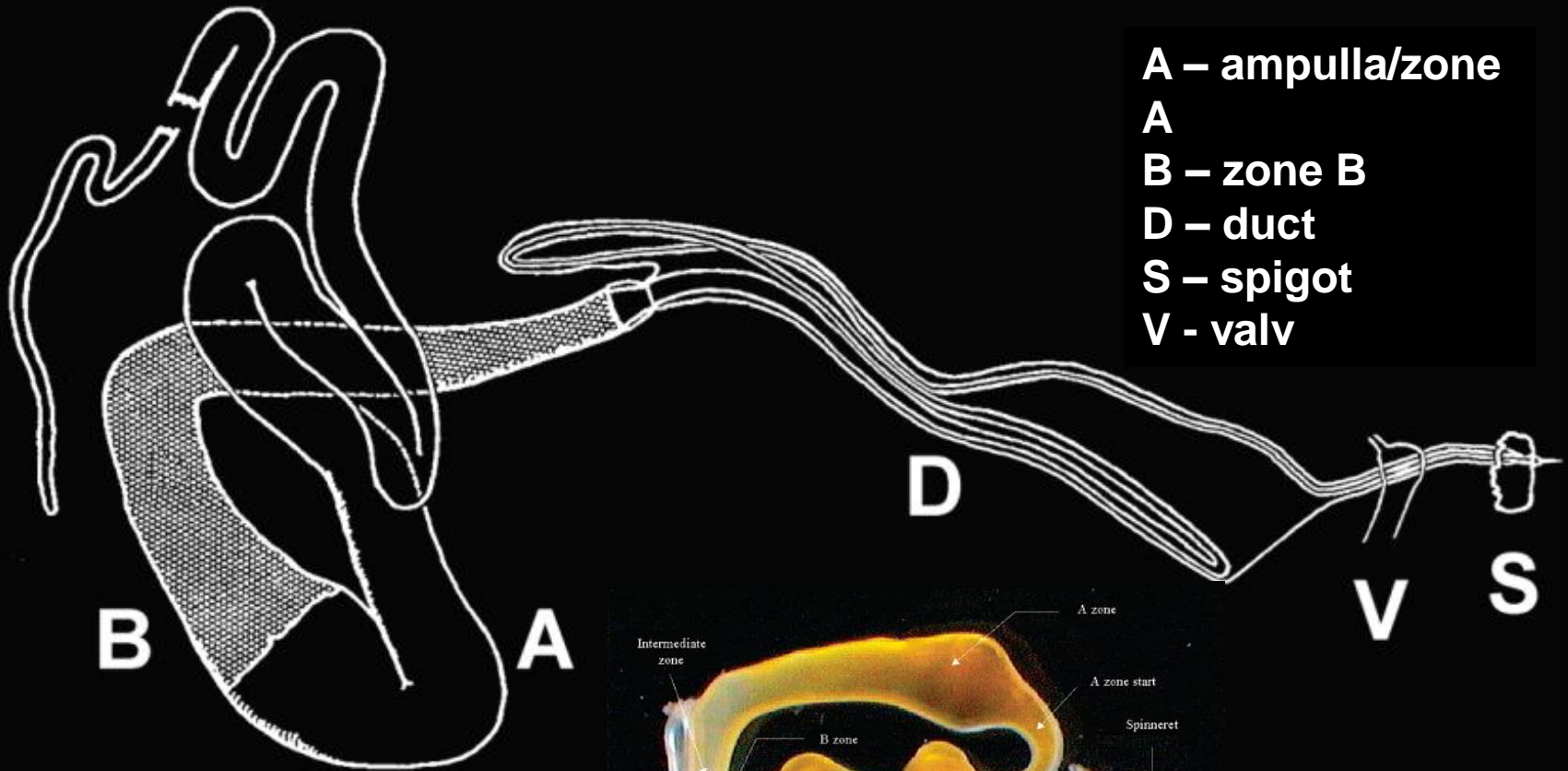
crystalline
β-sheet
(GA)_n / A_n



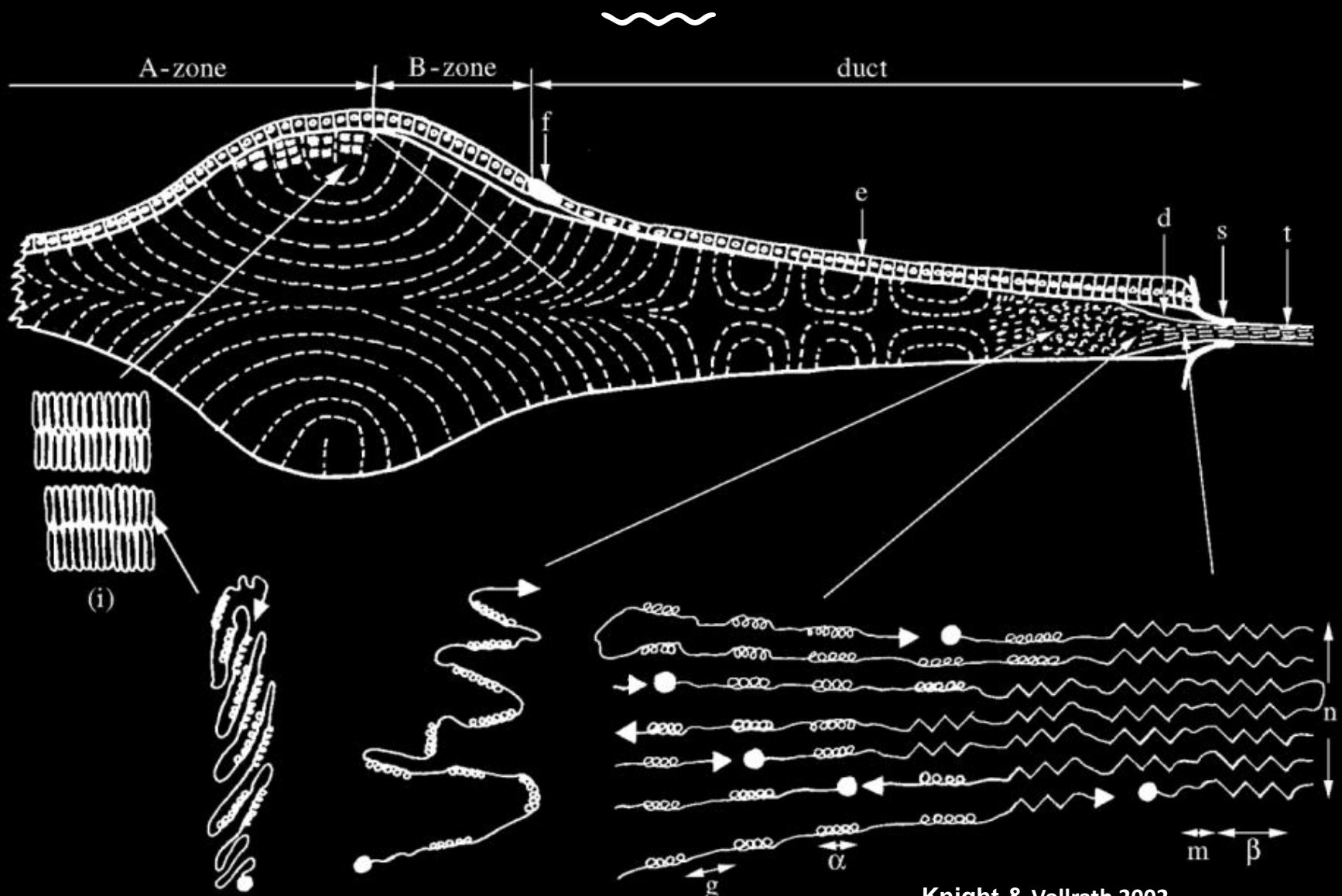
β-spiral
GPGXX

20 NANOMETERS

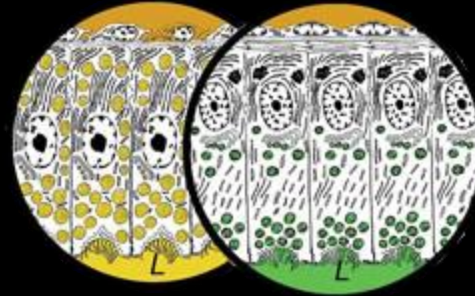
Morphology of the silk gland



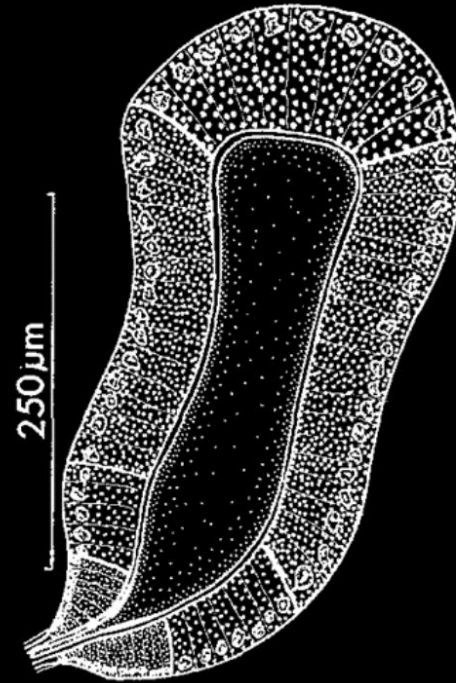
Spiders spin liquid crystals



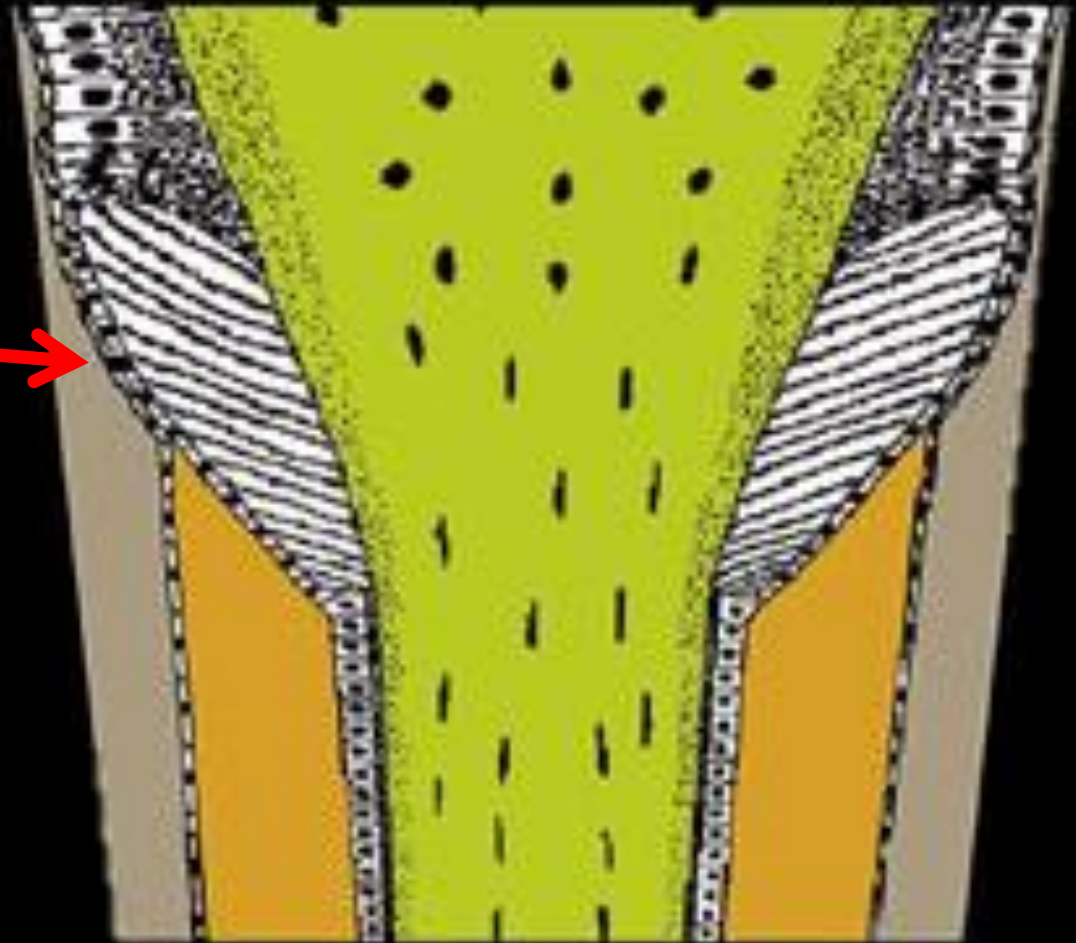
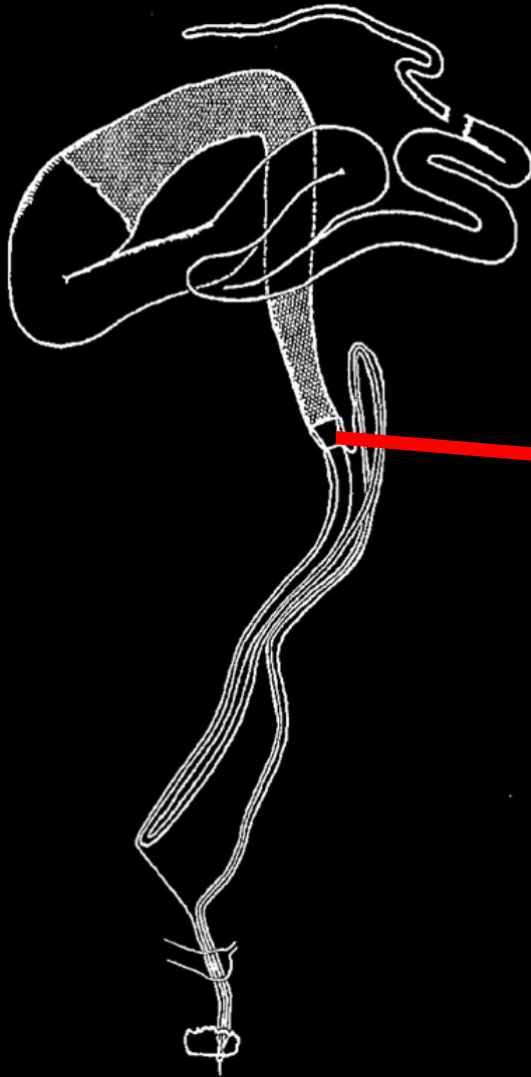
Gland ampulla



Vollrath & Knight 2001



Funnel between ampulla and duct



Functions of the duct

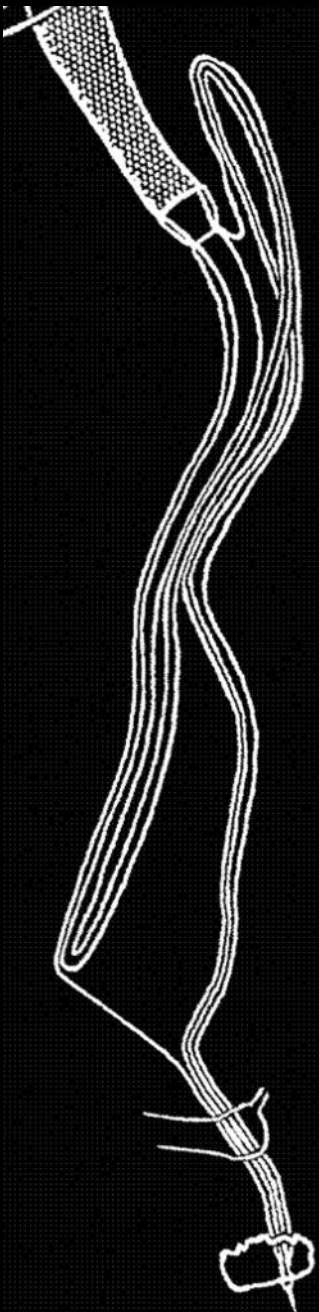


Alignment of protein molecules

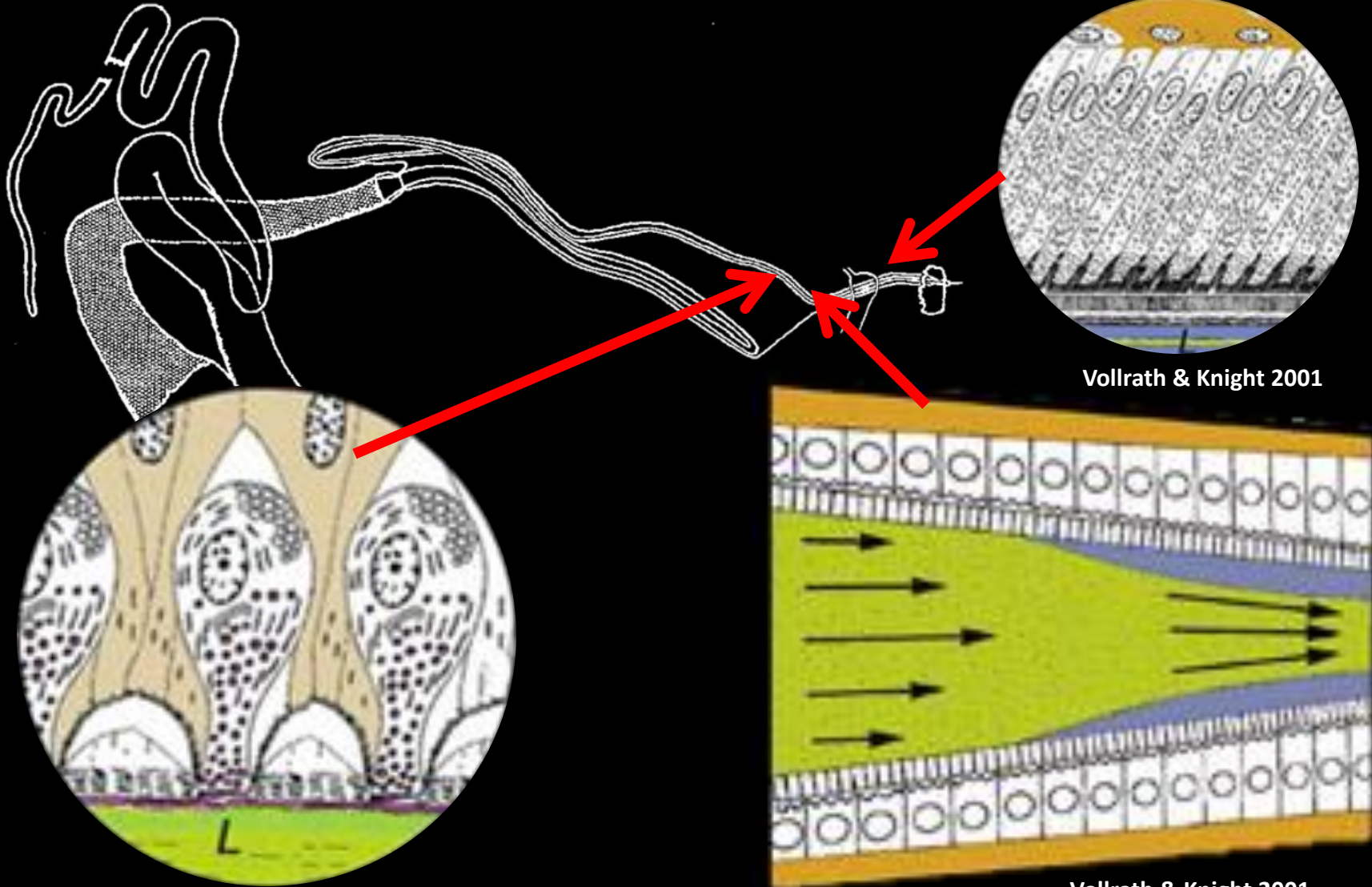
Reabsorption of water

Reabsorption of Na^+

Acidification – pumping H^+

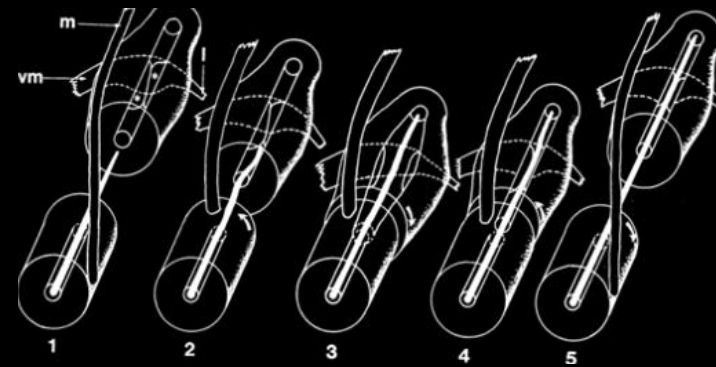
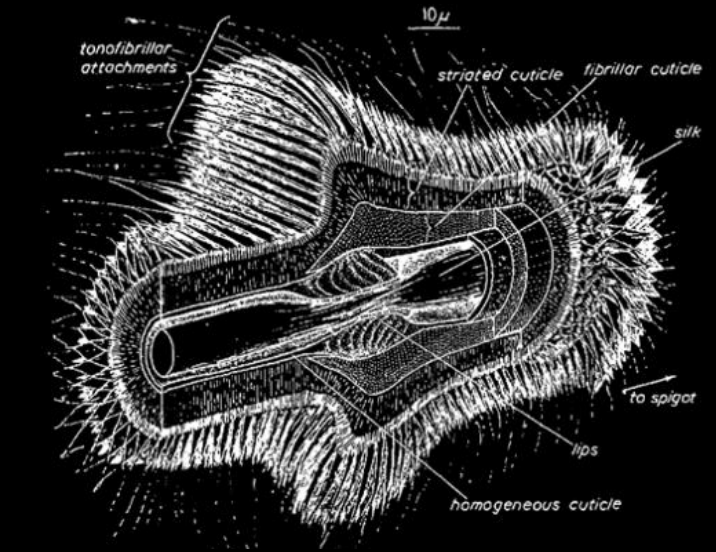
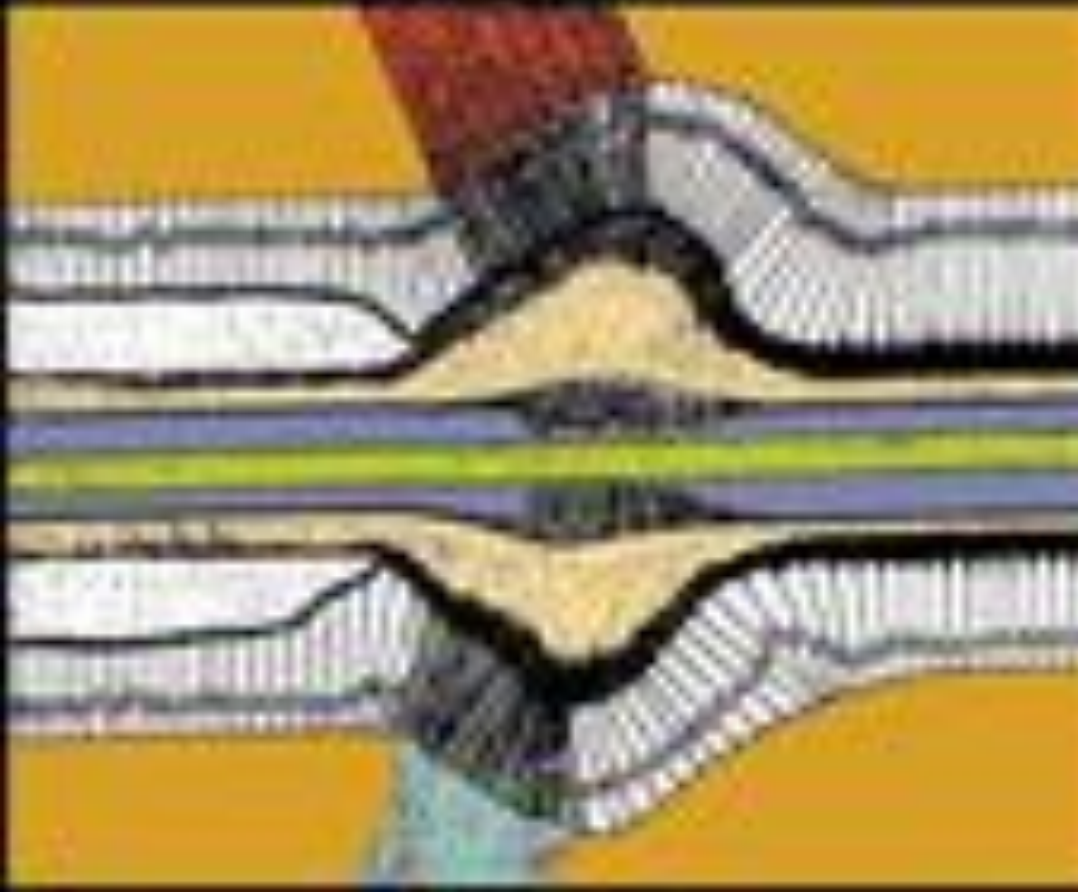


Flask cells, internal draw down, water pump

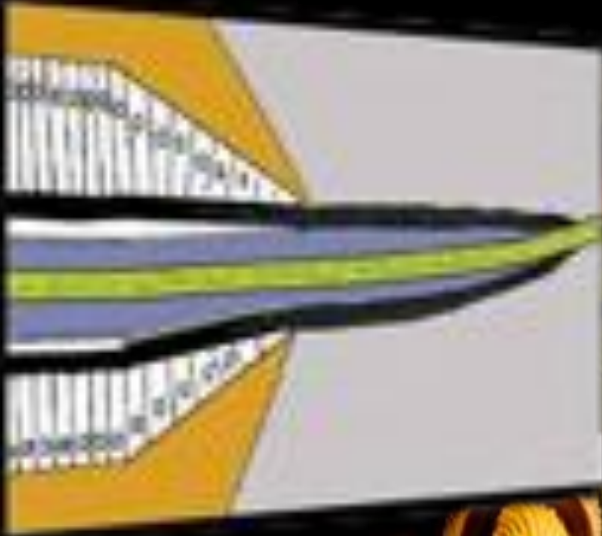


Vollrath & Knight 2001

Valve



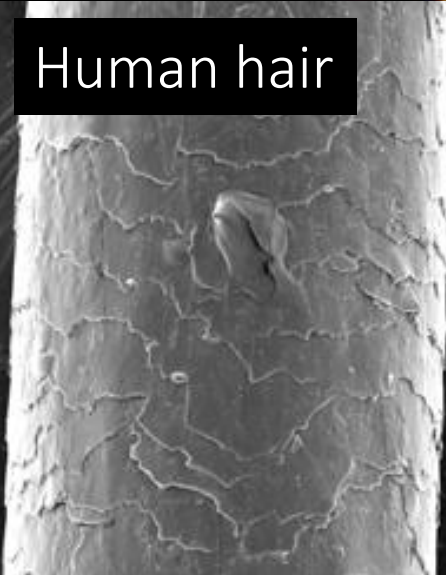
Spigot, spinnerets



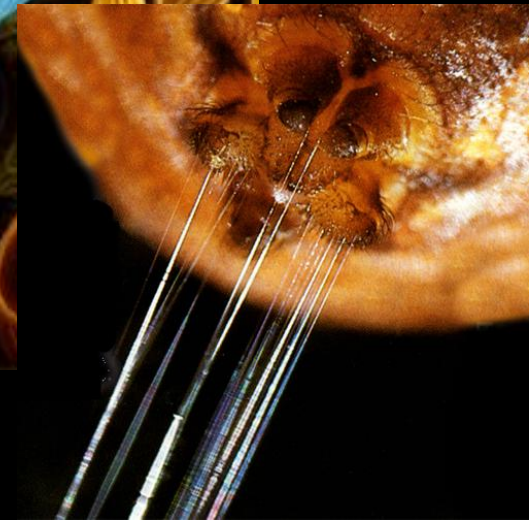
Vollrath & Knight 2001



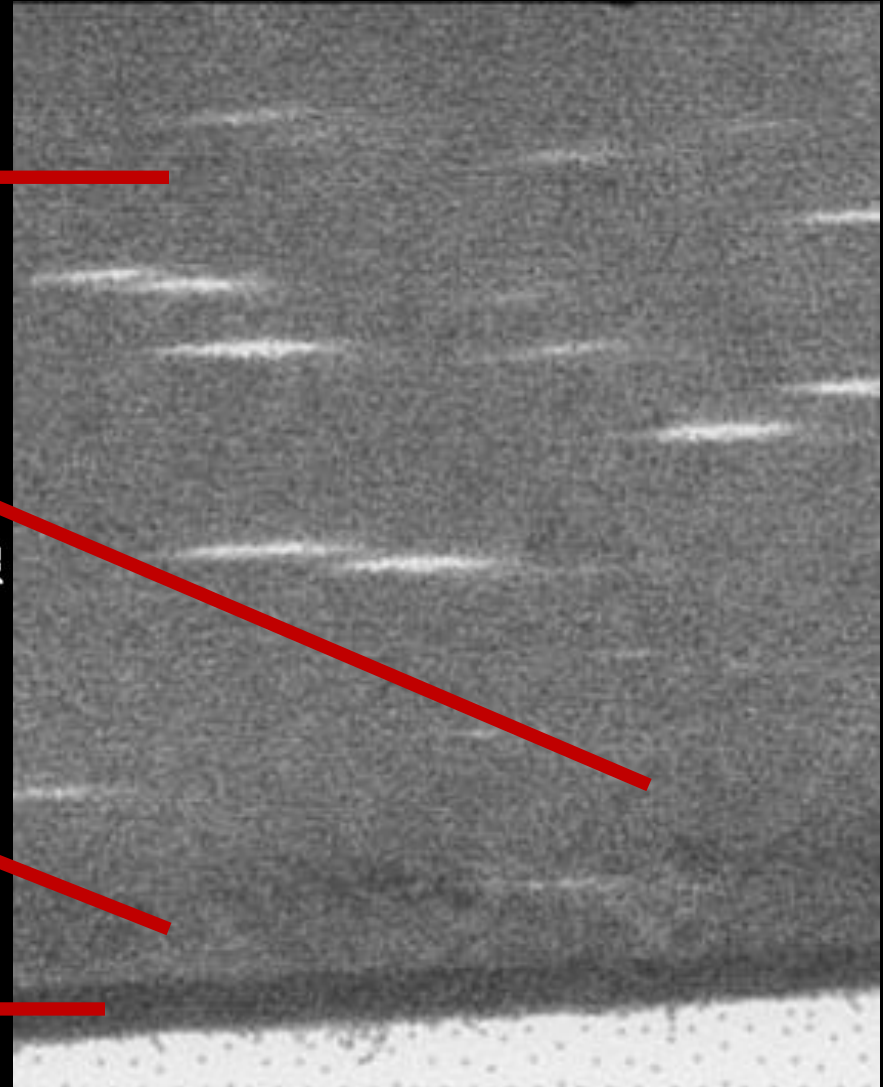
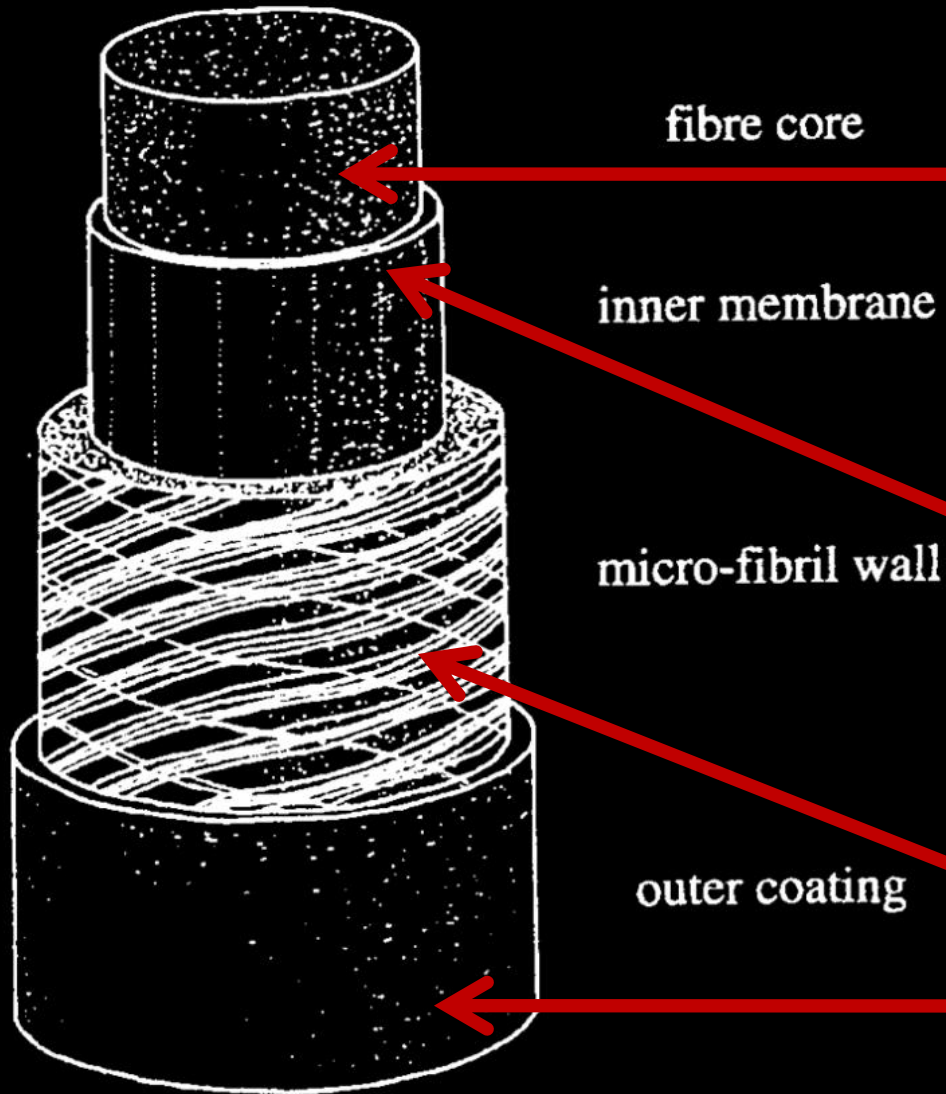
Human hair



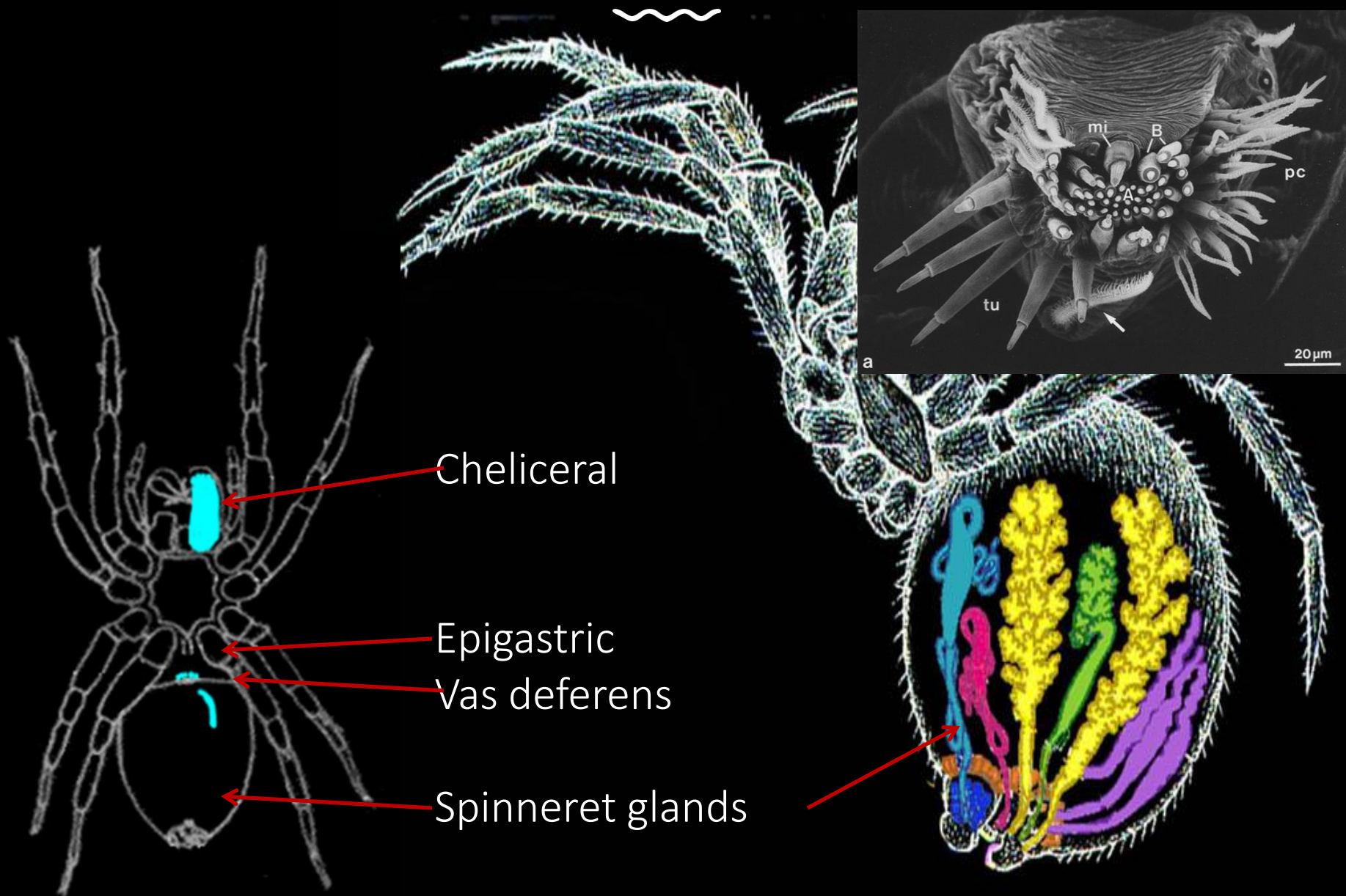
Silk



Final silk thread



Spider silk gland types



Cheliceral

Epigastric

Vas deferens

Spinneret glands

20 μm

Silks vary in amino acid composition

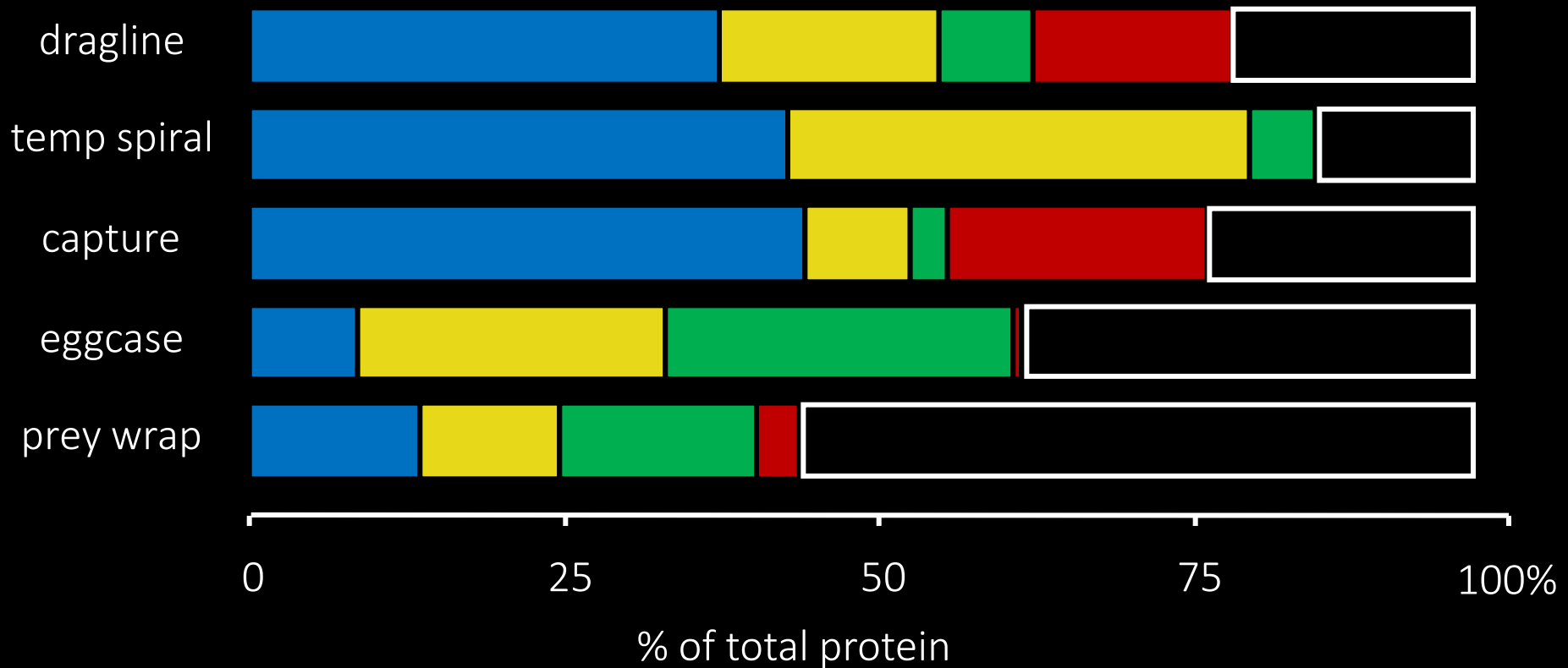


Gly

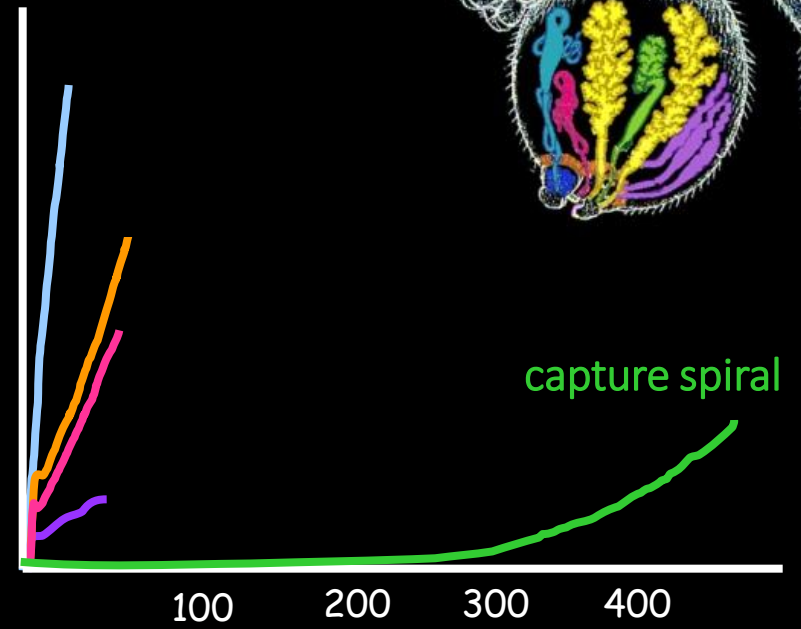
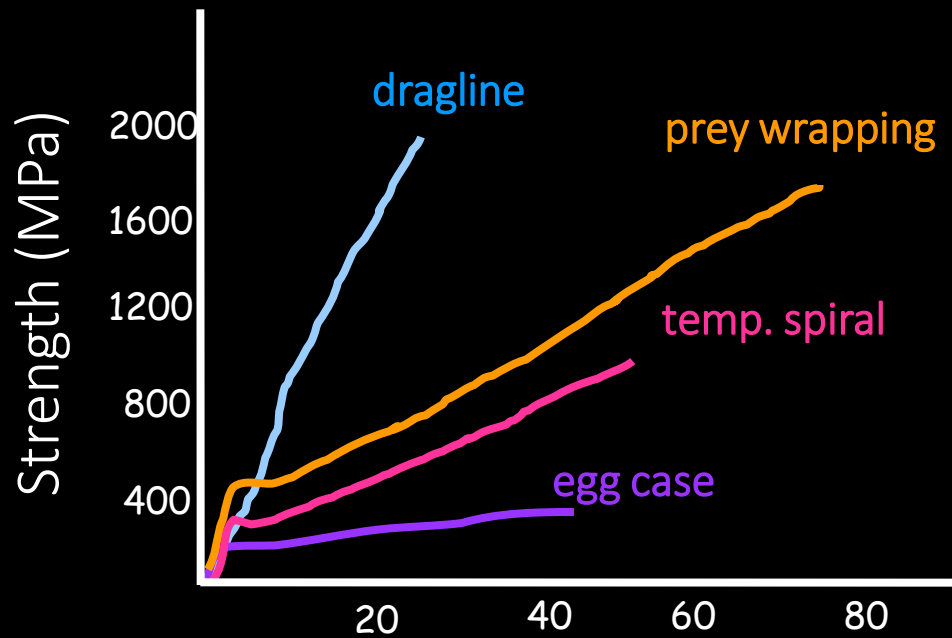
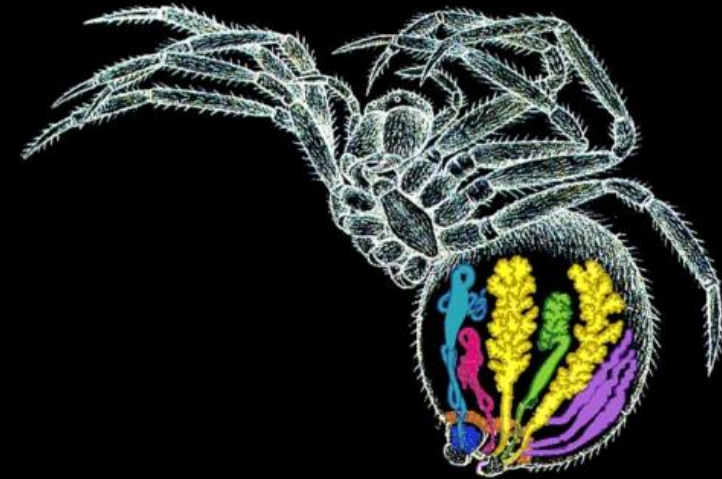
Ala

Ser

Pro

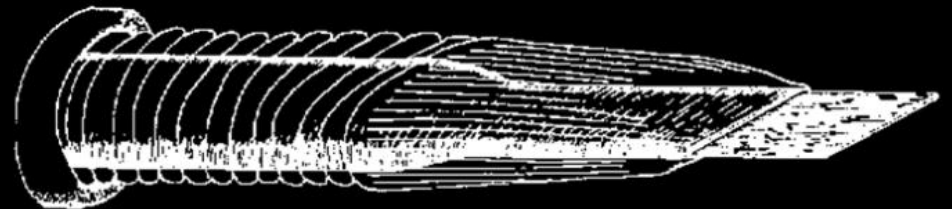
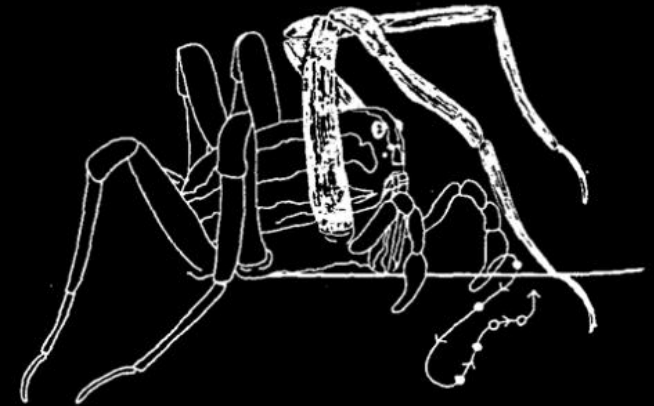


Silks have diverse properties

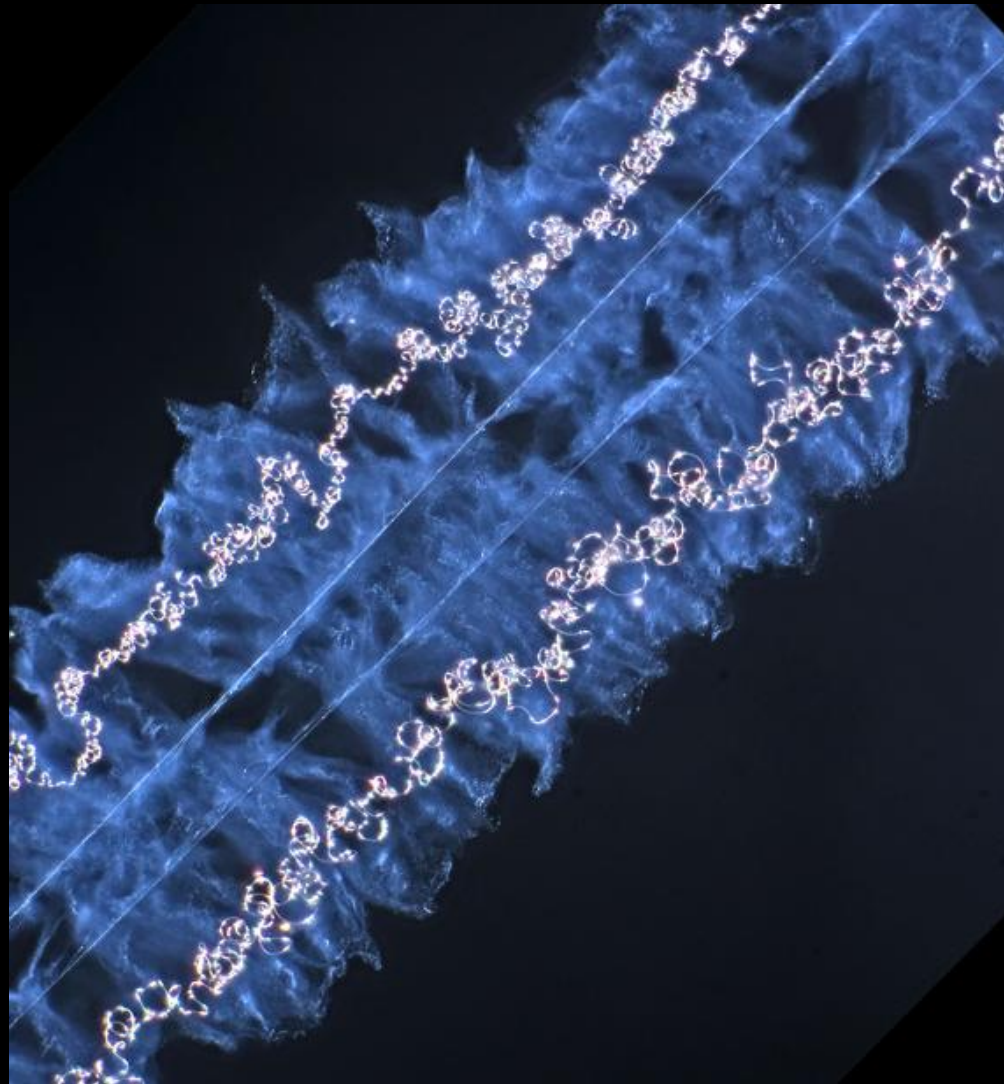


Extensibility (%)

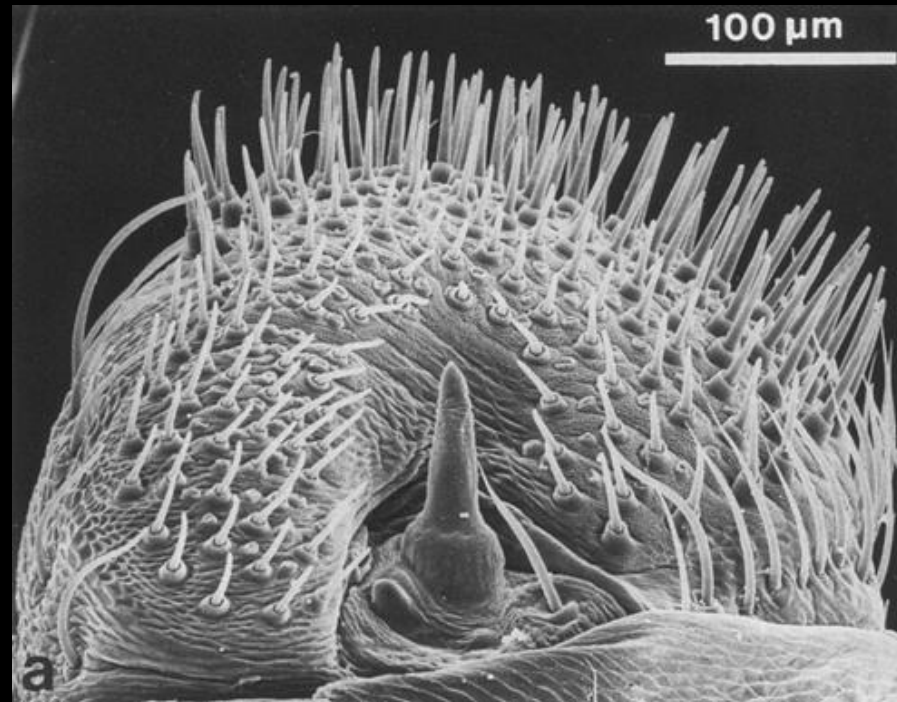
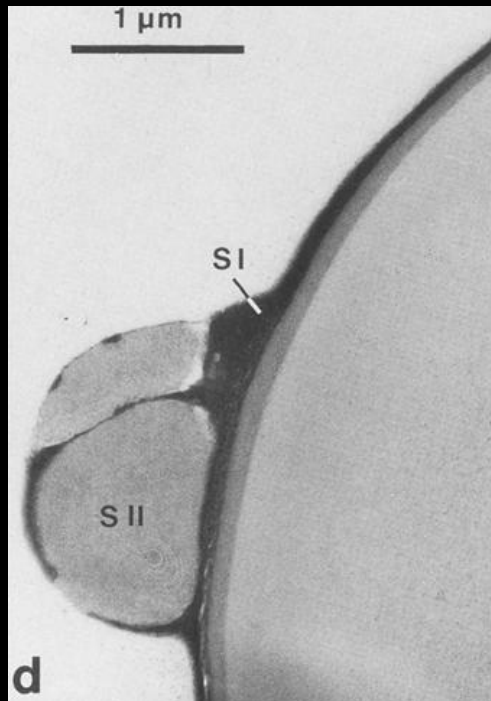
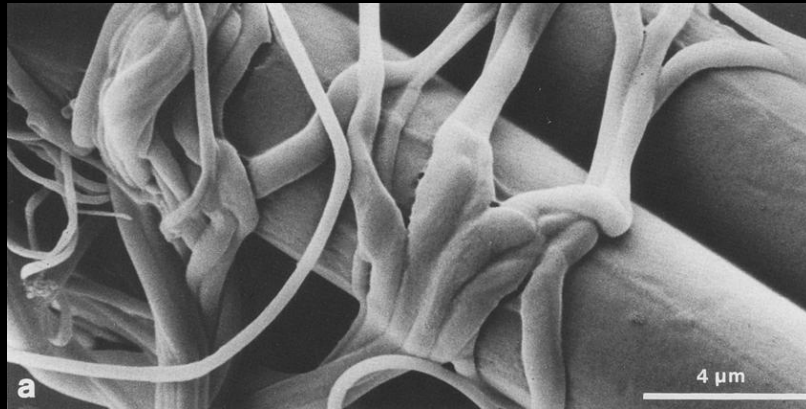
Major ampullate glands



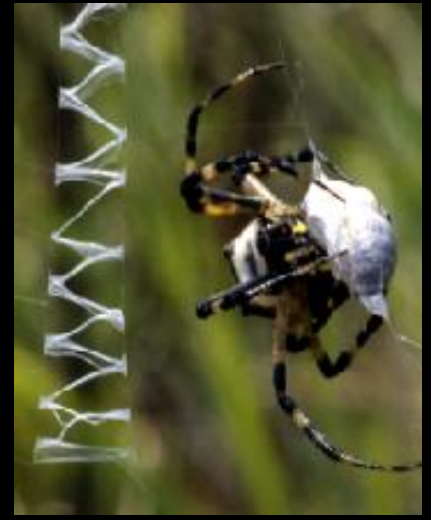
Minor ampullate glands



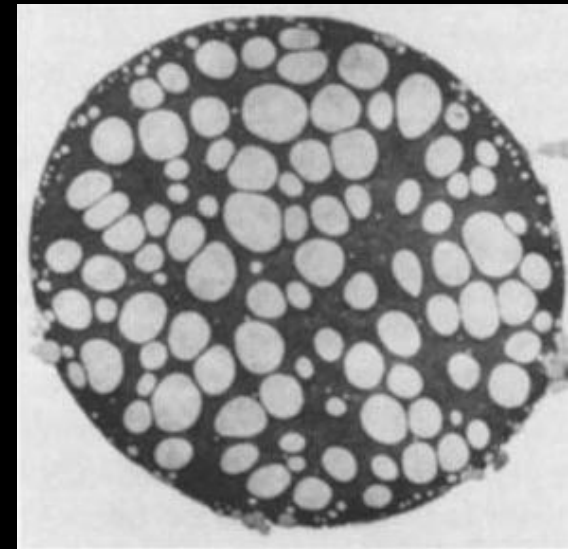
Pyriform glands



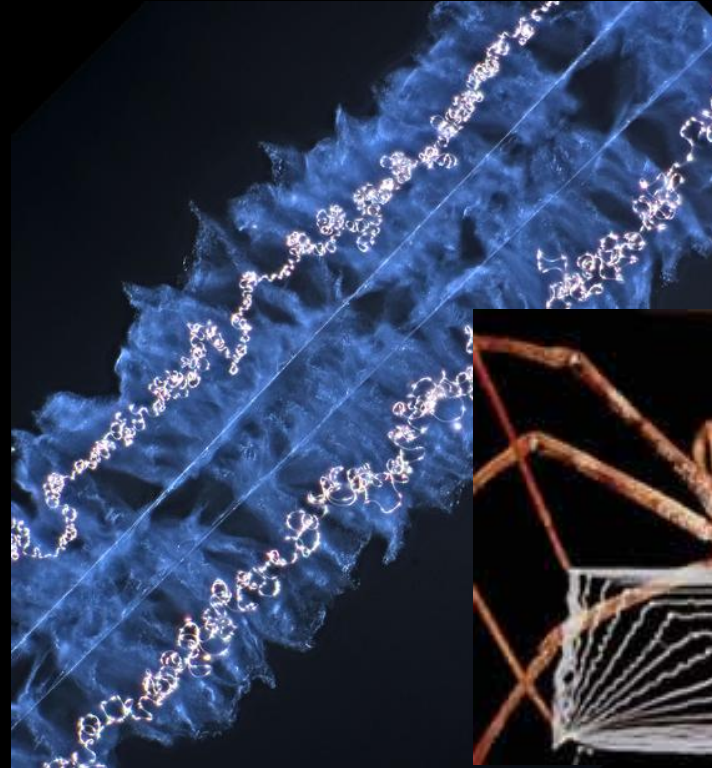
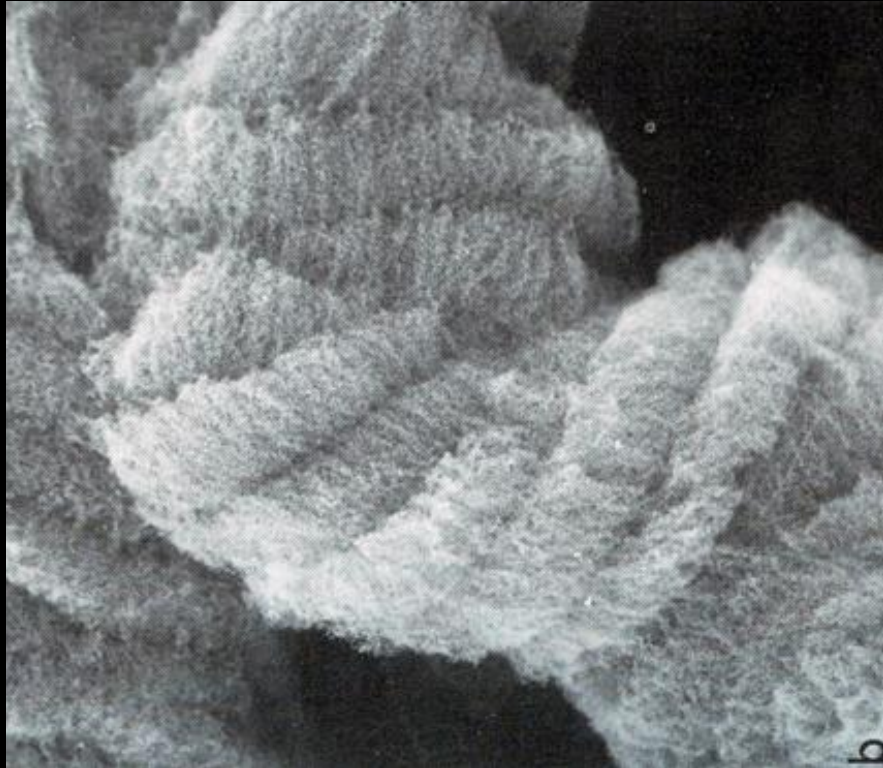
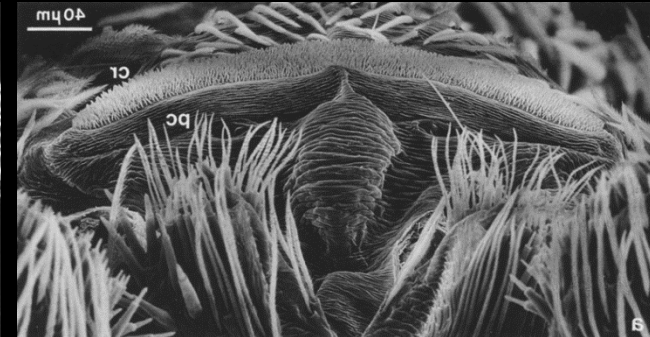
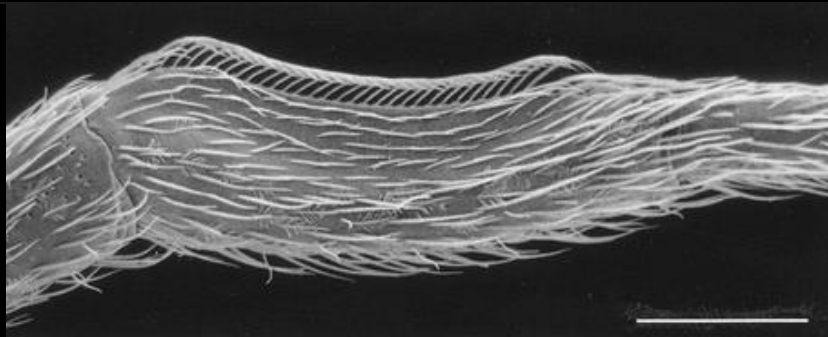
Aciniform glands



Tubuliform glands



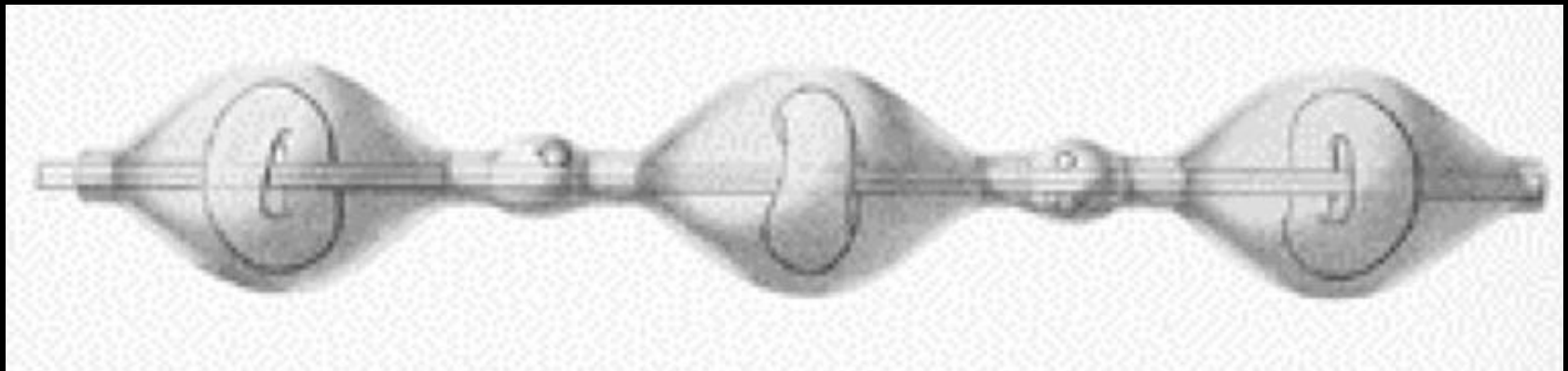
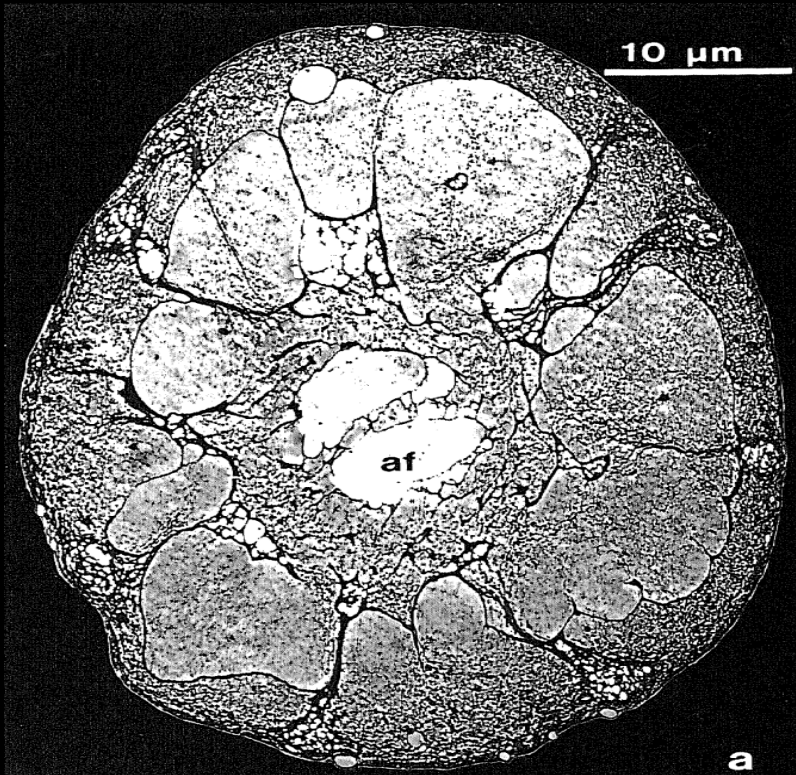
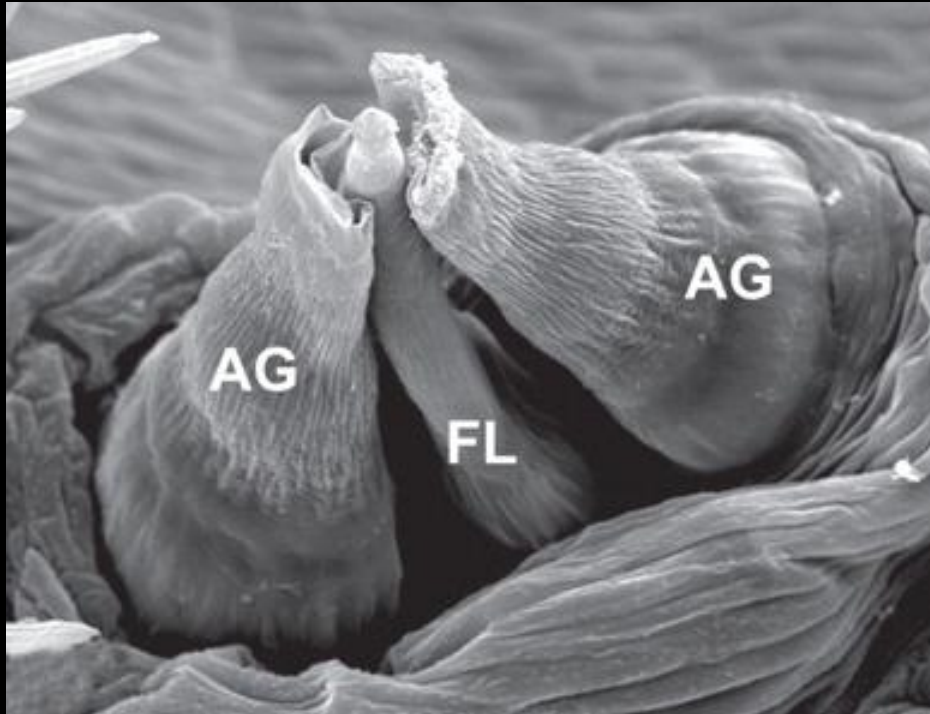
Cribellate capture thread – cribellate, paracribellate, and pseudoflafelliform glands



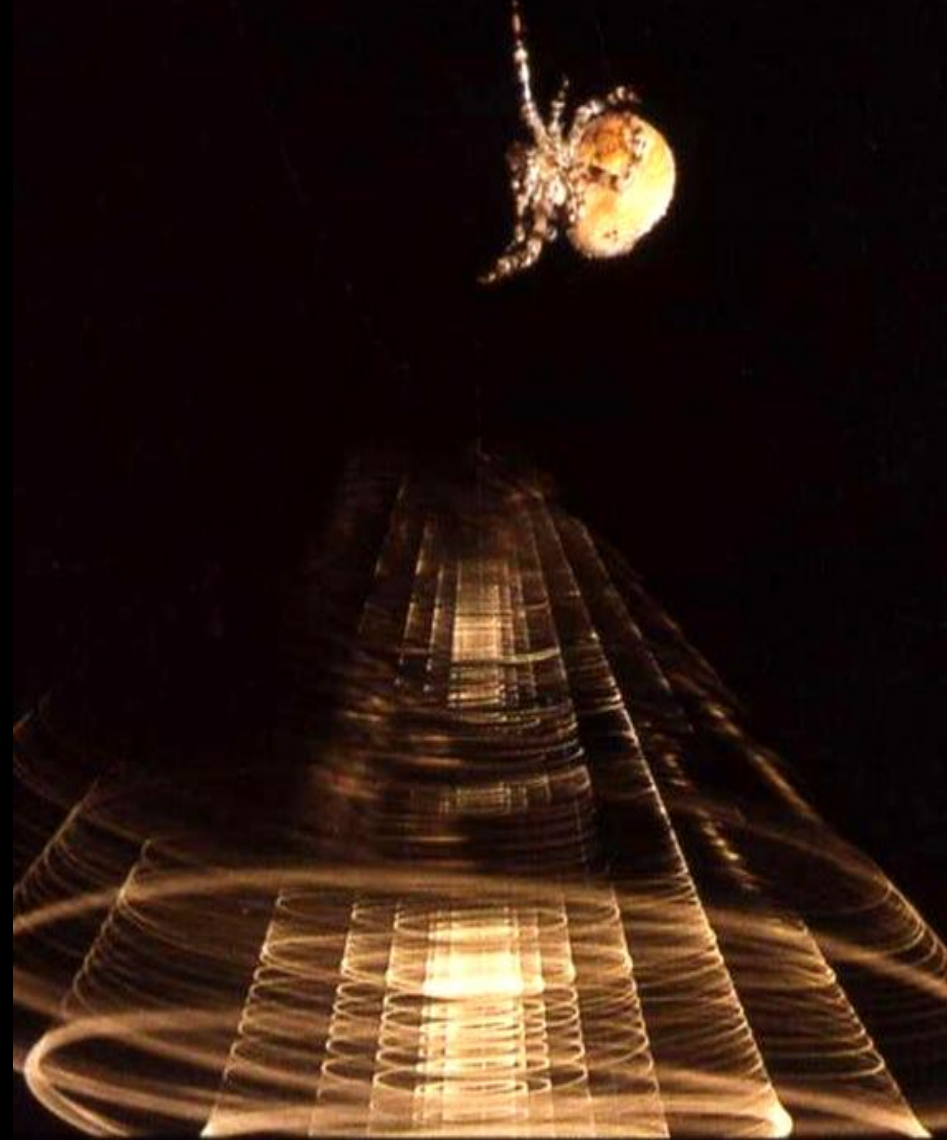
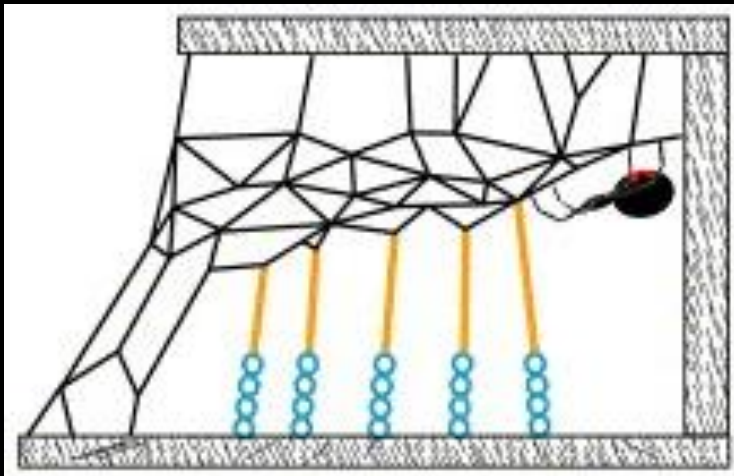
Flagelliform glands



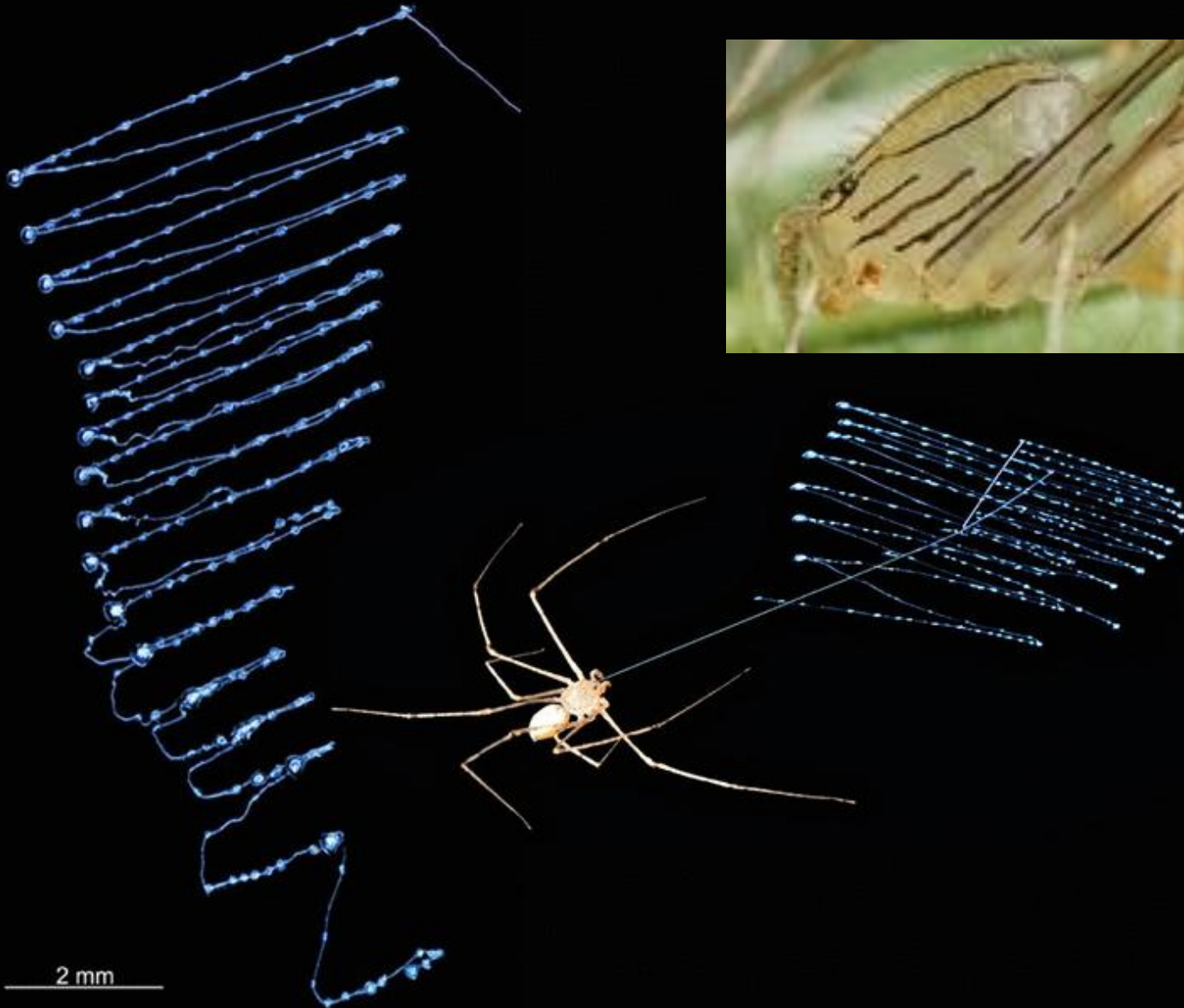
Aggregate glands



Aggregate glands



Scytodidae – Cheliceral glands



2 mm

Variability of spider silk



Up to nine silk gland types in one spider

Each gland contains up to four secretory zones

Each secretory zone produces more than one product (composite granules/more granule types)

Properties of the final silk thread are given by the spinning conditions (duct morphology, diet, speed, temperature, etc.)