Group 1 | Case A

A promising dairy supplement

ROUND 1: DIAGNOSE. Do not repair the design yet.

CASE FILE

A dairy farmer wants to know whether a new nutritional supplement can increase milk production. From a herd of 80 cows, the farmer gives the supplement to the 20 cows currently producing the most milk, while 20 lower-yielding cows continue on standard feed. Daily milk yield is recorded for four weeks and the two groups are compared at the end of the trial.

Understand the patient

Intended biological question	
Treatment / factor and levels	
Response variable	
Experimental unit	
Independent units per treatment	

Primary diagnosis

What has been done well?

What is the most serious design flaw or threat?

What alternative explanation could account for the result?

What conclusion would NOT be justified?

Group 1 | Case A

Repair: A promising dairy supplement

ROUND 2: OPERATE. Make the smallest defensible repair.

REALISTIC CONSTRAINT	No additional animals are available.

Draw the repaired design

YOUR SKETCH MUST SHOW	1. what one experimental unit is; 2. how many independent units enter each treatment; 3. how units are allocated; 4. which animals, samples or repeated measurements sit within each unit; 5. the final treatment comparison.

Use labelled boxes and connecting lines. You do not need to draw every animal when animals are observations within a pen, tank, litter or room.

DESIGN SKETCH

Exact comparison that estimates the treatment effect	How treatment will be allocated

Which original problem has been eliminated?

What important limitation still remains?

Second opinion

One strength	One unresolved risk	One feasible improvement

Group 1 | Case E

Two diets for juvenile fish

ROUND 1: DIAGNOSE. Do not repair the design yet.

CASE FILE

An aquaculture team wants to compare two diets for juvenile fish. Eight tanks are available: four tanks receive Diet A and four receive Diet B, with 20 fish stocked in every tank. After eight weeks every fish is weighed, and the planned analysis compares all 80 fish on each diet as separate observations.

Understand the patient

Intended biological question	
Treatment / factor and levels	
Response variable	
Experimental unit	
Independent units per treatment	

Primary diagnosis

What has been done well?

What is the most serious design flaw or threat?

What alternative explanation could account for the result?

What conclusion would NOT be justified?

Group 1 | Case E

Repair: Two diets for juvenile fish

ROUND 2: OPERATE. Make the smallest defensible repair.

REALISTIC CONSTRAINT	Only the eight existing tanks may be used.

Draw the repaired design

YOUR SKETCH MUST SHOW	1. what one experimental unit is; 2. how many independent units enter each treatment; 3. how units are allocated; 4. which animals, samples or repeated measurements sit within each unit; 5. the final treatment comparison.

Use labelled boxes and connecting lines. You do not need to draw every animal when animals are observations within a pen, tank, litter or room.

DESIGN SKETCH

Exact comparison that estimates the treatment effect	How treatment will be allocated

Which original problem has been eliminated?

What important limitation still remains?

Second opinion

One strength	One unresolved risk	One feasible improvement

Group 2 | Case B

Lighting for broiler growth

ROUND 1: DIAGNOSE. Do not repair the design yet.

CASE FILE

A poultry company is considering a longer daily lighting period to improve broiler growth. At one farm, House 1 continues with the standard lighting programme and House 2 switches to extended lighting; each house contains 500 broilers managed by its usual staff. After six weeks, researchers weigh a sample of 100 birds from each house and compare average body mass.

Understand the patient

Intended biological question	
Treatment / factor and levels	
Response variable	
Experimental unit	
Independent units per treatment	

Primary diagnosis

What has been done well?

What is the most serious design flaw or threat?

What alternative explanation could account for the result?

What conclusion would NOT be justified?

Group 2 | Case B

Repair: Lighting for broiler growth

ROUND 2: OPERATE. Make the smallest defensible repair.

REALISTIC CONSTRAINT	Only the two existing broiler houses may be used.

Draw the repaired design

YOUR SKETCH MUST SHOW	1. what one experimental unit is; 2. how many independent units enter each treatment; 3. how units are allocated; 4. which animals, samples or repeated measurements sit within each unit; 5. the final treatment comparison.

Use labelled boxes and connecting lines. You do not need to draw every animal when animals are observations within a pen, tank, litter or room.

DESIGN SKETCH

Exact comparison that estimates the treatment effect	How treatment will be allocated

Which original problem has been eliminated?

What important limitation still remains?

Second opinion

One strength	One unresolved risk	One feasible improvement

Group 2 | Case D

Minerals on pasture

ROUND 1: DIAGNOSE. Do not repair the design yet.

CASE FILE

A flock manager is concerned that grazing sheep may be deficient in an important mineral. Thirty sheep are weighed and have a blood sample taken, then every sheep receives a new mineral supplement while remaining on pasture. Six weeks later the same measurements are repeated, and any improvement is attributed to the supplement.

Understand the patient

Intended biological question	
Treatment / factor and levels	
Response variable	
Experimental unit	
Independent units per treatment	

Primary diagnosis

What has been done well?

What is the most serious design flaw or threat?

What alternative explanation could account for the result?

What conclusion would NOT be justified?

Group 2 | Case D

Repair: Minerals on pasture

ROUND 2: OPERATE. Make the smallest defensible repair.

REALISTIC CONSTRAINT	No additional sheep are available.

Draw the repaired design

YOUR SKETCH MUST SHOW	1. what one experimental unit is; 2. how many independent units enter each treatment; 3. how units are allocated; 4. which animals, samples or repeated measurements sit within each unit; 5. the final treatment comparison.

Use labelled boxes and connecting lines. You do not need to draw every animal when animals are observations within a pen, tank, litter or room.

DESIGN SKETCH

Exact comparison that estimates the treatment effect	How treatment will be allocated

Which original problem has been eliminated?

What important limitation still remains?

Second opinion

One strength	One unresolved risk	One feasible improvement

Group 3 | Case C

Choosing bedding for young calves

ROUND 1: DIAGNOSE. Do not repair the design yet.

CASE FILE

A calf-rearing unit wants to compare straw with wood shavings as bedding for newly arrived calves. All calves entering the unit in September are housed on straw, while all calves arriving in October are housed on wood shavings. Staff follow the calves for six weeks and compare the proportion developing respiratory disease.

Understand the patient

Intended biological question	
Treatment / factor and levels	
Response variable	
Experimental unit	
Independent units per treatment	

Primary diagnosis

What has been done well?

What is the most serious design flaw or threat?

What alternative explanation could account for the result?

What conclusion would NOT be justified?

Group 3 | Case C

Repair: Choosing bedding for young calves

ROUND 2: OPERATE. Make the smallest defensible repair.

REALISTIC CONSTRAINT	The data-collection period cannot be extended.

Draw the repaired design

YOUR SKETCH MUST SHOW	1. what one experimental unit is; 2. how many independent units enter each treatment; 3. how units are allocated; 4. which animals, samples or repeated measurements sit within each unit; 5. the final treatment comparison.

Use labelled boxes and connecting lines. You do not need to draw every animal when animals are observations within a pen, tank, litter or room.

DESIGN SKETCH

Exact comparison that estimates the treatment effect	How treatment will be allocated

Which original problem has been eliminated?

What important limitation still remains?

Second opinion

One strength	One unresolved risk	One feasible improvement

Group 3 | Case H

A new approach to canine anxiety

ROUND 1: DIAGNOSE. Do not repair the design yet.

CASE FILE

A veterinary behaviour clinic is testing a six-week training programme for dogs with separation anxiety. Eligible dogs are randomly assigned to the new programme or to usual-care advice, and owners record standardised videos before and after the study. The trainer who delivers the programme watches the videos, knows each dog's group, and assigns the anxiety scores used in the comparison.

Understand the patient

Intended biological question	
Treatment / factor and levels	
Response variable	
Experimental unit	
Independent units per treatment	

Primary diagnosis

What has been done well?

What is the most serious design flaw or threat?

What alternative explanation could account for the result?

What conclusion would NOT be justified?

Group 3 | Case H

Repair: A new approach to canine anxiety

ROUND 2: OPERATE. Make the smallest defensible repair.

REALISTIC CONSTRAINT	No additional assessor can be hired.

Draw the repaired design

YOUR SKETCH MUST SHOW	1. what one experimental unit is; 2. how many independent units enter each treatment; 3. how units are allocated; 4. which animals, samples or repeated measurements sit within each unit; 5. the final treatment comparison.

Use labelled boxes and connecting lines. You do not need to draw every animal when animals are observations within a pen, tank, litter or room.

DESIGN SKETCH

Exact comparison that estimates the treatment effect	How treatment will be allocated

Which original problem has been eliminated?

What important limitation still remains?

Second opinion

One strength	One unresolved risk	One feasible improvement

Group 4 | Case F

Parasite control for grazing goats

ROUND 1: DIAGNOSE. Do not repair the design yet.

CASE FILE

A goat farm wants to know whether a new parasite treatment works better than its standard product. The goats already grazing on Pasture 1 receive the new treatment, while those on Pasture 2 receive the standard treatment and remain where they are. Faecal parasite counts are measured before treatment and again four weeks later.

Understand the patient

Intended biological question	
Treatment / factor and levels	
Response variable	
Experimental unit	
Independent units per treatment	

Primary diagnosis

What has been done well?

What is the most serious design flaw or threat?

What alternative explanation could account for the result?

What conclusion would NOT be justified?

Group 4 | Case F

Repair: Parasite control for grazing goats

ROUND 2: OPERATE. Make the smallest defensible repair.

REALISTIC CONSTRAINT	Goats cannot be moved between pastures.

Draw the repaired design

YOUR SKETCH MUST SHOW	1. what one experimental unit is; 2. how many independent units enter each treatment; 3. how units are allocated; 4. which animals, samples or repeated measurements sit within each unit; 5. the final treatment comparison.

Use labelled boxes and connecting lines. You do not need to draw every animal when animals are observations within a pen, tank, litter or room.

DESIGN SKETCH

Exact comparison that estimates the treatment effect	How treatment will be allocated

Which original problem has been eliminated?

What important limitation still remains?

Second opinion

One strength	One unresolved risk	One feasible improvement

Group 4 | Case G

Enrichment and meerkat activity

ROUND 1: DIAGNOSE. Do not repair the design yet.

CASE FILE

Keepers at a zoo want to know whether a new puzzle-feeding activity makes their meerkat group more active. They provide the enrichment every Saturday and Sunday for four weeks, while weekdays follow the normal routine without it. Observers record the proportion of time the meerkats are active and compare weekend with weekday observations.

Understand the patient

Intended biological question	
Treatment / factor and levels	
Response variable	
Experimental unit	
Independent units per treatment	

Primary diagnosis

What has been done well?

What is the most serious design flaw or threat?

What alternative explanation could account for the result?

What conclusion would NOT be justified?

Group 4 | Case G

Repair: Enrichment and meerkat activity

ROUND 2: OPERATE. Make the smallest defensible repair.

REALISTIC CONSTRAINT	The observation dates cannot be extended.

Draw the repaired design

YOUR SKETCH MUST SHOW	1. what one experimental unit is; 2. how many independent units enter each treatment; 3. how units are allocated; 4. which animals, samples or repeated measurements sit within each unit; 5. the final treatment comparison.

Use labelled boxes and connecting lines. You do not need to draw every animal when animals are observations within a pen, tank, litter or room.

DESIGN SKETCH

Exact comparison that estimates the treatment effect	How treatment will be allocated

Which original problem has been eliminated?

What important limitation still remains?

Second opinion

One strength	One unresolved risk	One feasible improvement

Rapid Surgery reserve bank

Sixteen extra cases for early finishers or a whole-class lightning round. Each group has four assigned cases. Print these pages single-sided and cut along the centre line if you want separate cards.

GROUP 1	**I J K L**
GROUP 2	**M N O P**
GROUP 3	**Q R S T**
GROUP 4	**U V W X**

Suggested timing: 6 minutes diagnose + 4 minutes repair + 2 minutes challenge.

Deploy one case at a time. Ask groups to return a one-sentence primary diagnosis before they operate. Not every constrained case is fully repairable; recognising that is a valid design decision.

GROUP 1 | RAPID CASE I

Keeping mouse cages healthy

An animal facility wants to test whether a new disinfectant reduces infections in laboratory mice. For six weeks, cages on the upper rack are cleaned with the new product while cages on the lower rack continue with the standard product. Veterinary staff record infection for every mouse and compare the two cleaning groups.

CONSTRAINT The racks cannot be moved.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 1 | RAPID CASE J

Pain management after surgery

A veterinary hospital is evaluating a new analgesic for animals recovering from routine surgery. The attending veterinarian chooses either the new analgesic or usual care for each patient, then scores pain later that day using the clinical record and direct observation. Recovery scores from the two treatment groups are compared.

CONSTRAINT Only one veterinarian is available.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 1 | RAPID CASE K

Maternal nutrition and puppy growth

Breeders want to know whether a supplement given to nursing mothers improves puppy growth. Six mothers and their litters receive the supplemented diet and six mothers receive control feed; each litter contains eight puppies. Every puppy is weighed weekly, and the planned analysis compares all 48 puppies in each diet group as separate replicates.

CONSTRAINT No additional litters are available.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 1 | RAPID CASE L

Incubation temperature and hatch success

A hatchery wants to determine whether a slightly warmer incubation temperature improves hatch success. Two hundred fertile eggs are divided equally between two available incubators: one is set to 37.5 C and the other to 38.5 C. Hatch success is recorded for every egg and compared between temperatures.

CONSTRAINT Only two incubators are available.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 2 | RAPID CASE M

Diet and equine performance

A training centre wants to compare two performance diets using its 12 competition horses. Every horse receives Diet A during the first four weeks and then changes directly to Diet B for the next four weeks. Timed exercise performance is measured at the end of each period, and better performance in the second period is attributed to Diet B.

CONSTRAINT The study must finish in eight weeks.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 2 | RAPID CASE N

Comparing two calf vaccines

A research farm needs to compare the antibody response produced by two calf vaccines. Calves handled on Monday receive Vaccine A from Technician 1, and calves handled on Tuesday receive Vaccine B from Technician 2. Blood is collected four weeks later and antibody concentrations are compared between vaccine groups.

CONSTRAINT The two technicians work on different days.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 2 | RAPID CASE O

Measuring intake under two diets

Researchers use automated feeders to compare voluntary intake of two cattle diets. The equipment records the amount removed at every visit, but staff notice that the wetter, stickier Diet B blocks the sensor more often than Diet A. The software stores a blocked reading as zero intake, and all recorded values are included in the diet comparison.

CONSTRAINT The feeder hardware cannot be replaced.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 2 | RAPID CASE P

Health and growth in a pig feed trial

A six-week trial compares growth under Diet A and Diet B in young pigs. The protocol removes any pig that becomes ill and states that only animals completing all six weeks will enter the growth analysis. Twelve pigs are removed from Diet B and two from Diet A; the report compares weight gain among the remaining pigs.

CONSTRAINT Excluded pigs cannot be remeasured.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 3 | RAPID CASE Q

A feed additive on commercial farms

Two large cattle farms agree to help evaluate a new feed additive under commercial conditions. Farm North adds the product to its ration, while Farm South continues with its usual feed and management. After three months, average daily gain is calculated for 300 cattle on each farm and compared.

CONSTRAINT Neither farm will use both feeds.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 3 | RAPID CASE R

Rumen response to supplementation

A nutrition study tests whether a supplement changes rumen fermentation. Eight cows receive the supplement and eight receive control feed; five rumen samples are collected from every cow during the sampling day. The laboratory returns 80 measurements, which the planned analysis treats as 40 independent values per diet.

CONSTRAINT No more cows can be recruited.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 3 | RAPID CASE S

Support for canine anxiety

A clinic offers owners of anxious dogs either an intensive six-week training programme or a written advice leaflet. Owners choose the option they prefer, and the clinic records an anxiety score at enrolment and after six weeks. The programme group improves more, and staff conclude that the programme caused the difference.

CONSTRAINT Owners cannot be forced into a programme.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 3 | RAPID CASE T

Colostrum and calf health

A dairy unit wants to test whether a larger first colostrum feeding reduces infection in newborn calves. To give extra support to vulnerable animals, every low-birth-weight calf receives the high dose while heavier calves receive the standard dose. The calves are followed for eight weeks and infection rates are compared between dose groups.

CONSTRAINT The same calves must be used.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 4 | RAPID CASE U

Comparing feeds within pig pens

A farm proposes a trial of two grower diets using pigs housed in shared pens. Within every pen, half of the pigs are listed as receiving Diet A and half as receiving Diet B, with coloured ear tags marking the intended groups. Feed is delivered freely through one shared trough in each pen, and individual weight gain is recorded.

CONSTRAINT Pens cannot be subdivided.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 4 | RAPID CASE V

Cooling dairy cattle in summer

A dairy farm installs a new cooling system designed to reduce heat stress. Milk yield is recorded for the whole herd under the existing cooling routine throughout June; the new system begins on 1 July and remains in place for the rest of summer. Mean yield is higher in July, and the increase is credited to the system.

CONSTRAINT The system cannot be removed once installed.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 4 | RAPID CASE W

A treatment and blood biomarkers

Researchers are testing whether a veterinary treatment changes a metabolic blood biomarker in cattle. The treated cattle are brought in early and fasted before morning sampling, while control cattle are sampled later after their normal feed. The resulting biomarker concentrations are compared between treatment groups.

CONSTRAINT Existing samples must be used.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**

GROUP 4 | RAPID CASE X

Testing an aquaculture aeration device

An aquaculture facility wants to test whether a new aeration device raises dissolved oxygen. The device is installed in one tank while a second tank continues without it; six probes in each tank record oxygen every minute for 24 hours. The thousands of probe readings are then compared between the device and control conditions.

CONSTRAINT Only two tanks are available today.

Experimental unit + true n	Primary diagnosis
Minimum repair	**Conclusion still supportable**