ANNEX 8 – Example of Biological Sheets provided in Ideation Workshops

1. AskNature format

3. The nasal surfaces of camels help conserve water by using hygroscopic properties to remove water from air during exhalation.

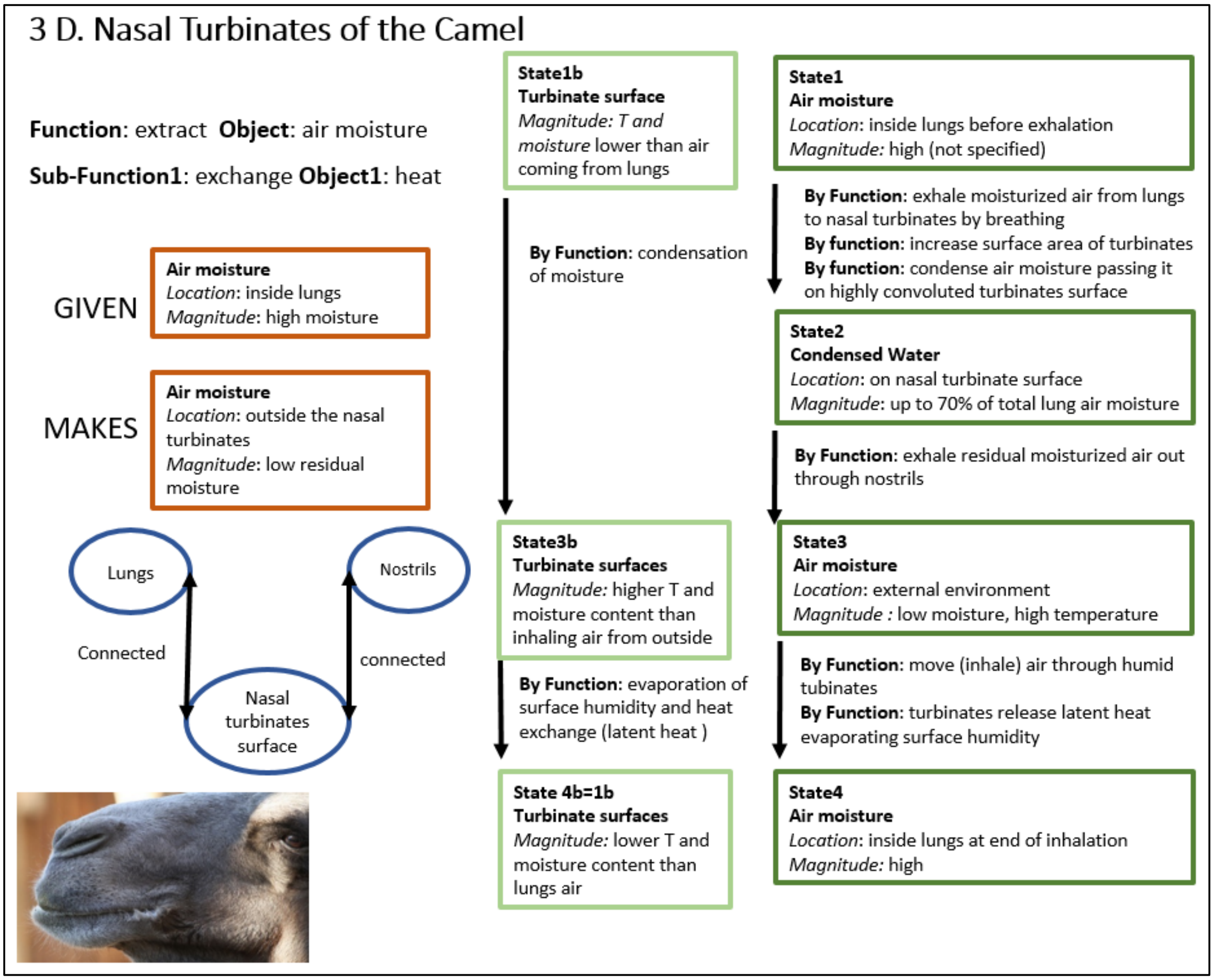
When the dromedary camel gets dehydrated in its hot and arid environment, its nasal surfaces help the animal conserve water using two mechanisms: by cooling exhaled air during the night, and by extracting water vapor from exhaled air.

During the nighttime, outside temperatures are typically lower than the camel's core body temperature. When the camel inhales, the cool outside air passes through the nasal passages where heat is exchanged: the nasal surfaces are cooled while the incoming air is warmed. Inside the camel's lungs, air is at body temperature and fully saturated with water (100% relative humidity). When the camel exhales, the warm air inside the lungs passes over the cool nasal surfaces and exchanges heat again. This time, the air is cooled as it's exhaled, and as it cools, water vapor in the outgoing air condenses onto the nasal surfaces as liquid water. The exhaled air is still at 100% relative humidity, but the lower temperature means that more water exists in liquid form than in vapor form. Several mammals and birds use this mechanism of cooling exhaled air to conserve water and heat.
But the dromedary camel uses a second mechanism to save even more water: it extracts water vapor from the exhaled air, desaturating it down to 75-80% relative humidity. The dry nasal surfaces of a dehydrated camel are hygroscopic, meaning they can absorb and hold onto water molecules from the surrounding air. The hygroscopic nasal surfaces absorb water from the exhaled air and give off water to inhaled air.

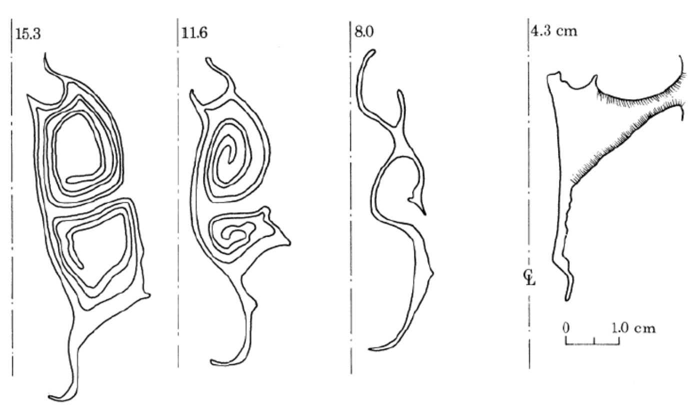
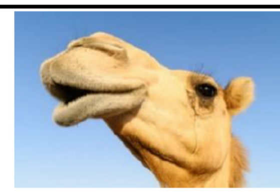
One reason these water recovery mechanisms work so effectively in the dromedary camel is the large total surface area of the turbinate structures in its nasal passages. Turbinates are spongy nasal bones, and the camel's turbinates are highly scrolled, providing narrow air passageways and a large surface area for water and heat exchange. Measurements suggest that camels have more than 1000 cm2 of nasal surface area, whereas the human nasal cavity may have a total surface area of only 160-180 cm2.

Why does the camel use the first mechanism and exhale cooled air only during the night? During the hot daytime, preventing the brain from overheating is prioritized over conserving water. Exhaling air that's warm and saturated with water vapor enables the camel to dump excess heat from its body, but this comes at the expense of saving water.

2. SBF-DANE format



3. Guild-Based BID format

Biological Organism	**Camel**	**Phenotype**	Respiratory system - Nasal turbinates	**Environmental conditions**	Desert environment with high T excursion night/day
Main Action	Extract	**Object of main action**	Moisture	**Context of main action** (Process condition)	Air
Sub/Extra-action 1	Condense/Evaporate	**Object action 1**	Moisture	**Context of Action 1** (Process condition)	air
Sub/Extra-action 2	Exchange	**Object action 2**	Heat	**Context of Action 2** (Process condition)	air
Biological strategy description	**Nasal turbinates** which **extract and recover air moisture** from breathing **as well as exchange heat.** In camels the recovery of water caused by nasal heat exchange might reach 70 % of the potential respiratory water loss. The main site at which the heat and water exchange occurs has been identified as the turbinate structures of the nasal passages.				
Biological Mechanism	**Nasal turbinates have a 3 D convoluted spiraling structure** which optimizes surface/volume ration as well as creates favourable turbulences and **allow to evaporate and condensate humidity**. The increased surfaces of the nasal passageways, which posses **hygroscopic property**, are cooled by the inhaled air and because of evaporation (loss of latent heat) they may be cooled to below the temperature of the inhaled air. On exhalation the air that passes over the cool surfaces gives up heat, water recondenses, and the exhaled air may even be below ambient temperature.				
Mechan. in short	Phase change - condensation/evaporation	**Active/ Passive** (Process attribute)	AC/PA	**Scale** (Process attribute)	Atomic/Molecular/Micro
Objective's properties	water molecoles	**Flow details** (Process condition)	Re high (turbulent)	**Energy** (Process condition)	Dynamic pressure gradient Surface energy
Extracted Design Principle	Spiraling/convoluted folded layer (with transversal section oriented perpedicularly to the direction of the fluid) which maximize surface on which fluid passes without increasing pressure losses due to increased length of obstacles to the flow.				
Process diagrams and pics	  Transversal sections of the turbinates at different distances from the larinx				

4. Non-Expert Guild Based BID (NE-GBBID) format (same as GB-BID format but different quality of information)

Biological Organism	**Camel**	**Phenotype**	Respiratory system - Nasal turbinates	**Environmental conditions**	Desert environment
Main Action	Extract	**Object of main action**	Water	**Context of main action**	air
Sub/Extra-action 1		**Object action 1**		**Context of Action 1** (Process condition)	
Biological strategy description	Camel can avoid water and heat losses thanks to its particular nasal surface				
Biological Mechanism	1° Mechanism: During the night time the air , being inhaling by the camel, warms cooling the nose of the animal. Then the air, at animal's temperature, is exhaling and it condensates on the nose (air still at 100% of humidity). 2° Mechanism: The dromedary (when is dehydrated) is able to extract water from the exhaled air and gives off the water to inhaled air. The great surface area of the nose increases the rate of evaporation. The hygroscopic property (when the camel is dehydrated) allow its nose to absorb water from exhaled air				
Mechan. in short	Avoid loss of water and heat	**Active/ Passive** (Process attribute)	AC	**Scale** (Process attribute)	Cm2
Objective's properties	water droplets	**Flow details** (Process condition)		**Energy** (Process condition)	heat
Extracted Design Principle	a surface ables to extract water from air or to avoid heat losses				
Process diagrams and pics