Animal Welfare in Practice: Mink Farming
OCTOBER 3–4, 2014

Sir James Dunn Animal Welfare Centre
ATLANTIC VETERINARY COLLEGE • UNIVERSITY OF PRINCE EDWARD ISLAND

Mink Health and Management-Related Diseases

Dr. Kirsti Rouvinen-Watt
Professor, Carnivore Nutrition and Physiology

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Nutritional Management of Mink Health and Welfare

- Mink is a strict carnivore
  - Makes blood sugar from dietary amino acids
  - Needs a high protein, high energy (fat) diet
  - Needs a diet based on animal products

- Mink is a seasonal breeder
  - Body fat deposition in preparation for winter
  - Slimming down, nutritional flushing prior breeding
  - Body condition is important for the health and welfare of mink

Finley et al. 2012 Code of Practice for the Care & Handling of Mink: Review of Scientific Research on Priority Issues. NFACC

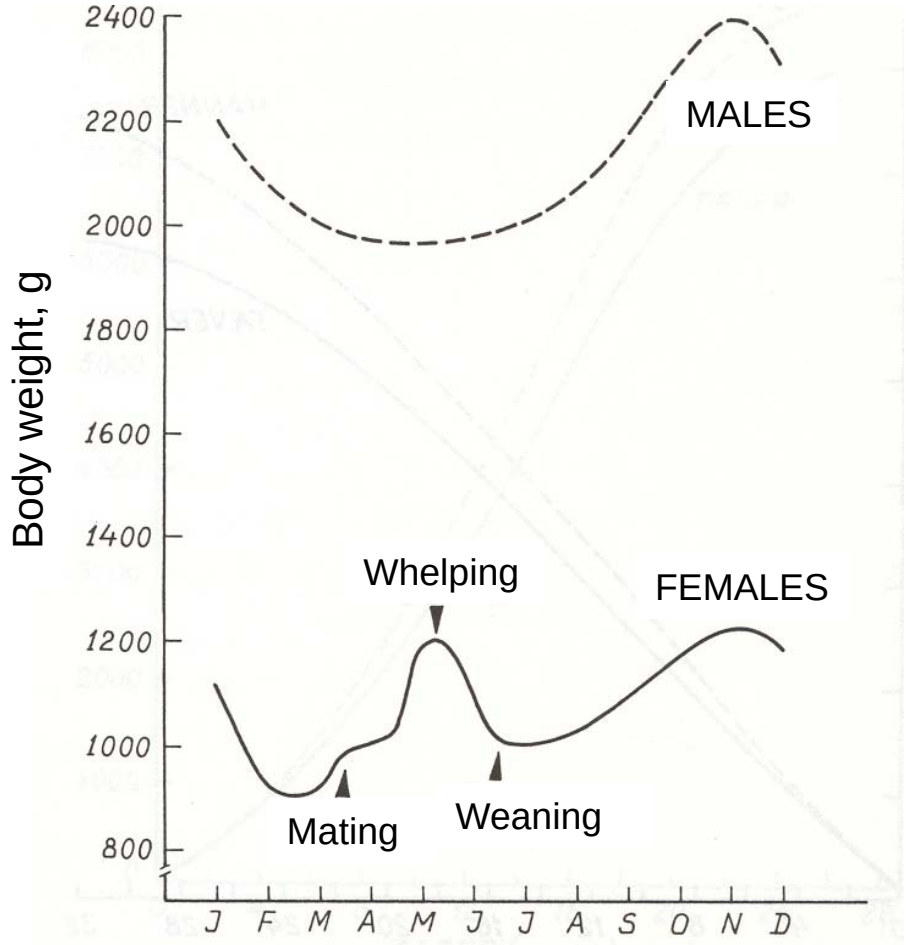
Mink Is a Seasonal Breeder

- Body weight and body condition
  - Responsive to changes in energy supply
  - Seasonal changes in hormonal status
- Wintertime food scarcity
- Reduced physical activity
- Successful reproduction depends on nutritional status and body condition

Dunstone 1993, Tauson and Alden 1984

Body Weight Shows Large Seasonal Fluctuations

- Sexual dimorphism
- Body fat deposition and mobilization
  - Autumnal weight gain
  - Loss prior to breeding
  - Loss during lactation



Enggaard Hansen et al. 1991, Dunstone 1993

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Practical Problems on Mink Farms

- Large pelts are paid premium price
  - Producers want to raise big mink
  - Genetic selection for large body size
- Heavy feeding results in obese animals
  - Need drastic slimming prior to breeding
  - Poor health
  - Poor reproduction

Clausen et al. 1992, Schneider and Hunter 1992, Wamberg et al. 1992, Rouvinen-Watt 2003

Practical Problems on Mink Farms

- The production of large pelts contradicts with the goals of successful reproduction and (metabolic) health
  - Nursing sickness
  - Fatty liver disease
  - Bladder infections and stones

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Nursing Sickness in Mink

- Nursing disease, nursing anaemia, June blues
- Leading cause of death in adult females
- Common cause for culling in high producing breeder ♀♀ and their kits
- Represent a large economic and genetic loss to industry

Hunter and Lemieux 1996

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Clinical Symptoms of Nursing Sickness

- Loss of appetite, emaciation; >30% BW loss
- Lethargy, staggering gait
- High blood glucose, protein, creatinine
- Severe dehydration
  - Extremely low plasma and urine sodium concentrations
- Rapid deterioration: Coma, death within 5 d
- Fatty liver common finding post mortem

Clausen et al. 1992, Wamberg et al. 1992

What Causes Nursing Sickness?

- Complex metabolic disorder
  - Develops when demands for lactation require extensive mobilization of body energy reserves
- Incidence may vary greatly between years
  - Morbidity up to 15%; Mortality up to 8%
- Old females with large litters most often affected
- Seen typically around 42 days after whelping
  - Stress has been shown to trigger the onset
  - Post-weaning cases also

Clausen et al. 1992, Wamberg et al. 1992

What Causes Nursing Sickness?

- Linked to poor blood sugar regulation
  - During pregnancy and lactation a degree of insulin resistance develops in the female
  - During these times the mink dam is particularly susceptible to problems in glycemic regulation

- Mink in non-ideal body condition have more problems with blood sugar regulation

  ➔ Poor reproductive performance

  ➔ Increased mortality of dams

Wamberg et al. 1992, Børsting and Gade 2000, Hynes et al., 2004; Hynes and Rouvinen-Watt 2007, Rouvinen-Watt 2003

Mink females in non-ideal body condition show higher gestational glucose levels and greater glycemic variation during breeding, gestation and lactation than dams in ideal condition

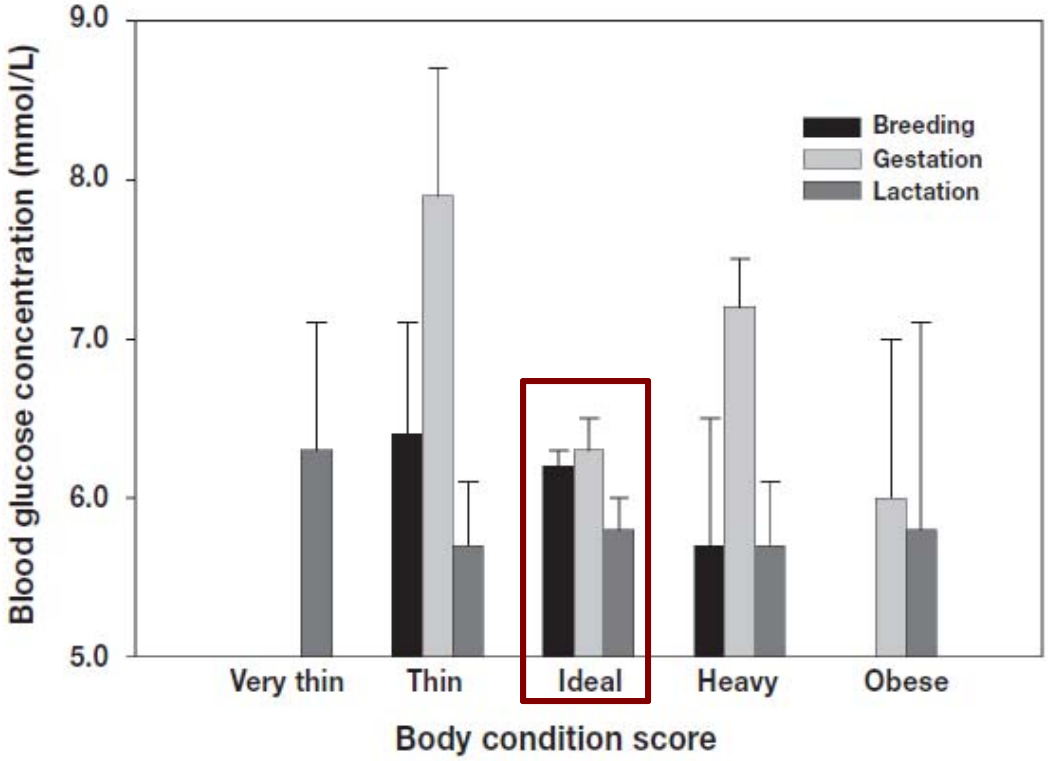


Figure 1. Mean blood glucose concentrations in mink females at breeding, gestation, and lactation according to body condition score: very thin (n = 0, 0, 3), thin (n = 4, 6, 13), ideal (n = 100, 78, 70), heavy (n = 3, 15, 11), and obese (n = 0, 3, 1).

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Hynes and Rouvinen-Watt 2007 Canadian Journal of Veterinary Research

Anti-inflammatory (HerO, ASA), insulin sensitizing (CrPic) and antioxidant (ASA) compounds restore glycemic regulation in mink dams with hyperglycemia during late lactation

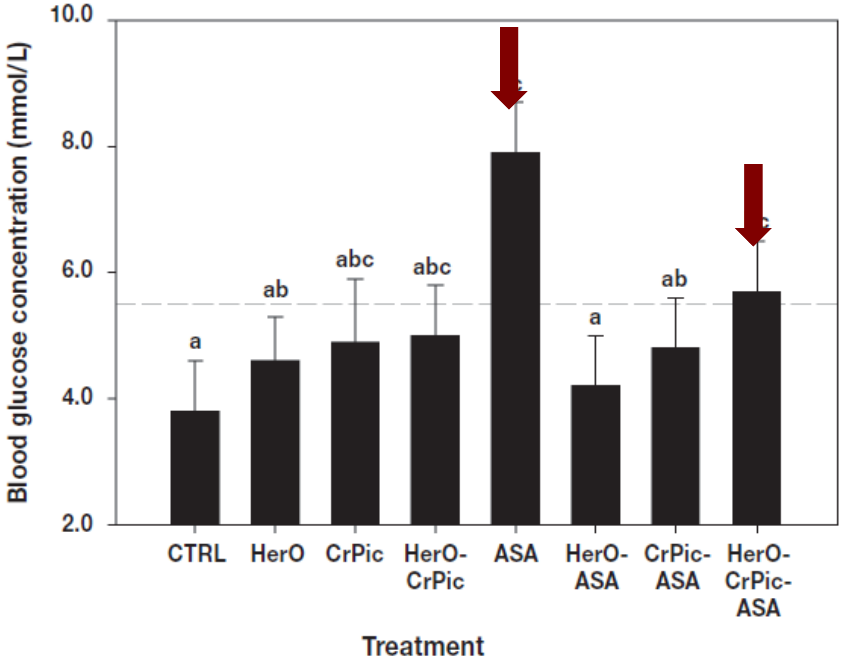


Figure 1. Mean (least-squares) blood glucose levels, with standard errors, averaged over days 28 to 42 of lactation, for normoglycemic mink females fed the basal, control diet (CTRL) or the basal diet plus various combinations of herring oil (HerO), chromium picolinate (CrPic), and acetylsalicylic acid (ASA) for 1 wk from day 21. Means with the same letter(s) are not significantly different, as determined with transformed data ($P < 0.05$). Broken line indicates the cutoff point for normoglycemia (5.5 mmol/L).

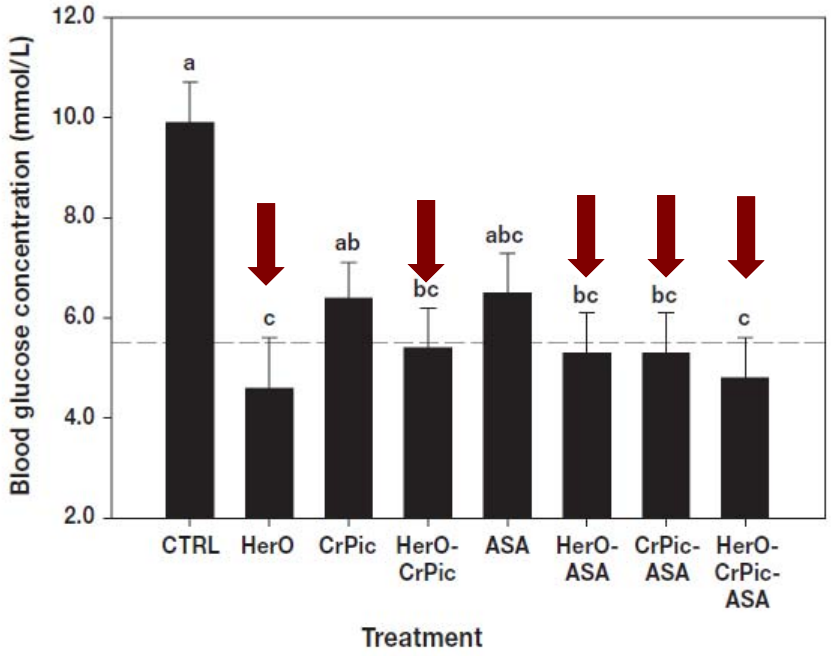


Figure 2. Mean blood glucose levels for hyperglycemic mink females receiving the same experimental dietary treatments. Details as for Figure 1.

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Hynes and Rouvinen-Watt 2007 Canadian Journal of Veterinary Research

What Causes Nursing Sickness?

- The lactating mink dam may become deficient in n-3 PUFA
  - These fatty acids are not synthesized and are secreted in milk fat
  - Lost selectively during mobilization of body fat reserves
- Rapid BW loss may result in the development of fatty liver
  - Especially a concern for obese mink
  - Loss of n-3 PUFA in the liver
- Low n-3/n-6 PUFA associated with insulin resistance

Bjornvad et al. 2004, McGill and Bell 2006, Mustonen et al. 2005, Nieminen et al. 2005, Rouvinen-Watt 2003, Rouvinen-Watt et al. 2010, Wamberg et al., 1992

Does Stress Make Insulin Resistance Worse?

- Stress hormones increase the mobilization of nutrients
  - Blood glucose, lipid levels ↑
- Epinephrine (adrenaline)
  - Induces insulin resistance in liver, muscle, and adipose tissue
- Glucocorticoids
  - Increase gluconeogenesis

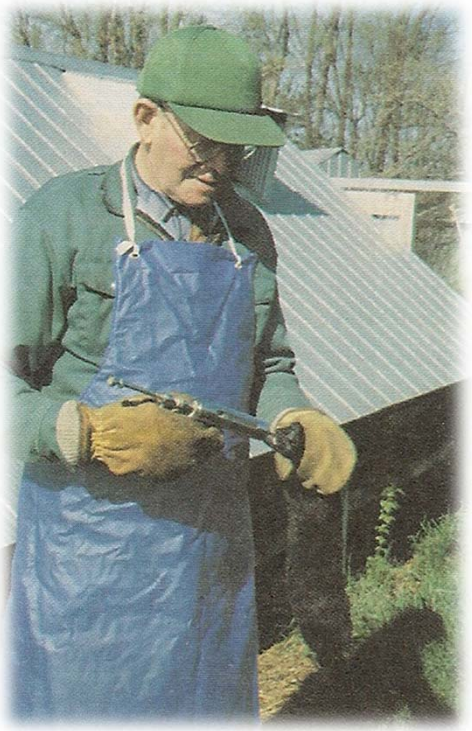
DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Deibert and DeFronzo 1980

Can We Cure Nursing Sickness?

- There is no effective treatment
- When clinical symptoms detected early, some females respond well to electrolyte therapy (oral, subcutaneous)
- Dietary salt supplementation of 0.42-0.50 NaCl/100 kcal during lactation is beneficial in reducing incidence of nursing sickness



Clausen and Hansen 1989, Clausen and Damgaard 2002, Hunter and Lemieux 1996, Schneider 1996

Can We Cure Nursing Sickness?

- On-farm practices related to breeder selection, animal management, and feeding management which promote better glycemic control reduce the incidence
- Risk increased by large fluctuations in body condition
  - Excessive fattening during the fall
  - Rapid slimming prior to breeding
  - Rapid mobilization of body fat reserves for milk production
  - Stress during pregnancy and lactation
- Proper conditioning of breeder females throughout the production cycle

Rouvinen-Watt and Hynes 2004, Boudreau et al. 2014

Fatty Liver Disease

- Hepatic lipidosis, liver steatosis, hepatic fatty degeneration
  - Mortality an increasing problem in mink
  - Overweight and obese males during September-December
  - Breeders during slimming down period
- Often asymptomatic and there is no effective treatment
  - Increased liver weight, liver fat content, plasma ALT
  - Terminal phases reduced feed intake
  - Melaena and gastric bleeding

Koskinen and Lassén 2006, Rouvinen-Watt et al. 2010

Liver Lipid Metabolism

- The liver plays a central role in fat metabolism
- Hepatic lipidosis / steatosis = Fatty liver
  - Characterized by excessive fat (TAG) accumulation
  - Increased influx of fatty acids (NEFA)
  - Reduced secretion of fat (TAG) in VLDL
  - Reduced mitochondrial β-oxidation of fatty acids
  - Increased fat synthesis (*de novo* lipogenesis)

Nguyen *et al*. 2008

How Does Fatty Liver Look Like?

- Normal liver fat content about 5%; Obese animals about 9%
  - Mink diagnosed with extreme hepatic fatty infiltration 40-55%

- Liver extremely enlarged
  - Bright yellow in colour
  - Fragile texture
  - May spontaneously rupture causing death

Clausen 2009, Clausen and Sandbøl 2007, Rouvinen-Watt et al. 2010

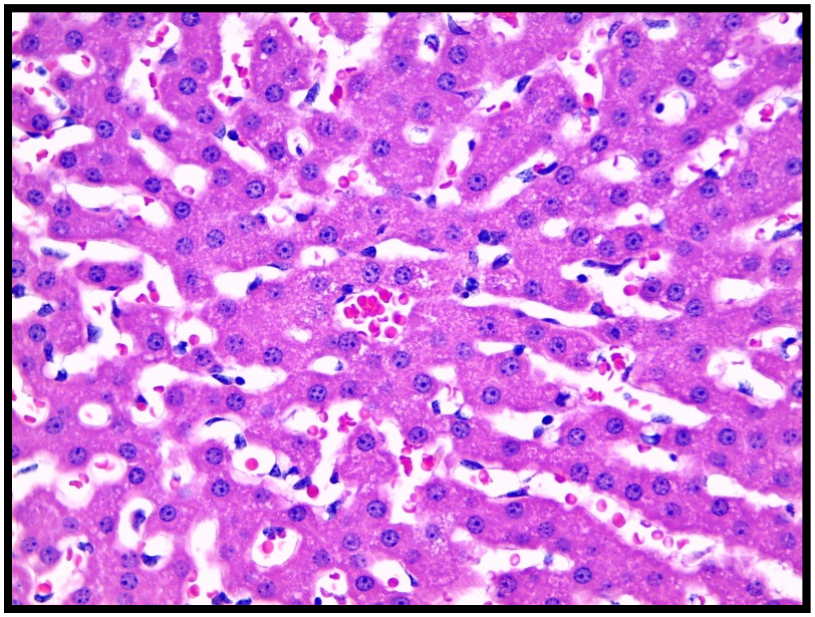
DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

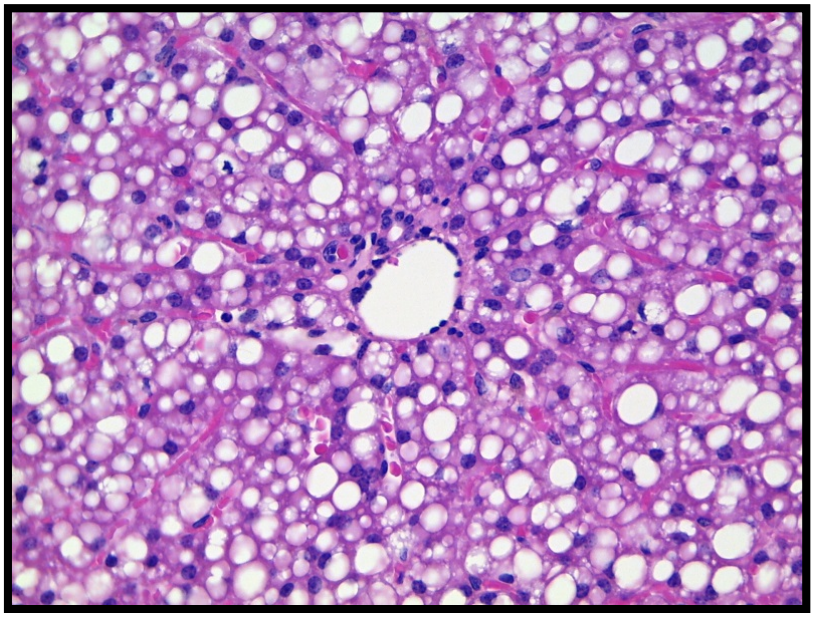
www.livers.org.nz

How Does Fatty Liver Look Like?

Healthy Liver



Macrovesicular Steatosis



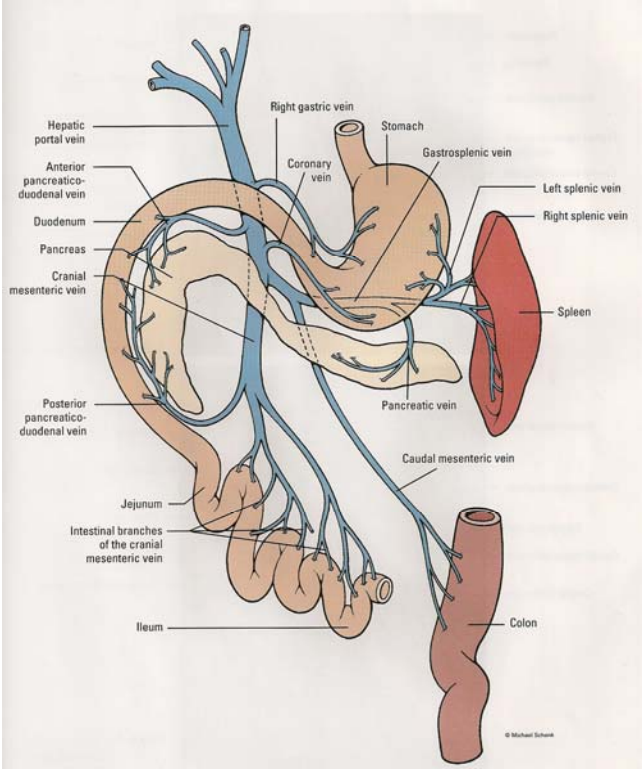
What Causes Fatty Liver in Carnivores?

- Protein-calorie malnutrition
  - Low dietary protein; Amino acid imbalance
  - Excess dietary fat; Fatty acid imbalance
  - Excess dietary carbohydrate
- Severe negative energy balance
  - Loss of appetite, restricted feeding
- Nutritional deficiency
  - Choline, Vitamin B
- Poor feed quality

Koskinen and Lassén 2006, Rouvinen-Watt et al. 2010

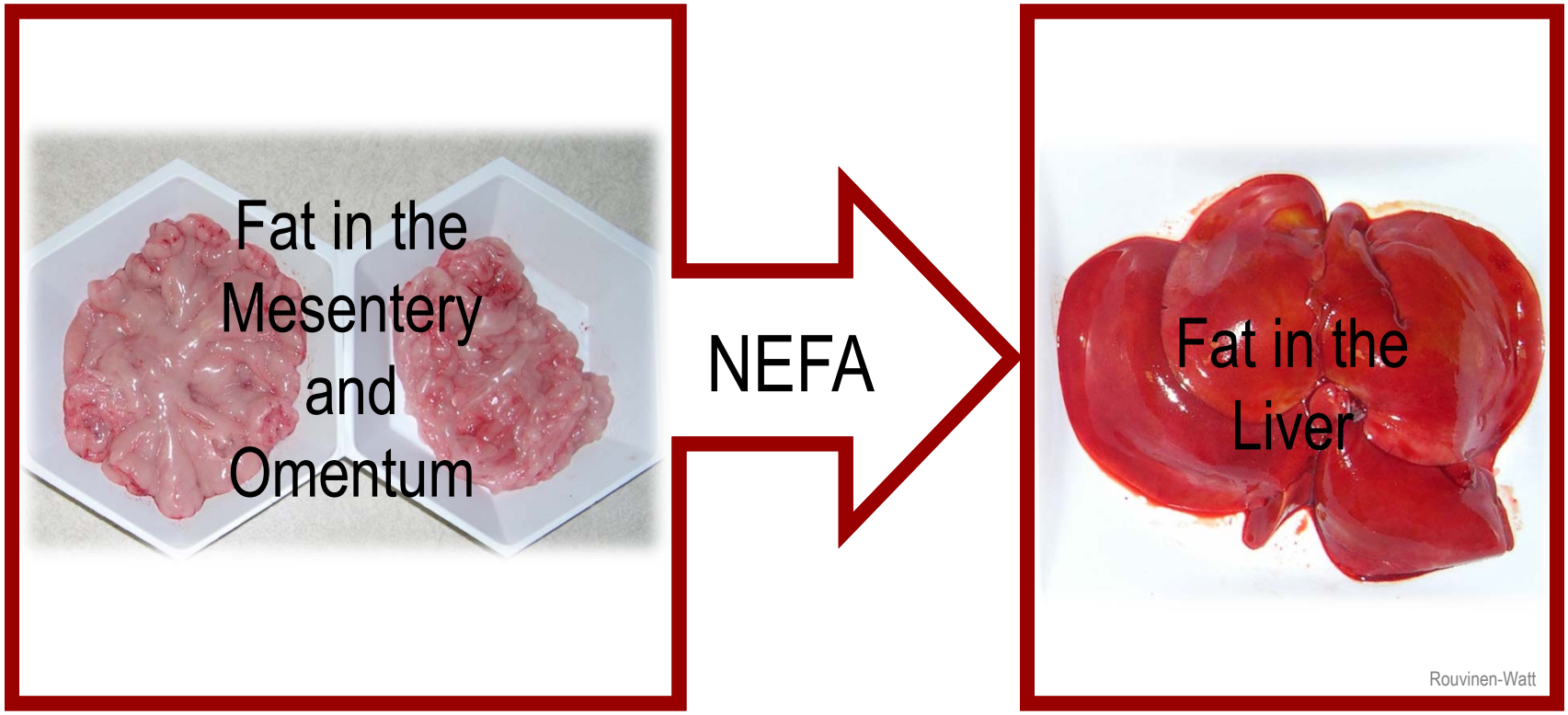
Fatty liver in mink during food deprivation is caused by the increased hydrolysis of fat depots

- Visceral fat is a problem
  - Drains into hepatic portal vein
  - Blood lipid levels ↑
  - Liver infiltrated by fat
- Similar situation in obesity
  - Fat storage in adipose ↓
  - Release of fatty acids ↑



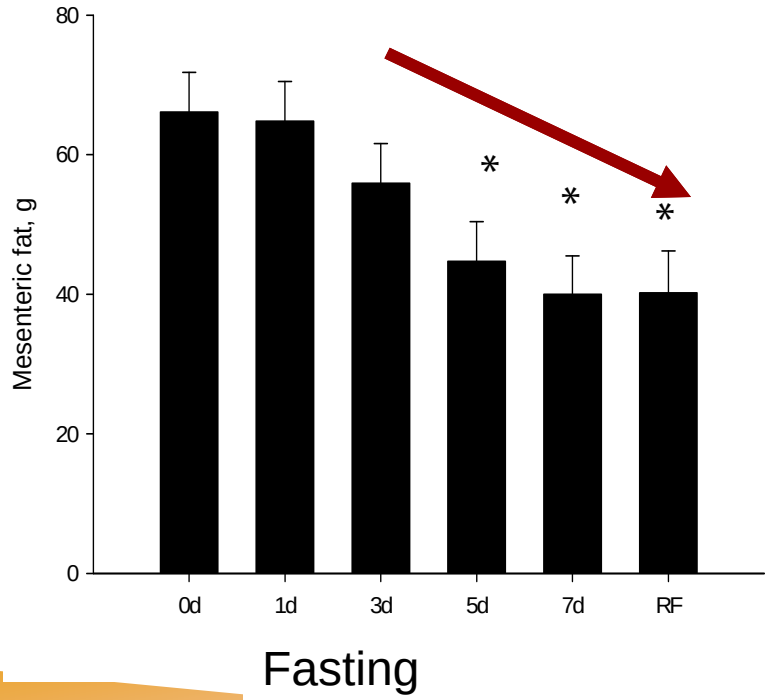
Smith and Schenk 2000

When mink are not eating enough they mobilize body fat to meet energy demands

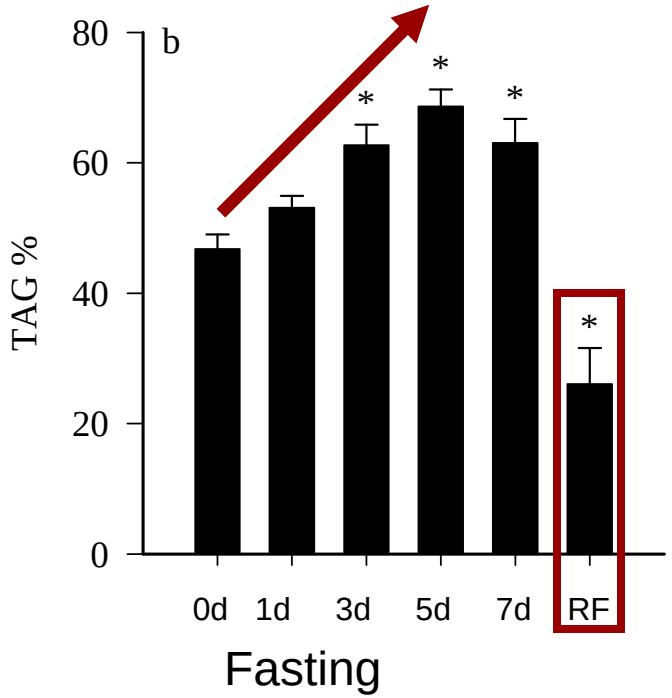


Mesenteric Fat and Liver TAG

Mesenteric fat is mobilized



Liver fat is increased

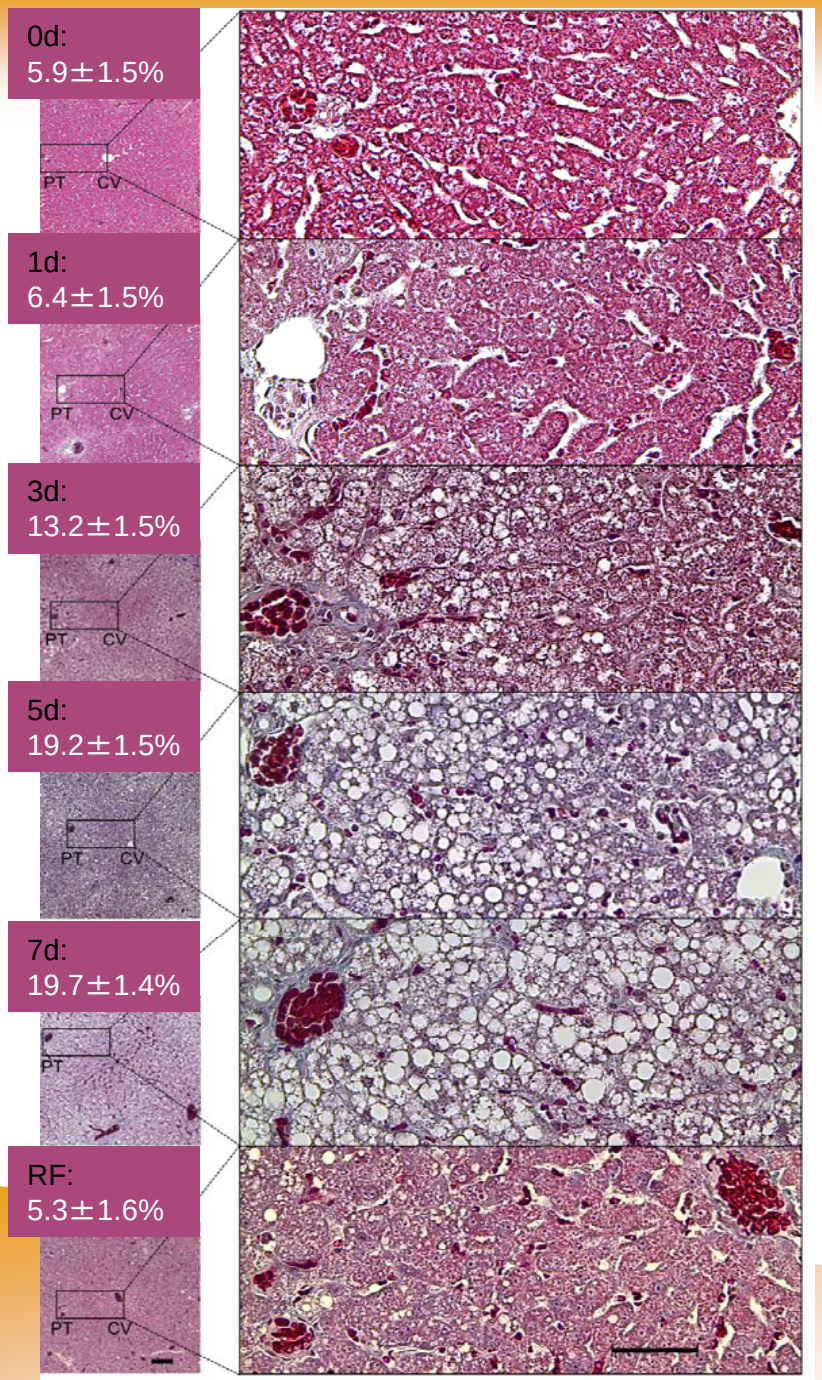


Rouvinen-Watt et al. 2010. Lipids 45:111-128.

DALHOUSIE UNIVERSITY
Inspiring Minds

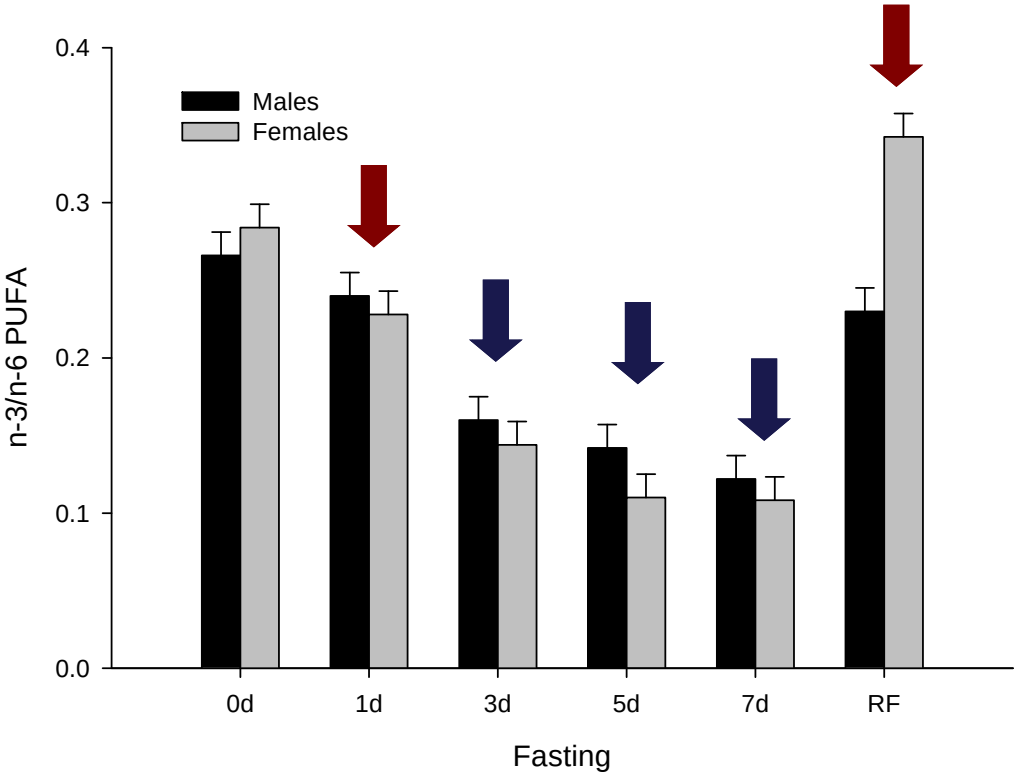
Faculty of Agriculture

Liver Fat Accumulation and Loss of n-3 Fatty Acids



Body fat mobilization depletes n-3 PUFA

Loss/Recovery more rapid in females

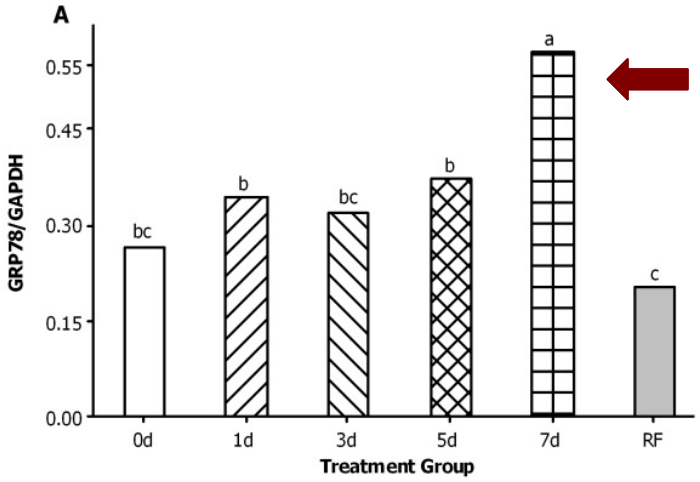


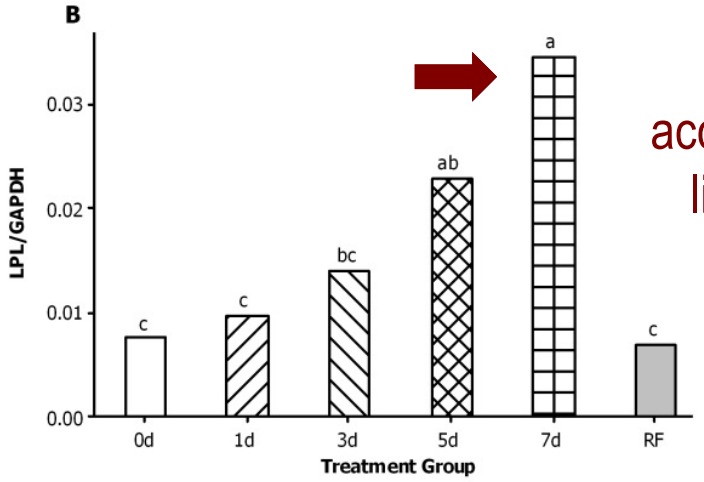
Rouvinen-Watt et al. 2010 Lipids, 2012 British Journal of Nutrition, 2014 Journal of Comparative Physiology B

DALHOUSIE UNIVERSITY
Inspiring Minds

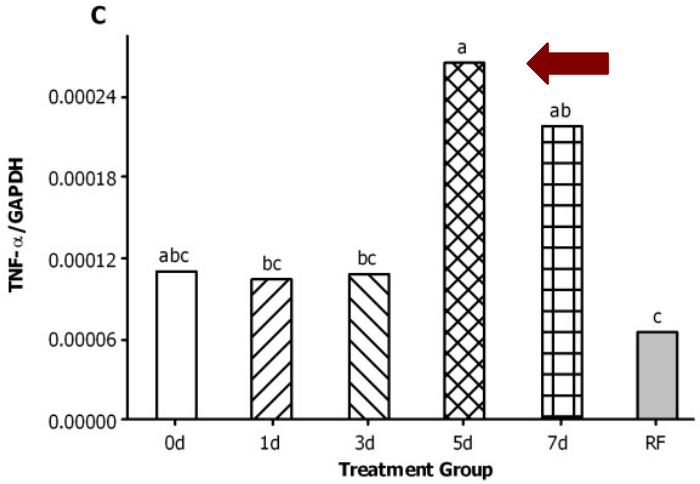
Faculty of Agriculture

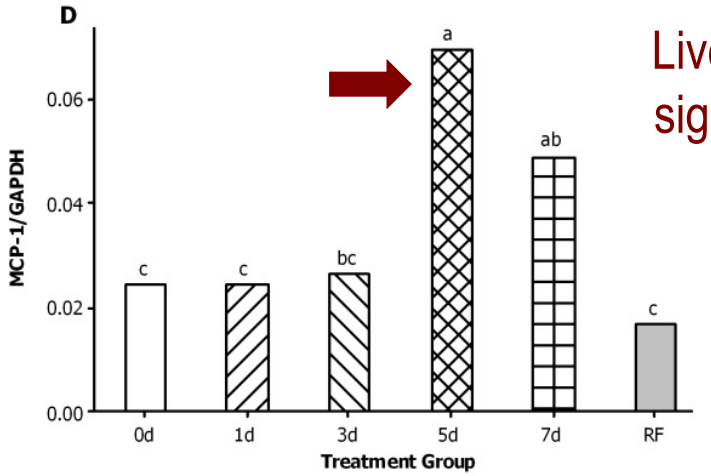
Indicators of Liver Inflammation





Excessive fat accumulation induces liver inflammation





Liver inflammation is a sign of a more serious liver disease

Rouvinen-Watt et al. 2014 Journal of Comparative Physiology B

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Recommendations

- Prevent over-conditioning of mink during the fall (Sept-Dec)
- Maintain normal feed intake during stressful periods
- Increase or maintain intake of omega-3 PUFAs during periods of body weight loss

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Urinary Tract Infections and Bladder Stones

- Urolithiasis, cystitis, plum bladder disease
- Bladder and kidney infections
- Stones (urinary calculi, uroliths) in bladder, kidneys, urethra
- Can be a serious problem in mink
  - Mortality 0.02-0.41%, 5–35 % of all dead kits
- Sudden death of apparently healthy animals
  - Blocked urethra
- Symptoms in earlier stages
  - Straining and vocalizing in discomfort, pain when urinating
  - Blood in the urine, oral ulcerations

Clausen 2006, 2007, Zellen 1996

Urinary Tract Infections and Bladder Stones

- Bladder infections late June – July
  - Large turnover of feed, high excretion of waste products
  - Predisposes to formation of crystals
  - 3/4 of mortality male kits
  - Male urethra long and narrow; voiding of calculi more difficult
- Uroliths from August onwards in the growing-furring period
- Breeding females during winter and lactation
  - Water balance is critical!

Clausen 2006, 2007, Zellen 1996

Urinary Tract Infections and Bladder Stones

- Bladder infections may be caused by e.g. *Staphylococci, Pseudomonas spp., Proteus spp., E. coli*

- Urease producing bacteria raise pH of the urine
  - Urine becomes oversaturated
  - Crystals are formed
  - About 60 – 80 % of the bladder stones are formed after bladder infection

Case et al. 1995, Zellen 1996, Nguyen et al. 1979 http://commons.wikimedia.org/wiki/File:Struvite_crystals_dog_with_scale_1.JPG

Bladder Stones and Urine pH

- Most bladder stones found in mink are struvite uroliths
  - Magnesium ammonium phosphate
- Struvite stones precipitate in alkaline urine > pH 7.0
  - Dissolve in acidic urine < pH 6.6
  - Fasting urine pH in mink ranges from 6.05 to 6.50
  - Urine samples with crystals > pH 6.6

Rouvinen-Watt

Case et al. 1995, Clausen 2010, Spears, 2003

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Important Factors in Prevention of Urinary Tract Infections and Bladder Stones

- Animal's water balance
  - Encourage consumption; *ad libitum* access
  - Winter period, lactation
- Environment and management
  - Encourage frequency of urination
  - Size of enclosure (territory marking)
  - Cage, nestbox, litter box hygiene
  - Antimicrobial treatment of animals
- Genetic background

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture

Important Factors in Prevention of Urinary Tract Infections and Bladder Stones

- Feeding of frequent small meals helps manage urine pH
- High diet digestibility, high caloric content
  - Mineral intake ↓, faeces volume ↓, faecal water output ↓
  - Volume of urine voided ↑
- Diet high in animal protein (SAA) decreases urine pH
- Lowering of feed pH will reduce/prevent stone formation
- Low magnesium (Mg) content in the feed is beneficial
- Diets high in cereal grain (K) produce more alkaline urine
- Dry diet increases risk

Summary

- Mink nursing sickness and fatty liver disease common causes of mortality in mink
  - Metabolic diseases linked to non-ideal body condition
  - May result from loss of appetite or obesity
  - Focus on prevention; no effective treatment

- Bladder infections in June-July
- Stones increased from August onwards
  - Good hygiene, diet and water balance
  - Management of urine pH

Code of Practice for the Care and Handling of Farmed Mink – Section 3: Feed and Water

- Welfare and productivity are highest in breeders when they are managed to maintain an ideal body condition
- Proper nutritional management will help prevent or manage metabolic diseases
- Feeding programs should focus on minimizing fluctuations in body condition

CCFAR

CANADIAN CENTRE FOR FUR ANIMAL RESEARCH

Thank you!

DALHOUSIE UNIVERSITY
Inspiring Minds

Faculty of Agriculture