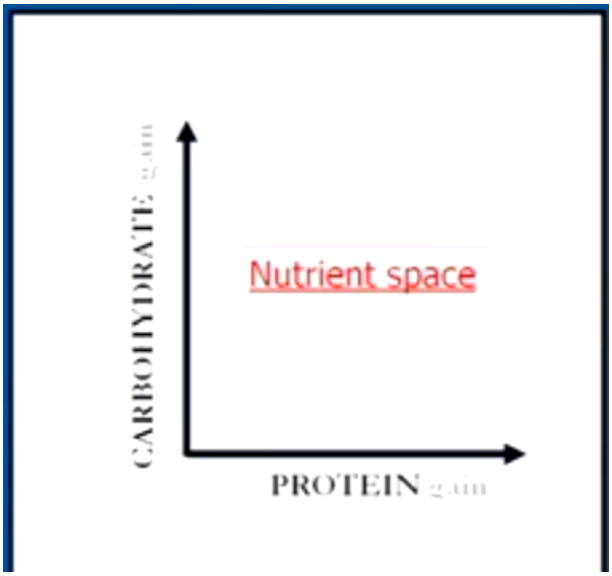
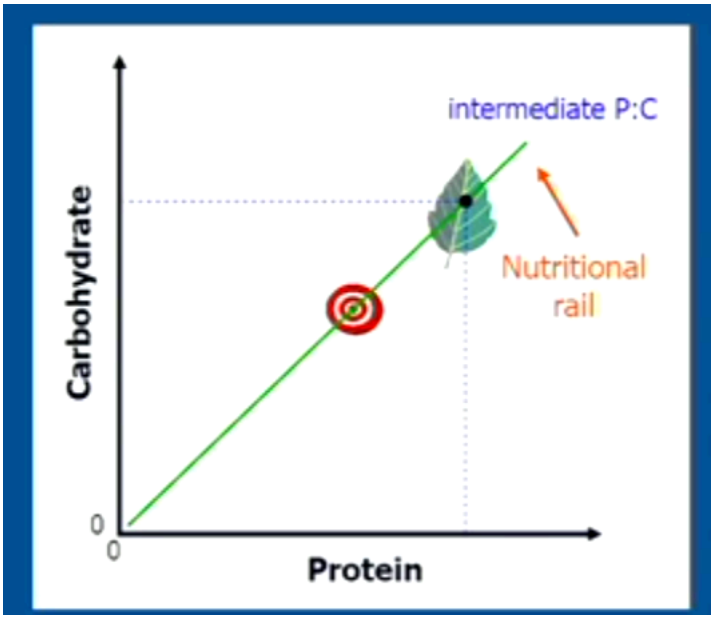
Lecture-nutritional geometry:

- **What drives the foraging choices of animals?**
  - Desire for nutrients e.g. carbs and proteins
  - Maximise protein intake
- Nutrients interact→maintain a balance
- **Nutritional geometry is**
  - an approach for understanding the balance
  - model nutrition in terms of two or more nutrients
  - make a multi dimensional nutrient space
  - plot→
    - nutrient requirements
    - food
    - feeding
    - performance



  - Intake target- levels of protein and carbs to reach certain space on the graph
  - Nutrition rail-ratio of protein to Carbs that animal must eat to get to its intake target.
  - Animal eats and "moves" along the rail towards intake target-



→can move towards or away from the intake target.
    - A balanced food has the correct ratio of Protein:Carbs to reach its intake target.
    - Imbalanced food has incorrect ratio→will eat and wont get to target
    - Animal can eat complementary food to reach target→eat either side of the target e.g. each fruit and nuts to reach an intermediate nutrient balance which is the target-this is important for measuring the target.
- **3 main options for an animal to reach its intake target when eating imbalanced food:**
    - achieve carb intake, but not protein carbs
    - achieve protein intake by eating too many carbs
    - eat to a slight excess of one nutrient, slight deficit of another
- Animal will try and maximise its protein intake as top priority!
- Is a trade off between protein and carbs.
- "rules of compromise"
- **consequences of feeding decisions:**
    - Add lifespan axis to graph
    - See if carbs or protein give a longer life
    - Can represent the lifespan/protein/carb intake as a contour plot/heat map
- **Captive animals in the lab:**
    - Do animals select an intake target?
        - Energy isoline=equal amounts of energy→animals may eat to this line which has equal amounts of energy
        - Animals may eat to maximise their protein intake→animals will eat different amounts of varying carb and protein food to maximise their protein intake
        - The animals **regulated their nutrient balance** to achieve the correct balance of protein to carbs.
        - **Goal of foraging is to balance their nutrients.**
    - **Carnivores →do they regulate nutrient balance?**
        - Found that animals selected an intake that maximised their reproductive potential!
        - They actively selected foods to do this.
        - **How do they respond when they cant maximise their repro potential?**
            - Rule of compromise!
            - They don't prioritise protein or lipids…. They get to "least cost compromise between protein vs lipid intake"→ they maximise their nutrient intake and stay at that level so they can maximise their repro potential/egg production.
    - **Main points:**

        - Animals regulate nutrient balance to intake target
        - Works for omnivores, herbivores and carnivores
        - Target selection and rule of compromise are important
- **Animals in the wild:**
    - In the lab, we experimentally manipulate the diet
    - In wild, rely on natural variation in diet.
    - **Do animals select an intake target in the wild**
        - The monkeys regulated their carb:protein balance of 1:5→maximised their protein intake each day no matter their energy intake each day.
- Animals prioritise their protein intake!
- In gorillas, they wont over eat protein and may sometimes have to eat more protein in order to reach their carb intakes→like humans
- Orang-utans-
    - Nutrient balance drives their foraging activity
    - Pregnant female eats more but has same macronutrient intake
    - Adult male-needs more protein because has more muscles.
    - Rule of compromise- the orang-utans have very tight protein regulation→this is more like the spider monkeys.
    - They have periods of low and high energy intakes→when food is abundant and when food is scarce
    - Ketone-metabolic marker→high level in urine shows high period of fat breakdown-suggests starvation.
    - C peptide in urine-shows the rate of fat accumulation.
    - Orang-utans are adapted to feast and famine ecology→"boom and bust"
    - They go through periods of gaining fat and losing fat
- Humans-
    - Macronutrient regulation→
        - Behave like spider monkeys and orang-utans- **prioritise protein over other macronutrients.**
        - Small change in % protein in food causes very large change in amount of carbs and fat eaten e.g. eat donut-has low protein levels so will eat lots to reach proteins intake. Eat steak-eat less since reach protein intake faster.
        - 1% decrease in protein conc, causes 14% increase in carbs and fat eaten→"**protein leverage hypothesis"**
        - protein drives over consumption of fats and carbs.
        - Dietary protein has decreased in humans over time which has caused over consumption of fats and carbs→obesity epidemic.
        - Humans are in a constant state of high energy→means will put weight on more-due to agricultural revolution

- The same thing is happening with orang-utans in captivity→since are in zoos, they have constant high energy and thus put on fat.