

**Dossier of documents for
China/USA Sea Turtle Workshop – Hawaii 2014**

**Convened by NOAA-CAFS-USGS
25-29 August 2014**



**Compiled by G.H. Balazs, J.A. Seminoff,
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October 2014

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China/USA Sea Turtle 2014 Workshop Directory

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Action Items Agreed Upon at the China/USA Sea Turtle Workshop Honolulu, Hawaii, 25-29 August 2014

In August 2014, a China/USA Sea Turtle Workshop was held in Honolulu, Hawaii for 5 days from 25-29 August. This workshop, convened under the Living Marine Resources initiative, was attended by scientists from the United States government agencies (NMFS and USGS) as well as top researchers and sea turtle conservationists from throughout the China region. This was a diverse meeting that included oral presentations by all workshop participants, a necropsy practicum where all participants got hands-on experience conducting necropsies of Hawaiian sea turtles, field outings to capture live green turtles and see basking green turtles in the wild, and a visit to Sea Life Park to see sea turtle research and husbandry facilities. After an extremely productive week, the workshop participants developed a collection of recommended next steps designed to foster additional dialogue, trust, and collaboration among all Workshop participants from across the Pacific Ocean.

Below is the list of recommendations that was developed by the team:

- 1) **Implement ways of having better communication and increasing communication** – *The more technically savvy Workshop participants suggested a smartphone application such as Wechat or Wassup that is usable on both Apple and Android platforms. There will of course be some training necessary to get all members of the team proficient in how to use these apps.*
- 2) **Create China/USA Sea Turtle Working Group** – *It was agreed that the inaugural members of this Working Group would be the participants convened for the present workshop, but that the Group would be open to the addition of new members as appropriate.*
- 3) **Convene again in a subsequent workshop somewhere in the China region** – *Workshop members suggested several different options and times to hold the meeting, including holding the meeting at A) Huidong Gangkou Sea Turtle Reserve, B) Marine Biology Aquarium in Pingtung, Taiwan, C) Xiamen (during Ocean week in November 2015/2016). It was mentioned that Xiamen Municipal Government offers monetary support for these workshops during Ocean week – Field trip to Nanao and Gangkou; D) In another year Hainan workshop possible – support from Hainan Normal University and Sea Turtles 911's hotel partnerships.*
- 4) **Establish a directory with various email, phone, Wechat addresses, etc. for all participants from the current workshop** – *Such a list is currently under development and will be sent to everyone.*
- 5) **Create a list of other sea turtle researchers that would be good resources for additional China/USA sea turtle efforts**
- 6) **Explore funding opportunities in China for more research, and material support for sea turtle work in China** – *To do this we could potentially combine efforts with other Ocean species – General marine ecosystem conservation. Integrated approach – with*

core day for sea turtle work. Explore funding opportunities on USA side to convene next workshop.

- 7) **Create a Visiting Scientist/Scholar Program** – For example, Jeffrey Seminoff offered to host a visiting scholar at his SWFSC laboratory in La Jolla California some time in 2015 or beyond and Thierry Work supported the possibility of hosting a student exchange in USGS Field Station for a visit up to 6 months. Likewise, a visit by a US Scientist such as George Balazs to China would be welcomed, during which time he could visit various institutions of learning in China for up to 2 months. Explore possibilities for travel and housing funding to visit Professor LIU's facility for 1- 3 month. City University of Hong Kong and Hainan Normal University– visiting students from China.
- 8) **Promote collaborations among scientists within the China region** – i.e. Intra-China collaborations.
- 9) **Identify pathology laboratory access and capacity within the China region** – Develop exchanges with Dr. LI, DVM and other Chinese pathologists.
- 10) **Explore Ocean Park Conservation Foundation Hong Kong funding for sea turtles and sea turtle workshop.**
- 11) **Identify key players that could help foster China region collaborations by determining what interests them:** for example: Global Environmental Facility – for general marine conservation (coral reef and other species). Post-Meeting Note: at a later stage we will ask for ideas from the group about other key players.
- 12) **Inquire about China/USA consulate cooperation** – Consulate support for sea turtle work in Hainan. Explore ways on how sister state relationship between Hainan and Hawaii could help sea turtle conservation.
- 13) **Propose Thierry Work conduct Wildlife Health and Disease workshops** – Thierry conducts these worldwide – possibly conduct Marine Wildlife Health and Disease Workshop for China region. The China/USA Sea Turtle Working Group strongly recommends increased collaboration and scholarly exchange on wildlife health issues within aquatic protected wildlife.
- 14) **Continue building a literature list of all China region sea turtle publications and reports.** – initiated by Connie NG of City University of Hong Kong.

"Working together into the future with trust and friendship to advance sea turtle research and conservation in the China region."

China/USA Sea Turtle Workshop – Hawaii 2014

NOAA-CAFS-USGS
25-29 August 2014

-- Agenda --

The goal of the Hawaii 2014 China/USA Sea Turtle Workshop is to foster information exchange to better understand sea turtle ecological concepts and research techniques. The workshop will promote information sharing and participation of all participants with an overarching theme that we can and will all learn from each other. The workshop will offer a diverse array of activities and learning opportunities. Our agenda below summarizes the daily events. We intend this workshop to be dynamic and the timing and duration of each activity will be flexible. Your principal hosts, - Thierry Work, Jeffrey Seminoff, and George Balazs, - will sincerely do everything possible to meet the needs of our honored guests from the China region. We view this workshop as a step forward for future collaboration and the convening of a second workshop sometime during 2015.

本次中國/夏威夷海龜研討會在夏威夷舉辦，其目的為促進海龜生態觀念和研究技術等相關資訊的交流。本研討會涵蓋的議題包羅萬象，誠摯地邀請各位參與者不吝分享自己的經驗，讓我們有彼此學習的機會。本研討會安排的活動和課程很多樣化，以下列有每日行程的簡述，為了讓研討會的互動性更高，每項行程的起訖時間皆保有彈性空間。從中國地區遠道而來的各位貴賓如有任何需要，主辦人 Thierry Work, Jeffrey Seminoff 和 George Balazs 將竭盡所能為您服務。希望本研討會能成為未來合作的基石，並計劃來年的海龜研討會。

DAY 1 – 25 AUGUST 2014, MONDAY - Prince Jonah Kūhiō Kalaniana 'ole Office Building

0800 Pickup at Queen Kapiolani Hotel. Workshop hosts will pick up participants and drive 20 minutes to Prince Jonah Kūhiō Kalaniana 'ole Office Building.

- Workshop participants please bring your passports for entry into the building.
- Attire: Casual Hawaii clothing

0830 Breakfast/tea/coffee at Prince Jonah Kūhiō Kalaniana 'ole Cafeteria

0915 Morning Session at Prince Jonah Kūhiō Kalaniana 'ole Office Building, Conference room 3-127

- Introduction of all Workshop Participants
- Welcome Statements by Workshop Co-Hosts
- Hawaiian Cultural Blessing by Denise Parker
- Group Photo

0945 Morning Presentations: Open forum for individual China region talks:

- Sea turtle conservation in Huidong, China – by He-Xiang GU and Zhong-rong XIA
- Migrating from Hawaii to Hainan to breed F2 generation of sea turtle conservationists in China – by Frederick YEH
- Educating locals and fishermen while rescuing and releasing sea turtles in Hainan, China – by Lili FU
- Rehabilitation center of sea turtle at National Museum of Marine Biology and Aquarium – by Tsung-Hsien LI
- Sea turtle status and conservation in China - by Yamin WANG
- Research and conservation work in Taiwan – by Robert LO
- Conservation biology of globally endangered sea turtles in Hong Kong and South China – by Margaret MURPHY
- Transprovincial marine biodiversity conservation - a case in the waters between Fujian and Guangdong Province, China – by Wenhua LIU

~1200-1300 Lunch at nearby food court

1300-1330 Tour of United States Geological Survey – Honolulu Field Station research facility led by Thierry Work and Associates.

1330 Afternoon Presentations at Conference room 3-127.

- Sea turtle life history: a brief overview and recent advances – by Jeffrey Seminoff
- Methods used to investigate wildlife diseases – by Thierry Work
- Sea turtle diseases and health issues – by Thierry Work
- Sea turtle foraging ecology: key concepts and research techniques – by Jeffrey Seminoff
- Necropsies – The inside and outside of a sea turtle: Introduction and overview – by Thierry Work

1615 Overview – Plan for Day 2 - by George Balazs

1630 Adjourn for Day 1, Drive back to Queen Kapiolani Hotel

DAY 2 – 26 AUGUST 2014, TUESDAY - Halawa Valley Necropsy Facility

0800 Pickup at Queen Kapiolani Hotel. Workshop hosts will pick up participants and drive 25 minutes to Halawa Valley to the State of Hawaii/USGS-Thierry Work Necropsy Facility.

- Workshop participants please take breakfast on your own prior to hotel pickup.
- Attire: old clothes, clothing you might get dirty in, with covered shoes

0845 Necropsy Orientation including Safe Practices - by Thierry Work

0900 Review and demonstration of flipper/PIT tagging, carapace measuring and DNA skin sampling – by George Balazs.

- Group participation with questions and answers
- Assisted by USGS Bob Raymeyer, JIMAR Denise Parker and NOAA Shandell Brunson

0915 Demonstration of esophageal lavage techniques for foraging ecology research – by Jeffrey Seminoff

- Group participation with questions and answers
- Assisted by USGS Bob Raymeyer, JIMAR Denise Parker and NOAA Shandell Brunson

0930 Demonstration of sea turtle necropsies - by Thierry Work

- Group participation with questions and answers
- Assisted by USGS Bob Raymeyer, JIMAR Denise Parker and NOAA Shandell Brunson
- Dr. Work will necropsy and teach techniques using up to three (3) fresh dead turtles.

~1200-1315 Lunch at nearby Stadium Mall restaurant

1315 Lavage and Necropsy Practice

- Hands-on activity for all participants
- Three (3) participants per fresh-dead turtle

1600 Cleanup from necropsy and lavage activities

1630 Depart Halawa Facility for Queen Kapiolani Hotel.

DAY 3 – 27 AUGUST 2014, WEDNESDAY – All day Field Study at Kailua Bay – Private shore-front estate

0730 Pickup at Queen Kapiolani Hotel.

- Workshop participants please take breakfast on your own prior to hotel pickup.
- Bring: Beach attire, towel, hat, sunscreen, shoes to get wet, change of clothes, mask snorkel fins- going into the water is Optional with two choices- walking wading on rock reef flat, or snorkeling, if swimming skills are sufficient for safety.
- We will be working from private Scherman Family Estate, a grassy, shaded shoreline setting with toilet/washroom availability.

0800 We will visit the scenic Pali overlook on the way to Kailua Bay.

0845 We will stop at a store for participants to purchase drinks and food for lunch at the Scherman Estate.

0915-1600 Live capture of juvenile green turtles in near-shore foraging habitat

- Participants will set up and take down all gear
- We will capture turtles in the wild by hand-snorkel, scoop net, or tangle net.
- All work will be from shore – we will not be in a boat.

- We will demonstrate lavage, tagging, and health assessments
- We will examine algae growing in shallow foraging habitat
- Dr. Robert Morris, Clinical Veterinarian, will meet participants and give a short talk.

1615 Depart Kailua Bay for Queen Kapiolani Hotel.

DAY 4 – 28 AUGUST 2014, THURSDAY – East-West Center Jefferson Hall, Kaniela Room at the University of Hawaii at Manoa

0800 Pickup at Queen Kapiolani Hotel. Workshop hosts will pick up participants and drive 10 minutes to the University of Hawaii at Manoa.

- Workshop participants will take breakfast together at Gateway Cafeteria near our Jefferson Hall Conference Room.
- Attire: Casual Hawaii clothing

0900 Workshop review of Day 1, 2, and 3 activities: What have we accomplished so far? – led by George Balazs, Thierry Work and Jeffrey Seminoff.

- Open forum for participants - round table discussion and presentations showing team in action during previous days
- Discussion of next steps and outcomes with the goal of formulating a list of recommendations, actions, and activities for the next 12-18 months.

1030 Special Presentations

- Hawaiian green turtles: 50-year history of changing ecology and restoration – by George Balazs
- Leatherback telemetry and research in the Pacific Ocean– by Jeffrey Seminoff

1200-1315 Lunch at Manoa Gardens at the University of Hawaii

1315 Group Photo by Chinese Guardian Stone Lions in front of Jefferson Hall

1330 Special Presentations

- Overview of hawksbill turtles in the Hawaiian Islands – by Kyle Van Houtan
- By-catch reduction technology in coastal fisheries: NOAA-PIFSC Research and Development – by John Wang
- Introduction and mapping of ARGOS data – by Denise Parker

1430 Participants visit to Sea Life Park at Makapu'u Point, Waimanalo

- Drive along the Kaiwi Coastline with stop at picturesque Blow Hole overlook and Sandy Beach.

1600 Special Tour for participants of Sea Life Park including Turtle Breeding Program - hosted by Curator Jeffrey Pawloski

1730 Depart Sea Life Park for Workshop participant dinner at Harbor Village Cuisine, a Chinese restaurant – hosted by George Balazs, Thierry Work, and Jeffrey Seminoff

1930 Return to Queen Kapiolani Hotel.

DAY 5 – 29 AUGUST 2014, FRIDAY – Guided Eco-Tour of green turtle basking and foraging sites on Oahu's North Shore

0800 Pickup at Queen Kapiolani Hotel. Workshop hosts will pick up participants and drive across the middle of Oahu to the North Shore

- Workshop participants please take breakfast on your own prior to pickup.
- Attire: Casual Hawaii clothing
- We will visit Laniakea and Haleiwa Ali'i turtle basking beaches.
- We will visit a private home on the Anahulu River - habitat used by green turtles

1200 Lunch on Oahu's North Shore.

- Awarding of Workshop Certificates of Achievement and special souvenirs to participants

1500 Return to Queen Kapiolani Hotel

Farewell and Aloha

Traditional Hawaiian Greeting (Oli Aloha)

Hawaiian:

Onaona i ka hala me ka lehua
He hale lehua nō ia na ka noe
'O ka'u no ia e ano'i nei,
E li'a nei ho'i o ka hiki mai
A hiki mai nō 'okou,
A hiki pū no me ke aloha
Aloha ē, aloha ē, aloha ē

English:

Fragrant with pandanus and lehua
A lehua dwelling surrounded by mist
My fond memories are these
And my hope is to see you again
And then you appear
Arriving together with love
Greetings, welcome, love



CHINA



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Nickname: The Gathering Place
 Flower: Ilima
 Color: Yellow
 State Capital & County Seat: Honolulu
 Area: 594 sq. miles
 Length: 44 miles
 Width: 30 miles
 Population: 836,231
 Highest Point: Kaala Peak (4,003 ft.)
 Coastline: 112 miles

Diving times from Waikiki to:
 Arizona Memorial: 30 minutes
 Downtown Honolulu: 15 minutes
 Hanauma Bay: 30 minutes
 Honolulu International Airport: 30 minutes
 Sea Life Park: 40 minutes
 Polynesian Cultural Center: 1 hour 15 minutes
 Waimea Falls Park: 1 hour



REPORT

China/USA Sea Turtle Workshop in Hawaii 2014

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An invitational China/USA Sea Turtle Workshop was convened in Honolulu August 25-29, 2014 under the auspices of the Bilateral Living Marine Resources (LMR) initiative of NMFS Headquarters and the Chinese Academy of Fishery Science in Beijing. The official hosts and organizers for the workshop were George Balazs (PIFSC), Jeffery Seminoff (SWFSC) and Thierry Work (USGS) assisted by PIFSC John Wang, Shandell Brunson, and JIMAR Denise Parker. The workshop had been formally in the development and planning stages since April 2012, as the result of a LMR-sponsored sea turtle meeting in Shanghai attended by Balazs, Seminoff, and Wang. Nine Chinese region scientists participated in the workshop using non-USA travel funds. Areas represented included Hainan Island, Hong Kong, Taiwan, and Mainland China. Four of the participants were university professors, three were government biologists, one was a graduate student, and one represented an NGO involved in research.

Workshop activities over the five days consisted of mixtures of seminar presentations, conversation exchanging information to build bridges and formulate ideas for future actions, including collaborative research, and actual hands-on field work with Hawaiian sea turtles. Two of the several 'ways forward' agreed upon for cooperation consisted of a follow-up workshop in mainland China in 2015, and reciprocal China/USA visiting scientists for 1-2 month periods.

The workshop was deemed highly successful by all involved. The Chinese scientists were harmoniously engaged under the LMR initiative. Cross-cultural goodwill and cooperation were advanced between China and the USA, using sea turtle science and ecology as the means of person-to-person diplomacy.



Figure 1. Group photo taken on 25 August of participants of the China/USA Sea Turtle Workshop in Hawaii 2014. Left to Right Back Row: M. Murphy, W-C Huang, J. Seminoff, T-H Li, Y. Wang, R. Lo, S. Brunson, J. Wang, W. Liu. Left to Right Front Row: D. Parker, G. Balazs, F. Yeh, H-X Gu, L. Fu, Z-R Xia, T. Work.

SEATURTLE.ORG Directory Library Resources Support Affiliates
Sea Turtle Document Library
China Collection
Compiled by Connie Ka-yan NG

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SWOT Volume VI

Hawaii's Unique Turtles By Nicolas J. PILCHER

Chinese translation By Connie Ka-yan NG

活在夏威夷群島獨一無二的綠海龜

綠海龜幾乎出現在地球上每片海洋，在世界各地的沙灘產卵，並遷移往返距離甚遠的覓食地和繁殖地。當中一群綠海龜只棲息於夏威夷群島這個家。

全球其中一個最長期的海龜監測和保育項目記錄這個獨特綠海龜群落的興衰及當中種種的人類威脅。此綠海龜群落受潛水者、衝浪者、浮潛人士、遊客和當地人愛戴。在最近幾十年，科學家們發現這綠海龜族群屬於一個相對較小、原生特有的群落，只在夏威夷群島出生、長大並繁殖產卵。像在這個熱帶天堂的人類鄰居一樣，這些原生綠海龜會爬上沙灘，享受溫暖的夏威夷陽光。海龜曬太陽的景象只在全球某幾個地方找到，其中最著名的一定是夏威夷。

所有在夏威夷群島產卵和覓食的綠海龜均屬於同一世系：牠們與其他太平洋綠海龜種群沒有任何遺傳基因的聯繫（雖然偶爾有些在東太平洋產卵的綠海龜會到夏威夷水域）。這事實使夏威夷綠海龜種群獨一無二，科學家們稱此群落為特有種群段 (Distinct Population Segment) 或區域管理單元 (Regional Management Unit)。夏威夷群島處於浩瀚的太平洋中，這地理上的隔離也說明夏威夷綠海龜沒有與其他太平洋群落混合，在保育上容易受到更大的風險。因此，任何夏威夷綠海龜種群的衰落亦大有可能不會被從其他地區遷移的群落所補償。

雖然沒有可靠的方法知道種群於幾百年前的狀況（主要是因為當時沒有人記錄綠海龜的數量），夏威夷綠海龜（當地人稱之為 Honu）在原生文化擔當著重要的地位。牠們 honu 出現在神話和岩石畫，並被尊貴視為個人圖騰和守護神（稱 aumakua）。古代夏威夷人通過皇室控制的狩獵活動 (ali'i) 獵殺綠海龜，海龜肉是重要的食物資源。龜殼和骨頭被用作工具、魚鈎和裝飾品。綠海龜在夏威夷文化的多種用途和重要角色表明當時應有相當數量的綠海龜。

在 1600 年代，西方文化的來臨增加對海龜肉的需求。尤其是過去的兩個世紀內，為滿足海龜湯的市場，在夏威夷群島有大量綠海龜被獵殺。現存法例禁止狩獵、傷害或騷擾海龜或人工圈養牠們（除有許可證外）。違規可能導致巨額罰款和監禁，因此綠海龜數量在近幾十年內呈上升趨勢。目前，超過 90% 的產卵活動集中在夏威夷群島的 French Frigate Shoals (FFS)。FFS 是美國魚類及野生動物服務 (U.S. Fish and Wildlife Service) 設立的國家野生動物保護區 (National Wildlife Refuge)，而綠海龜在 FFS 的珊瑚礁及沿岸生境棲息覓食。

除了被獵殺，夏威夷海龜亦面對一種神秘疾病的威脅。該疾病首次發現於 1930 年代，及後於 1980 和 90 年代處於高峰期，使綠海龜嚴重衰弱及死亡。受感染的綠海龜的軟組織部分（主要是皮膚）會長出由 fibropapilloma 病毒（或 FP）引起的葉形腫瘤。此外，腫瘤也出現在鱗片(scale)與盾甲(scute)之間、口腔內、眼睛上，甚至在內臟的表面。然而，持續不斷的研究和監測工作帶來令人鼓舞的展望：綠海龜，尤其是體型較大的，可以從該疾病康復過來，而在夏威夷的 FP 感染個案數字亦正在下降。因此，即使現時仍發現有些綠海龜有 FP 症狀，該疾病對整體種群的威脅已大幅減少。


儘管現時夏威夷群島的綠海龜數量仍比受西方影響前低，由於對海龜及其生境的法例保護、傳統狩獵的停止及 FP 疾病的緩解，綠海龜數目持續增長。夏威夷綠海龜種群的復原是其中一則罕見成功保育例子，其關鍵基於社會關注和法例保護。夏威夷綠海龜正面臨充滿希望的未來，並成為一回人類對自然帶來正負面影響的反思。

(完)

A photograph of two Hawaiian monk seals resting on a black sand beach. The seals are in the foreground, with one slightly behind the other. The ocean waves are breaking in the background under a blue sky with some clouds. The text 'Hawaii's Unique Turtles' is overlaid on the upper part of the image.

Hawaii's Unique Turtles

By NICOLAS J. PILCHER



Although green turtles swim in nearly all the world's oceans, nest on sandy beaches around the globe, and migrate vast distances between feeding and breeding areas, a curious population of green turtles calls only the Hawaiian Islands home.

One of the longest-running monitoring and conservation projects in the world for sea turtles has tracked the fall and rise of this distinctive population amid an array of human threats. In recent decades, scientists have discovered that these abundant green turtles—favorites of divers, surfers, snorkelers, tourists, and locals—belong to a relatively small, endemic, and growing population whose members are born, grow up, and reproduce solely within the Hawaiian Islands. Like other residents in this tropical paradise, the native greens exhibit the distinctly human behavior of hauling out on beaches to soak up the warm Hawaiian sun.

All the green turtles that nest and feed throughout the Hawaiian archipelago belong to the same lineage: they do not share any substantial genetic links with other green turtle populations in the Pacific Ocean, although occasionally some turtles from the East Pacific stock that nest in the American Pacific are recorded in Hawaiian waters. This fact makes Hawaiian greens a unique subset of the greater global population or, as scientists like to call them, a Distinct Population Segment or Regional Management Unit. The geographic isolation of the Hawaiian greens means that they are at greater conservation risk because they do not intermix with other stocks in the Pacific; thus, any population declines are unlikely to be compensated for by immigration from other populations.

Although there is no reliable way to know what the population might have looked like hundreds of years ago (mostly because no one thought of counting them back then), Hawaiian turtles, or *Honu* as they are known to native Hawaiians, have been an important part of Hawaiian culture. They feature prominently in mythology and petroglyphs and are revered as personal totems and guardians, or *aumakua*. Ancient Hawaiian people hunted turtles, and turtle meat was an important food resource managed through *aliʻI*, or royalty-controlled hunting programs. Turtle shells and bones were used as tools, fishing hooks, and personal ornaments.

Green sea turtles exhibit basking behavior at only a few sites worldwide, the most well-known of which is in Hawaii, U.S.A. Although it is possible that turtles haul out of the ocean to avoid predators, it's more likely that this behavior allows them to rest and get some sun. © TIM FITZHARRIS / MINDEN PICTURES / NATIONAL GEOGRAPHIC STOCK

The multiple uses and important roles that *Honu* have played in Hawaiian culture suggest that there were substantial numbers in the past.

The arrival of western culture in the 1600s brought increased exploitation of sea turtles. Particularly during the past two centuries, large numbers of green turtles were harvested throughout the island chain, often destined for the soup pot. Laws now prohibit hunting, injuring, or harassing sea turtles or holding them in captivity (at least without a special permit). Violations can bring hefty fines and prison time, and as a result, the population has been on the rise in recent decades. Presently, more than 90 percent of nesting activity in the archipelago occurs within French Frigate Shoals, a National Wildlife Refuge administered by the U.S. Fish and Wildlife Service, while foraging turtles can be found in coral reef and coastal habitats throughout the islands.

In addition to harvest, the Hawaiian greens came under the negative effect of a mysterious disease that first appeared in the 1930s, that peaked in the 1980s and 1990s, and that severely debilitated and often killed turtles. Infected turtles developed lobe-shaped tumors caused by the fibropapilloma virus, or FP, which afflicts most soft portions of the body—primarily on the skin. Moreover, it can also appear between scales and scutes, in the mouth, on the eyes, and even on internal organs. However, continuous research and monitoring efforts have provided an encouraging outlook: Turtles, particularly larger ones, can recover from FP infections, and the frequency of FP infections in Hawaii is declining. Therefore, although turtles today still exhibit FP symptoms, the severity of the threat to the overall population has substantially diminished.

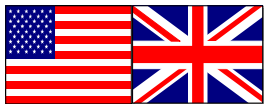
Although abundance is probably lower than before western-origin impacts, the Hawaiian green turtle population is growing consistently—thanks to a combination of legal protection for turtles and their habitats, the virtual cessation of traditional hunting, and the remission of FP. The Hawaiian green is one of those rare examples of recovery where societal concern and legal governance came together and reversed the declining trend. Today, Hawaiian green turtles face a promising future, and serve as an example of the might of human effects on nature—both negative and positive. ■

SEA TURTLE NECROPSY MANUAL FOR BIOLOGISTS IN REMOTE REFUGES

BY

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CENTER
HAWAII FIELD STATION



2000

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INTRODUCTION

This manual is for biologists in remote refuges who have little to no background in necropsy techniques. It is intended to assist you in recognition of turtle organs and in procurement of appropriate samples for pathologic and other laboratory assays. The manual will probably be most useful in situations when wildlife disease specialists are unable to assist in sample collection due to remoteness or inaccessibility of the site.

WHY DO A NECROPSY?

A necropsy is one of the basic tools used to determine why an animal dies. It involves the thorough examination of a carcass externally and internally for any indications of causes of death (lesions). A good necropsy involves careful observations of lesions or abnormalities and procurement, labeling, and storage of tissue samples. Laboratory tests on properly preserved tissues allow wildlife disease specialists to systematically evaluate potential causes of wildlife mortality.

The better job you do with the field necropsy, the better the chance that wildlife disease specialists can determine what killed the animal. As such, select the freshest carcasses and, if at all possible, avoid freezing and thawing the carcass prior to necropsy as this can compromise microscopic appearance of tissues. When doing a necropsy, be observant and record your findings. If possible, take close up photos of interesting findings.

Generally, findings will deviate from normal either in shape, color, consistency, number or size. For example, a normal green turtle liver would be firm with rounded borders and be homogenous dark purple-brown. An abnormality in the liver may manifest itself in the form of abnormal coloration (spots or blotches), consistency (too soft, too hard), size (excessively large or small), or shape (lumps, bumps or scars). Obviously, many of these interpretations require knowing what a "normal" organ looks like. Although this is best learned by doing many necropsies, reference to photographs (as in this manual), will aid the novice in assessing whether or not an organ appears normal.

MATERIALS NEEDED FOR A NECROPSY

Scissors	Toothed forceps	Rubber gloves
Plastic bags	Jars	Indelible marker
Knife	Cutting board	Water
Scalpel handle	Bone saw	10% formalin
Scalpel blade	Labels	Aluminum foil
Pencil	Paper	

Additional items that would be helpful include a scale, tape measure, calipers and camera. Several types of plastic bags should be available including larger bags for carcass disposal and smaller bags (whirlpaks) to store individual organs.

The back of the manual has a recipe for making buffered formalin (a tissue preservative). It is unlikely that you will have the resources to make buffered formalin on site. An adequate substitute is mixing 15 parts of 37% formaldehyde with 85 parts seawater. **Placing organs directly in 37% formaldehyde or unbuffered formalin is unacceptable.**

SAFETY

Doing a necropsy on a turtle is hard work. Be careful with knives and sharp bones and follow proper hygiene. Wear gloves and do not eat or drink while dissecting a carcass. Remember, you don't know whether you're dealing with a disease transmissible to humans.

When working with formalin, **ALWAYS** use gloves, work in a well ventilated area and wash hands after all necropsies. All formalin containers should be clearly labeled.

LABELS

All labels should be written in indelible ink (e.g. sharpie) or pencil...**no ball point pens**. Minimum information on the label should include location of collection, date and unique specimen ID. To avoid confusion, abbreviate the month (i.e. MAR 5, 2000 not 3/5/00).

TAKING SAMPLES FOR LABORATORY ANALYSIS:

FORMALIN FIXATION (2 steps)

(Formalin fixation allows pathologists to examine tissues under the microscope and diagnose disease)

1) To ensure that enough formalin is present in the jar to allow for adequate fixation of the tissue, the ratio of formalin to tissue should be a minimum of 2 parts formalin to 1 part tissue by volume (Fig. 1). All tissues from one animal can go into one jar. **Label the jar.**

2) Ensure that tissue section is not too large to allow for adequate fixation. A piece of tissue should generally be no thicker than ~0.5 cm (1/4 in). If there is a lesion, make sure to take a portion of "normal tissue" adjacent to the lesion (Fig. 2). This is crucial as many diseases are diagnosed based on microscopic examination of the "margin" between a normal and abnormal tissue.

It is advisable to change the formalin once (say after 24 hours of fixation). This will result in better fixation and staining for microscopic analysis. Used formalin should be disposed of appropriately. **Tissues in formalin should never be frozen.**

FREEZING (1 step)

(Frozen organs can be used to isolate microorganisms or detect poisons)

1) Collect a good amount (20-30 g or 1/4 to 1/2 cup) of tissue, place in a small plastic bag, seal and label the bag using an indelible marker. In some cases, you may be asked to wrap the sample in aluminum foil prior to placement in a plastic bag. Collect tissue for freezing as early as possible during the necropsy to avoid contamination by gut contents, dirt, etc. Tissues should be placed in a freezer (-20C or colder is best) and kept frozen when shipped to the laboratory.

LID

JAR WITH
FORMALIN AND
TISSUES
(1 part tissues
to 2 parts
formalin)



FIGURE 1

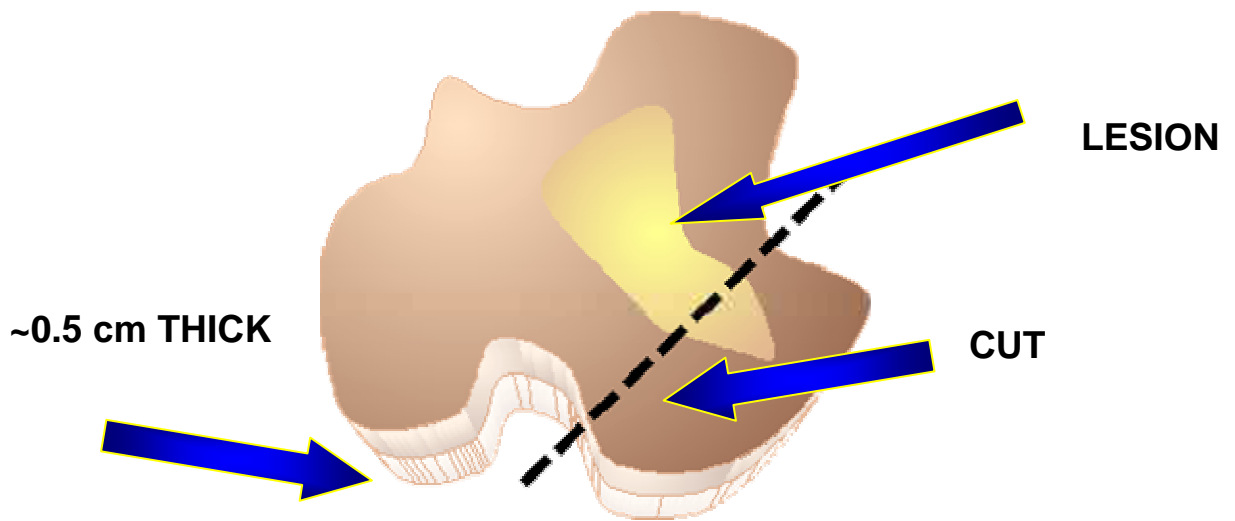


FIGURE 2

HOW THIS MANUAL IS ORGANIZED

The rest of this manual will show you, step by step, how to dissect a sea turtle carcass using a green turtle as our "model" turtle. All turtles have the organs shown here although size and shape may vary from one species to the next. The photos in this manual should give you a good general idea of what "normal" organs look like.

This manual is composed of a series of photos with a facing page of text. There are two sorts of icons throughout the text, scissors and glasses.



Sections with scissors icons are in bold type and describe the nuts and bolts of taking a carcass apart.



Sections with glasses describe organs and their appearance. Commonly encountered abnormalities appear in italics. Use these sections as a reference for taking notes on appearance of different organs. As you go through a necropsy, it would be wise to take samples of organs as you encounter them. There is a table at the end summarizing what organs you should have taken in formalin when you are done with your necropsy (P.22) and a blank necropsy form (P. 24).

NOTE: This manual assumes you are doing a necropsy on a fresh dead turtle (either you saw it die or it died within the last 12-24 hours). Appearance of some organs (and their diagnostic value) will change dramatically depending on stage of decomposition so it is best to limit your efforts to the freshest specimens available.

Finally, remember **TO NOTE AND RECORD EVERYTHING THAT YOU SEE**. There can **NEVER** be too much detail.

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EXTERNAL EXAM



Examine the turtle externally from head to tail for any abnormalities or damage. You may want to take photos of any abnormality or for ID confirmation. When examining the carcass, check the following :



-Plastron, carapace, and skin: Are the scutes peeling? Are there fresh or old wounds? Are there barnacles (numbers?), leeches (Numbers?), algae (Percent cover?) or other epibionts growing on the carapace? Are there abnormal growths on the skin?.

-Body condition: Turtles in good condition will usually have a nice rounded plastron. In severely emaciated turtles, the plastron is dished in and concave.

-Measurements (see page 10)

-Cloaca: Is there anything protruding out of the cloaca?

-Nostrils: Is there anything (blood or mucus) leaking out of them?

-Mouth: the mucus membranes in the mouth should be homogenous. Colors like red splotches or yellow-brown raised areas are abnormal. Note any ulcers, cuts, plaques, growths, hooks, fishing line, blood, spots or lumps in the oral cavity. Also note the presence of algae in the mouth and collect samples in a separate small vial of formalin.

-Eyes: Are the eyes collapsed, cloudy, weepy? Are there abnormal warty growths around the eyes?

-Flippers: Are there abnormal warty growths on the skin? Are the flippers intact? Is there fishing line wound around or hook embedded in the flipper?

-Any other abnormality: lumps, bumps or exudates in unusual places.

MEASURING TURTLES

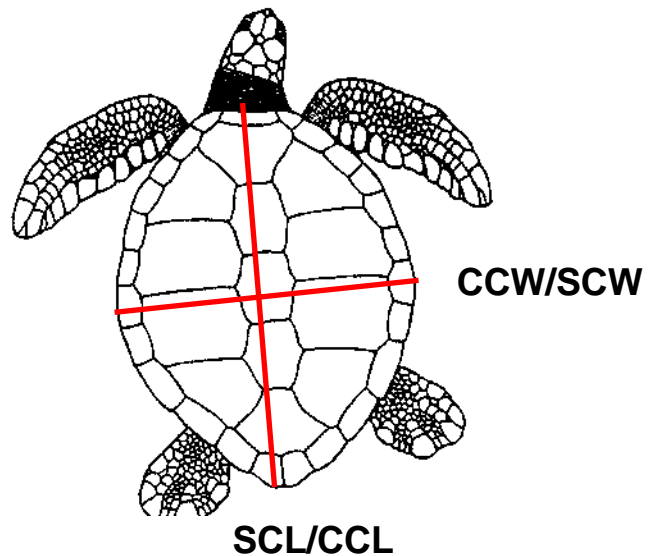
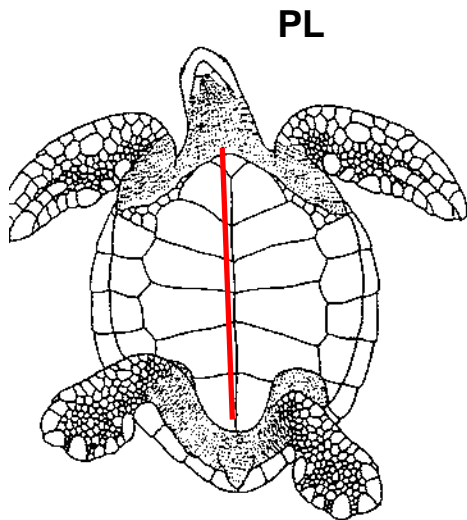
To properly measure a turtle, you need both a tape measure and calipers, and all measurements should be in centimeters. While many measurements can be taken on a turtle, a select few are critical. The diagram below illustrates how these should be taken.

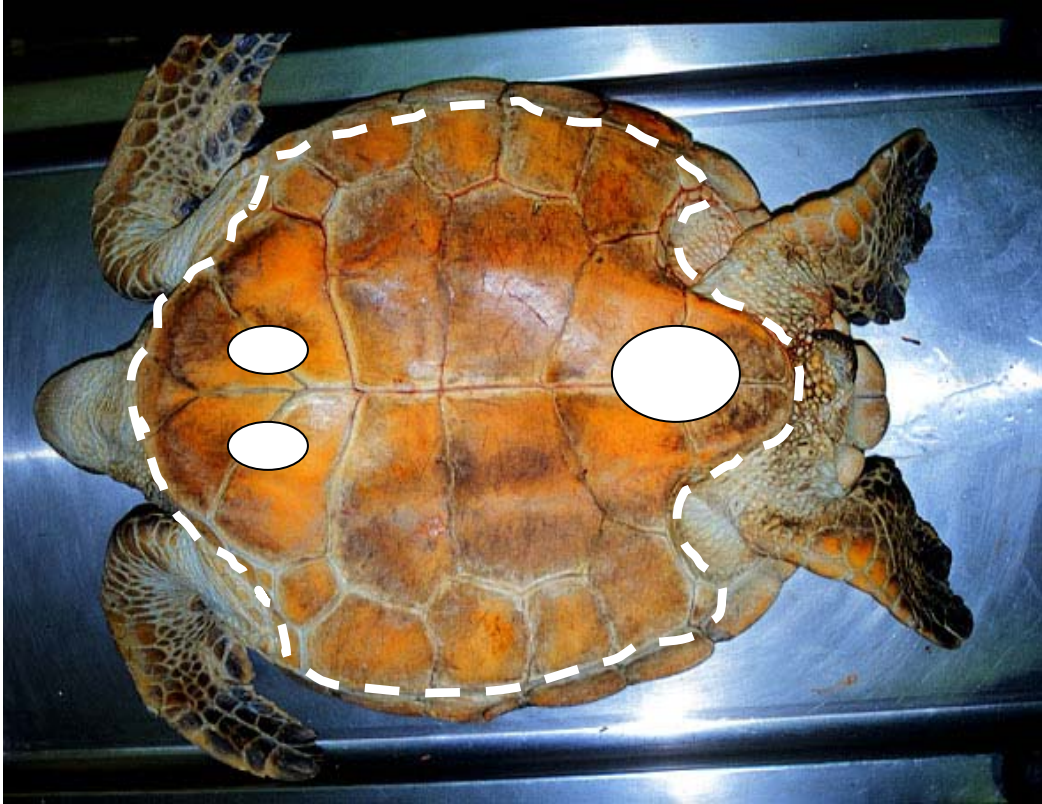
Calipers:

Straight carapace length (SCL)
 Straight carapace width (SCW)
 Plastron length (PL)

Tape measure

Curved carapace length (CCL)
 Curved carapace width (CCW)





Prior to starting the necropsy, Place the turtle on its back. Using a sharp knife or scalpel blade, cut along the dotted line (see photo). If you cut between the carapace and plastron, you should encounter only cartilage which can be cut with a knife. Pull the plastron away from the carapace as you cut skeletal muscle attachments.

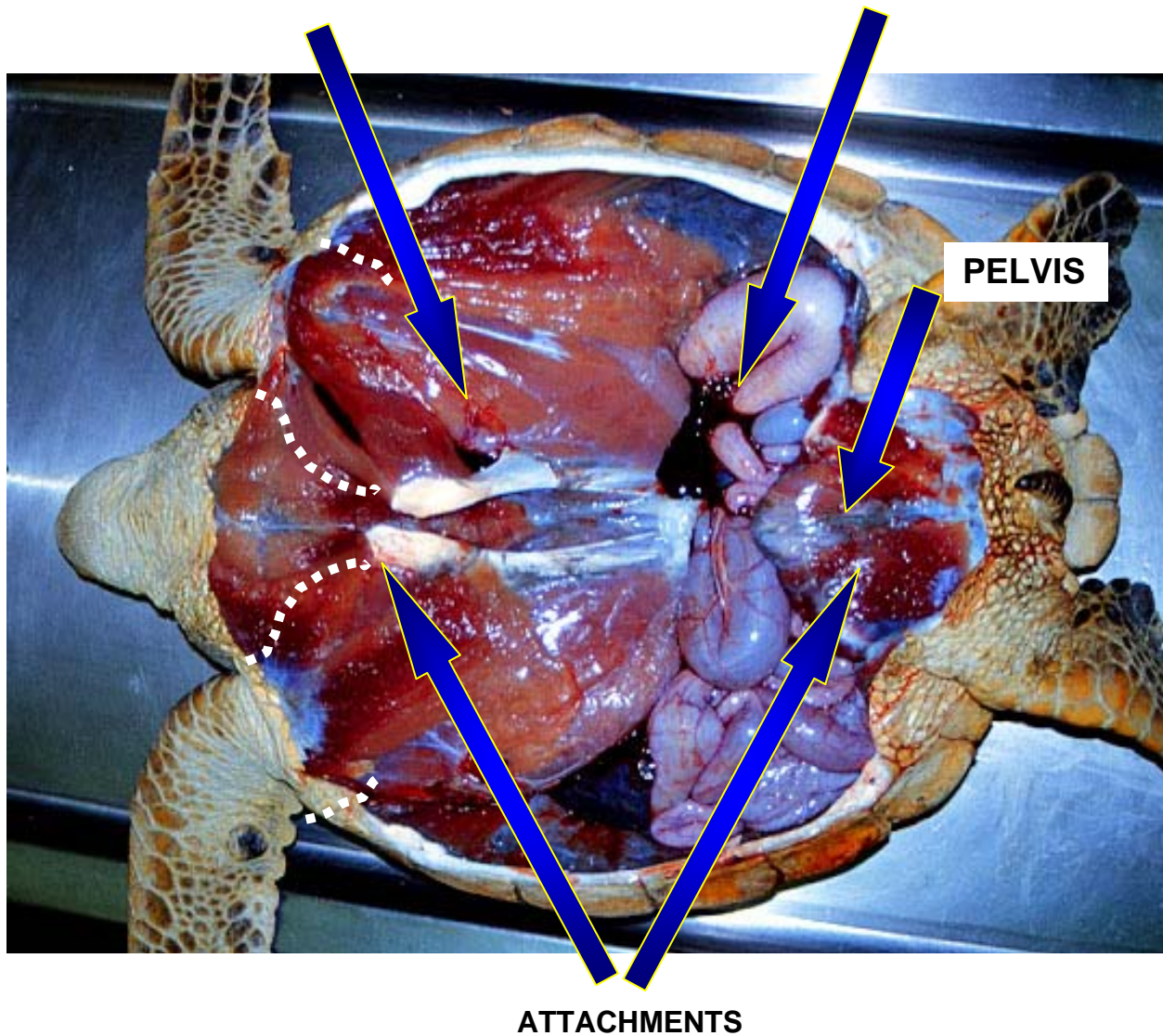
The white circles indicate areas where clavicles (forward) or pelvis (rear) attach to the plastron. These can be detached from the plastron by cutting the ligaments and cartilage close to the inside of the plastron.



Beware that in very emaciated turtles, dagger-sharp bones may protrude through the plastron.

PECTORAL MUSCLE

INTESTINE



Once the plastron is removed, you should see the pectoral muscles and intestines. Note that the pectoral muscles (the “engine” of the turtle) take up a large proportion of the body (coelomic) cavity. Note also attachments of clavicles and pelvis to plastron.

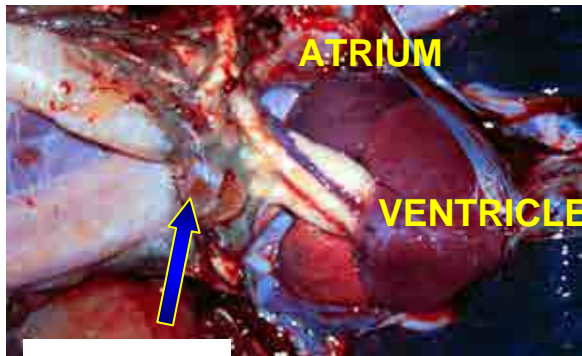


Remove the pectoral muscles and foreflippers by cutting the muscle around the flippers (dotted line, p 12) and twisting the flippers off from their attachment to the carapace. This will reveal the organs in the following page.



INTESTINES: These should be smooth and homogenous tan. In most turtles, they will be filled with algae (note it if not).

HEART: Unlike us, turtles have a three chambered heart (one ventricle, 2 atria).



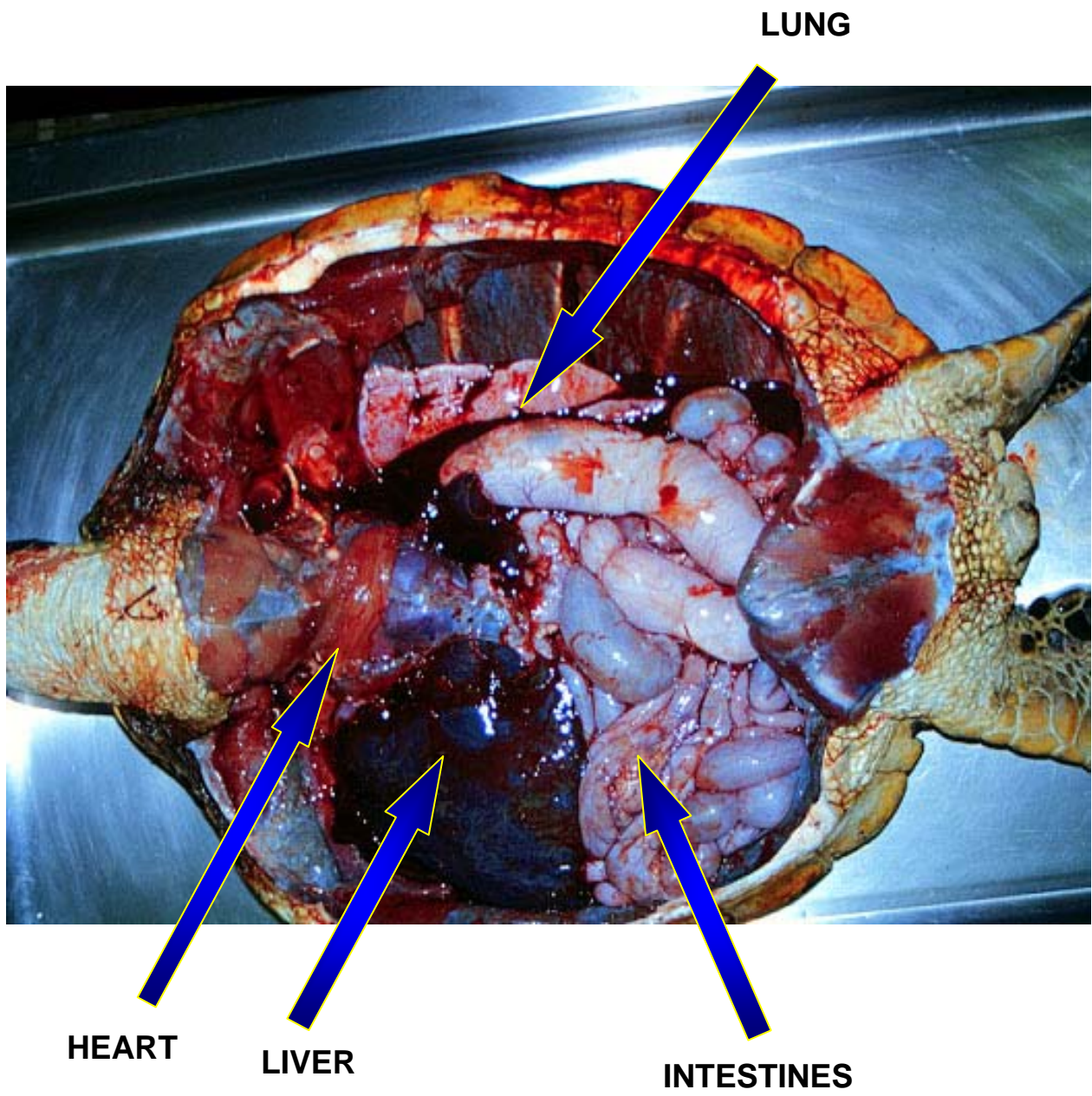
The picture below shows the heart in situ with white arteries leading out of the ventricle. If you're careful, you can see the **thyroid** gland near the heart. This is a translucent spherical organ. The heart should be firm and homogenous dark red-pink and the external and internal surface should be smooth.

Abnormalities: Tumors, pale spots on the heart muscle, a rough sandpaper like surface on the exterior or interior, semiliquid fat on the heart.



LIVER: This organ should be firm, smooth with rounded borders and homogenous dark purple brown. Like us, turtles have a bile-filled gallbladder. The consistency and texture of the liver should be homogenous on cut surface.

Abnormalities: Nodules, tumors, rough exterior, shriveled surface, discoloration in the form of spots or large pale areas.





Remove the heart and liver. You should also cut the skin on the midline of the ventral neck to expose the esophagus and trachea (windpipe). Once you have done this, your turtle should look something like the facing picture.



TRACHEA: It should be tan and have a smooth lumen on cut surface. The trachea bifurcates into two bronchi.

Abnormalities: Froth, blood, or food material in lumen, rough surface in lumen, tumors in opening of trachea (glottis).



ESOPHAGUS: The soft tubular organ next to the trachea. The lumen mucosa contains numerous large spines...this is normal in a sea turtle (Photo). This contrast with the smooth surface of the stomach mucosa. The external and internal surface should be smooth and tan.



Abnormalities: Hooks or fishing line embedded in mucosa.



CROP: Note in the facing photo how the esophagus dives between the bronchi and becomes the crop. The crop is a pouch that stores food before it goes into the stomach. Crops in green turtles are found only in individuals from Hawaii.

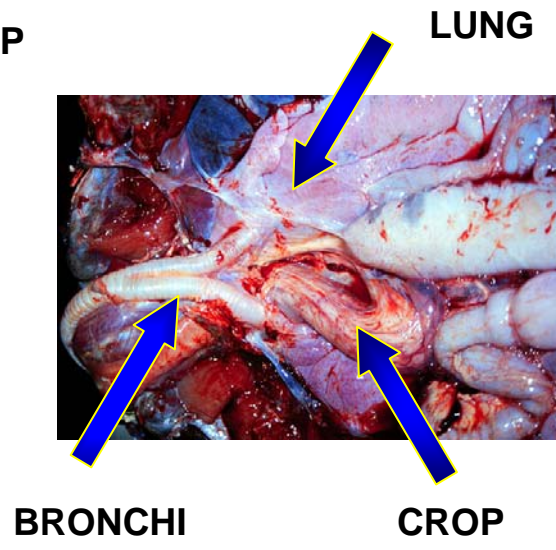
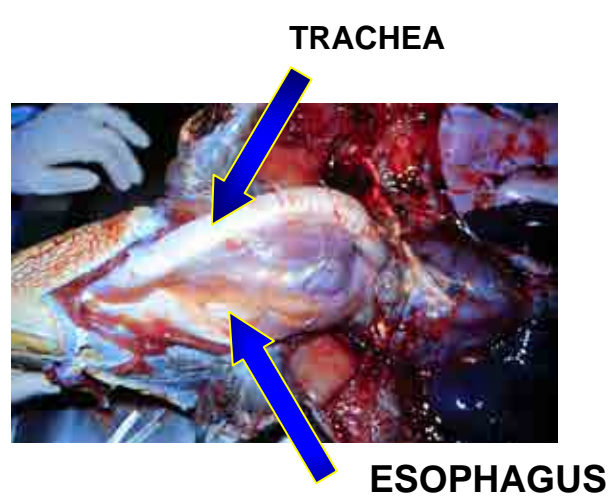
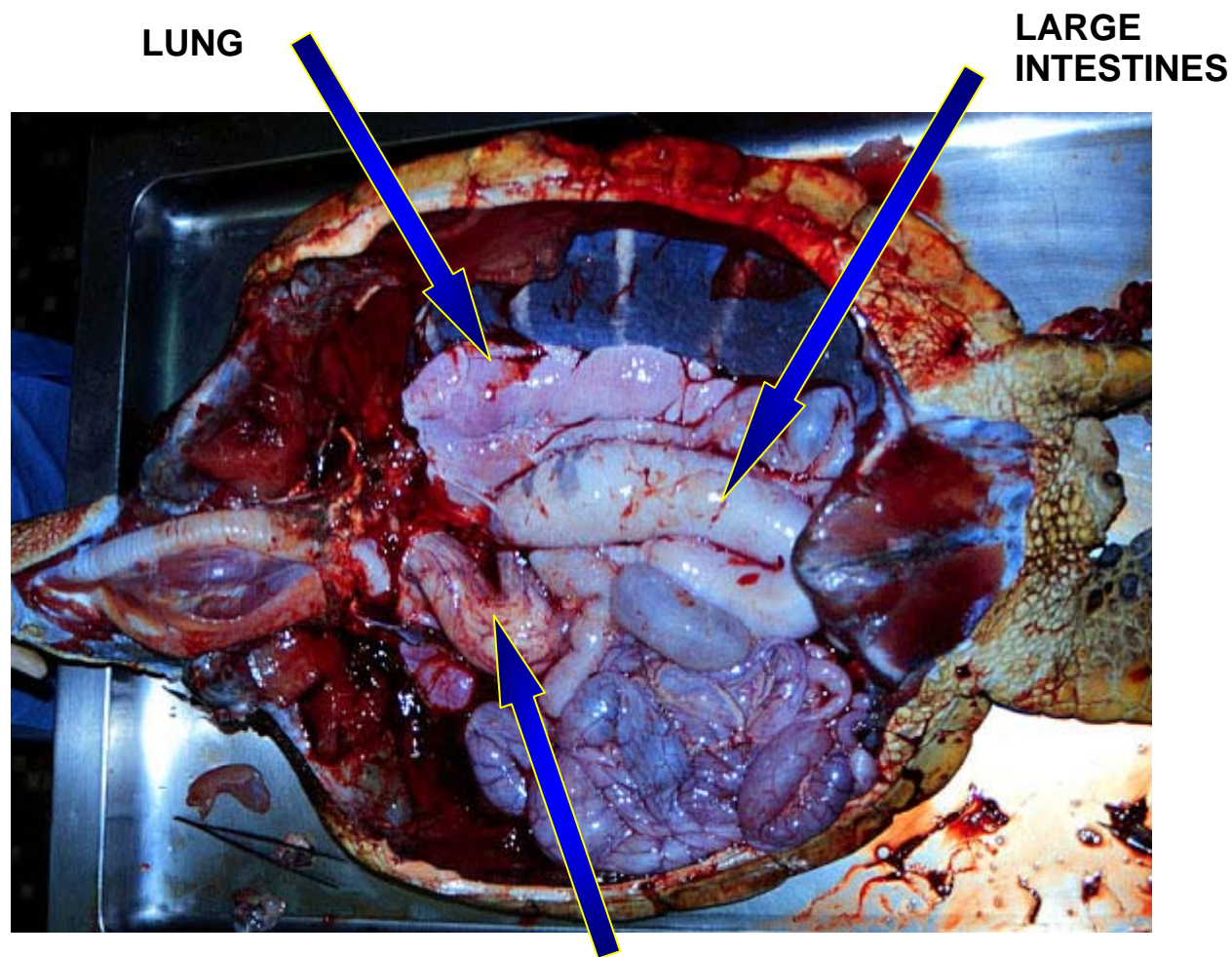
It should be full of algae and the mucosa should be tan.

Abnormalities: Rough sandpaper-like consistency of mucosa, hooks or fishing line embedded in mucosa.

This is a good time to take samples for food habit studies



LUNG and LARGE INTESTINES: Those two organs should also now be visible. Normally, the large intestines contain large amounts of macerated vegetation (for herbivorous turtles)





GASTROINTESTINAL TRACT: This is the entire gastrointestinal tract laid out from mouth to cloaca. The following organs should be visible:

HYOID APPARATUS-This is the same as your Adam's apple. Underneath (dorsally) is the glottis which is the opening to the trachea.

ESOPHAGUS: mentioned earlier

CROP: Mentioned earlier

STOMACH: The mucosa will generally have smooth ridges.



SMALL INTESTINES: Note that they have been cut and the contents emptied. Hence the reason they look smaller than they did in previous pictures. In many turtles, the mucosa will have a "honeycomb" like appearance.



LARGE INTESTINES: Note that they also have been emptied of contents. The mucosa of the large intestines is smooth and tan.

Abnormalities in GI tract: Hooks, fishing line, or other foreign matter in lumen, blood in mucosa, rough sandpaper consistency in mucosa, parasites (worms).



SPLEEN: This round organ is part of the turtles immune system. It is usually firm, smooth and tan-pink and closely associated with the pancreas. The spleen can be found near the small intestines as they exist from the stomach.

Abnormalities: Tumors, pale areas, dark spots, sandpaper-like surface.

HYOID

ESOPHAGUS

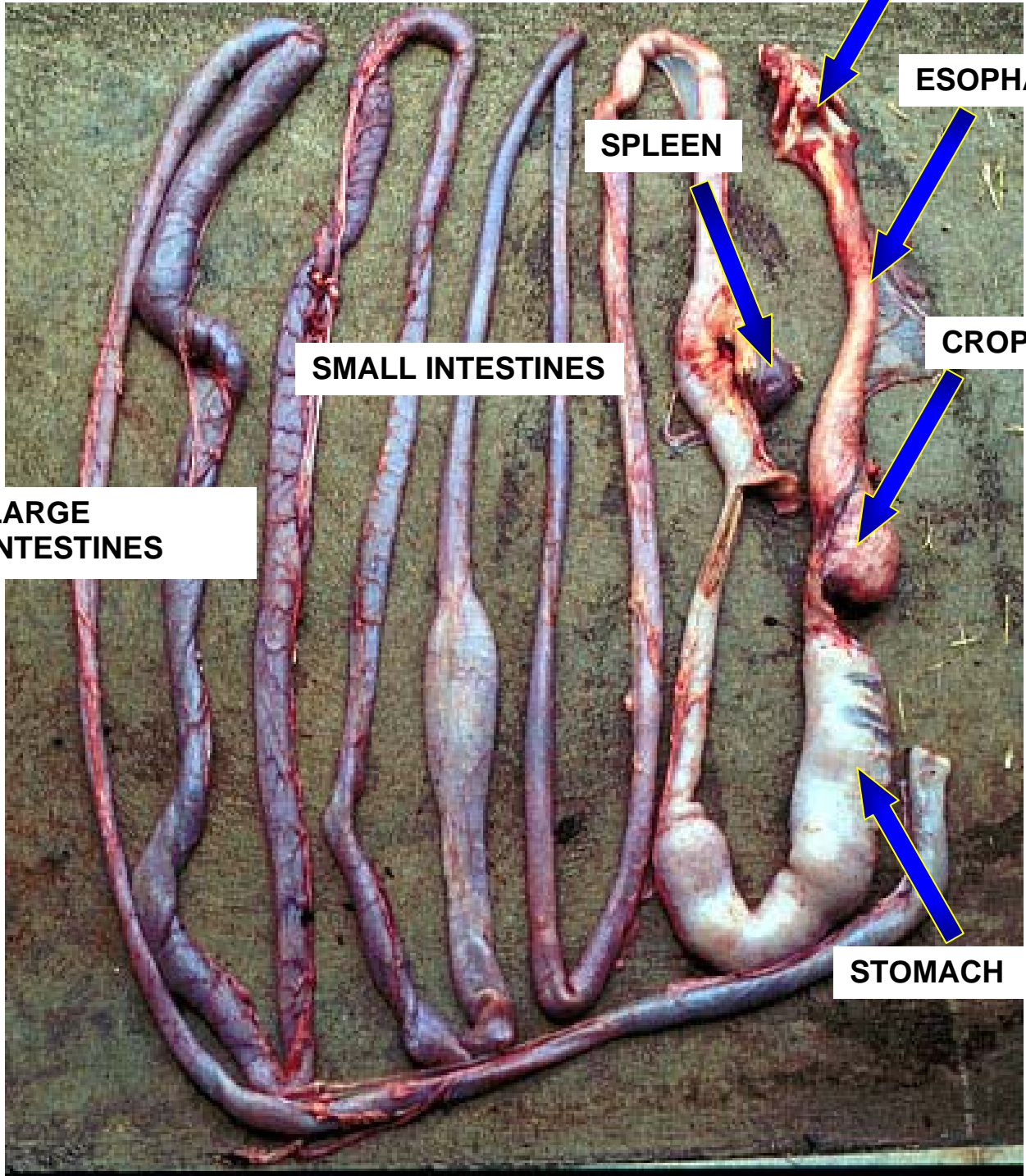
SPLEEN

CROP

SMALL INTESTINES

LARGE
INTESTINES

STOMACH





Once you have removed the gastrointestinal tract, you should be left with the something like the facing picture:



LUNGS: These should have a spongy consistency and be smooth and homogenous pink on surface and cut surface.

Abnormalities: tumors, nodules, large areas of discoloration, dense consistency, large amounts of frothy blood exiting from small airways on cut surface.



DESCENDING AORTA: this is like your aorta except that turtles have two of them. They should be smooth and homogenous tan to white.

Abnormalities: Nodules, rough sandpaper like surface on lumen.



BLADDER: This is a thick walled sack that holds urine and that is located just above the large intestines and under the pelvis. The bladder may contain clear yellow urine that may have white flecks (mucus) in it. The mucosa will appear wrinkled and may have dark pigmentation.

Abnormalities: Parasites in lumen.



KIDNEYS: These are hidden under the carapace just behind the lungs and under the pelvis (outlined in yellow in photo). They should be firm and homogenous brown with a rough nodular surface.

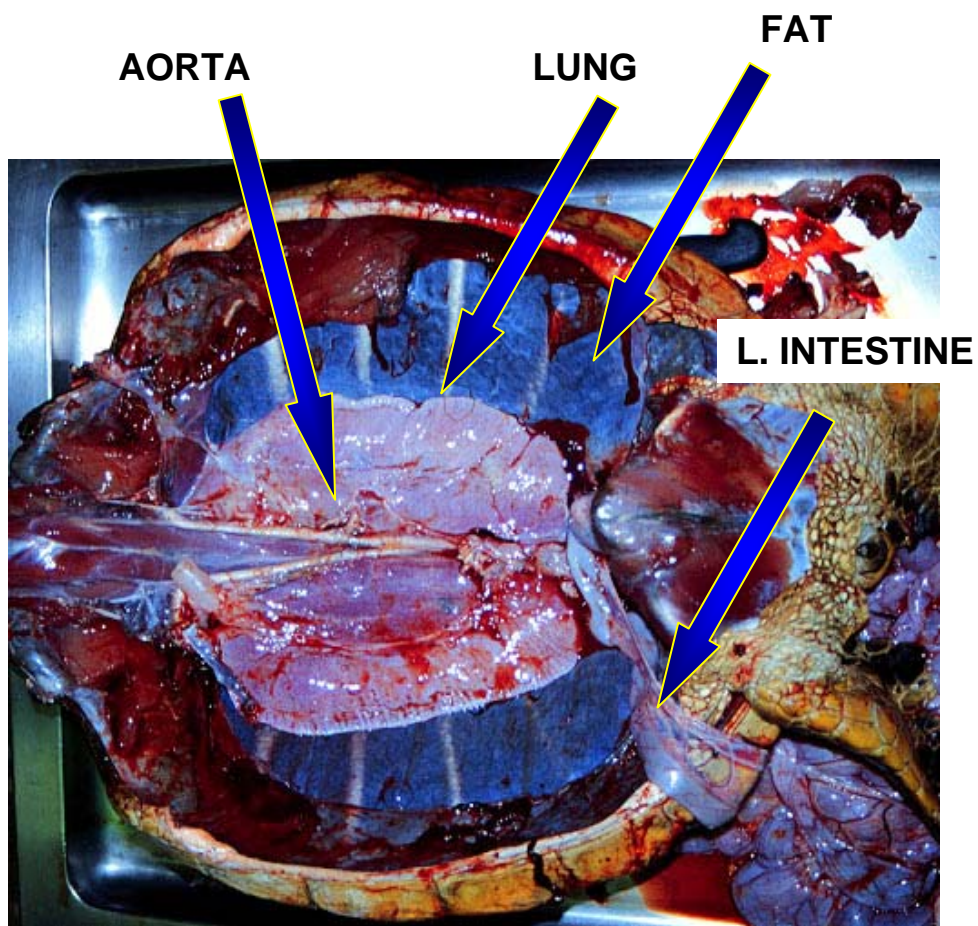
Abnormalities: Large pale round firm white tumors.



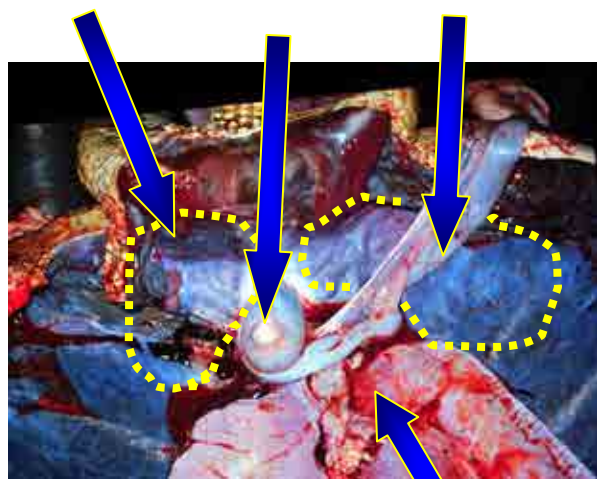
GONADS: These lie just above the kidneys. Adults are easy to differentiate, however, in immatures, this is harder. **MALES** have a smooth tan gonad. **FEMALE** gonads look like small clusters of grapes.



FAT: This is also a good time to check fat reserves. Turtles in good body condition have a nice layer of firm green to tan fat under the shell. This fat is jelly-like and watery in thin turtles.



KIDNEY BLADDER L. INTESTINE

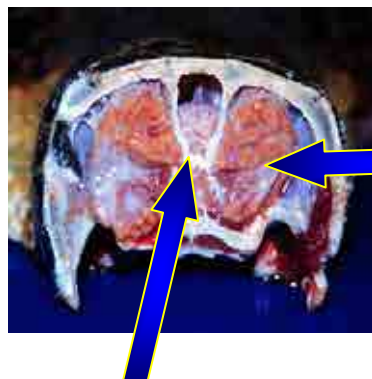


GONADS



LUNG

LUNG



SALT GLAND

BRAIN



The last part of the necropsy involves removing the brain and salt gland. To do so, simply saw the skull on the dotted line and you will see something like the picture above.



BRAIN: This organ should be firm and homogenous tan. You will note that it is rather small relative to the size of the head.



SALT GLAND: These are important for osmoregulation. They are firm, lobular and pink to light brown.

Abnormalities: Pale spots, gritty textures.

WHEN YOU ARE DONE WITH A NECROPSY, ENSURE THAT:

- 1) All samples and jars are labeled with a unique number referring to the animal along with date of collection. All organs collected (see checklist p. 23).
- 2) All information on the necropsy record sheet is complete (see form pp. 24).
- 3) All "dirty" gloves and other material are disposed of properly. Any sharp items such as scalpel blades and needles should be disposed of in a rigid, sealable puncture proof container (i.e. a plastic jug).
- 4) Any used formalin is to be stored in sealed containers labeled with the following words: "WARNING: FORMALDEHYDE: HANDLE WITH GLOVES" and disposed of appropriately.

TWO RECIPES FOR 10% FORMALIN

RECIPE 1

If you have graduated cylinders and scale mix the following:

Na ₂ HPO ₄ (Sodium phosphate dibasic)	6.5 g
NaH ₂ PO ₄ .H ₂ O (Sodium phosphate monobasic)	4.0 g
Fresh water	900 ml
37% formaldehyde	100 ml

RECIPE 2

If you have no scales or measuring apparatus

37% formaldehyde	150 ml or 15 parts
Seawater	850 ml or 85 parts

WHEN PREPARING FORMALIN, USE GLOVES AND WORK IN A WELL VENTILATED AREA

CHECKLIST OF ORGANS YOU SHOULD HAVE TAKEN IN FORMALIN

Plain numbers indicate where organ is mentioned in text.

Bold numbers indicate figures in which organs are labeled.

ORGAN	PAGE(S)
TRACHEA	15, 16
ESOPHAGUS	15, 16, 17, 18
MUSCLE	12
LIVER	13, 14
HEART	13, 14
THYROID	13
CROP	15, 16, 17, 18
SPLEEN	17, 18
STOMACH	17, 18
SMALL INTESTINE	17, 18
LARGE INTESTINES	15, 16, 17, 18, 20
LUNGS	15, 16, 17, 18, 20
KIDNEYS/BLADDER	19, 20
GONADS	19, 20
BRAIN/SALT GLAND	21

NECROPSY DATA SHEET
(all measurements are metric)

Species _____ ID# _____ Date Collected _____ Date _____
Necropsied _____
mmddyy mmddyy
Collection site _____

History: _____ SEX (M/F/U) AGE: _____

Weight _____ (kg) SCL ____ CCL _____ PL ____ SCW ____ CCW _____

(Circle most appropriate term(s)). Add notes as you see fit.

BODY CONDITION: (Good, fair, poor)

POST-MORTEM CONDITION: (Fresh dead, ~1 day old, >2 days old)

EXTERNAL EXAM (Skin, carapace, eyes, nostrils, cloaca)

MUSCULOSKELETAL: (*Pectoral muscle atrophy*-None, moderate, severe; *Fat*: firm, soft, jelly-like; *body cavity*-Lots of fluid, small amounts of fluid, no fluid)

LIVER: (*Surface*: smooth, rough, granular, wrinkled; *Consistency*: firm, friable; *Color*: homogenous/mottled, red, black, brown, purple, tan, yellow.)

HEART: (*Surface*: smooth, rough, granular, wrinkled; *Consistency*: firm, friable; *Color*: homogenous/mottled, red, black, brown, purple, tan, yellow.)

LUNGS: (*Surface*: smooth, rough, granular, wrinkled; *Consistency*: firm, friable, spongy; *Color*: homogenous/mottled, pink, tan, yellow, grey, red, brown; **TRACHEA-Lumen**: smooth, rough; *Color*: homogenous/Mottled, tan, white, red, brown, green, pink.)

SPLEEN: (*Surface*: smooth, rough, granular, wrinkled; *Consistency*: firm, soft; *Color*: homogenous/mottled, brown, tan, red, black, brown, yellow.)

KIDNEY: (*Surface*: smooth, rough; *Consistency*: firm, soft; *Color*: homogenous/mottled, brown, tan, red, black, brown, yellow.)

GONAD: (*Surface*: smooth, rough; *Consistency*: firm, friable; *Color*: homogenous/mottled, red, black, brown, purple, tan, yellow.)

THYROID: (*Surface:* smooth, rough; *Consistency:* firm, friable; *Color:* Translucent/mottled, orange, red, tan, yellow.)

ORAL: (*Mucosa:* smooth, rough, granular, pitted; *Color:* homogenous/mottled, pink, tan, yellow, grey, red, brown); Contents?

ESOPHAGUS-*Mucosa:* smooth, rough; *Color:* homogenous/Mottled, tan, white, red, pink.) Contents?

CROP: (*Mucosa:* smooth, rough; *Color:* homogenous/mottled, tan, red, yellow, black, brown,) Contents?

STOMACH: (*Mucosa:* smooth, rough; *Color:* homogenous/mottled, tan, red, yellow, black, brown) Contents?

SMALL INTESTINES: (*Mucosa:* smooth, rough; *Color:* homogenous/mottled, tan, red, yellow, black, brown) Contents?

LARGE INTESTINES: (*Mucosa:* smooth, rough; *Color:* homogenous/mottled, tan, red, yellow, black, brown) Contents

BLADDER: (*Mucosa:* smooth, rough; *Color:* homogenous/mottled, tan, red, yellow, black, brown) Contents

BRAIN: (*Surface:* smooth, rough; *Consistency:* firm, friable; *Color:* Homogenous/mottled, tan, red)

SALT GLAND: (*Surface:* smooth, rough; *Consistency:* firm, friable; *Color:* Homogenous/mottled, brown, pink, tan, orange)

SAMPLES:

Formalin: _____

Frozen: _____

Other: _____

海龜解剖手冊

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夏威夷研究站



2014

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前言

這本手冊是專門為海龜解剖生手或是解剖經驗較少的生物學者與科學家設計的，它能協助你辨識海龜的器官並採集適合的檢體，以供病理學和相關的實驗室檢驗。若野生動物專科醫生無法到場協助採樣時，這本手冊將會是你的最佳幫手！

為何要解剖呢？

解剖是評估動物死因的基本工具之一，徹底檢查屍體的外部 and 內部，尋找與死因有關的任何線索（病灶），包括仔細檢查病灶或異常處，並採集病材、標記和保存組織樣本，才能算是一個好的解剖。正確地保存組織樣本有利於野生動物疾病專科醫師進行後續評估，以瞭解野生動物致死的可能原因。

解剖工作做得越好，正確判定死因的機會越高，所以須盡可能地選擇最新鮮的屍體，在解剖前避免屍體的冷凍和解凍，因為這會影響組織切片在顯微鏡底下的觀察結果，使判讀效果打折。進行解剖時，要仔細觀察屍體狀況並詳細記錄下你的觀察結果和發現，可能的話，你也可以替有趣的發現拍攝一些特寫近照，並放大尺度從腹部和背部將整體一併拍攝下來。

一般而言，要先將臟器的異常處指認出來，像是異常的形狀、顏色、硬度、數量和大小。例如，正常的綠蠓龜（*Chelonia mydas*）肝臟為邊緣圓滑、組織結實，並呈現均勻的暗紫褐色。而異常的肝臟可能會顯現不正常的顏色（斑點或汙點）、硬度（太軟或太硬）、大小（過大或過小）或形狀（凸起、腫塊或疤痕）。顯然，必須先知道「正常」的臟器看起來是如何，才能夠指認出臟器的異常處。最好的學習方式是透過解剖經驗的累積，並參考本手冊中的照片，這些都有助於初學者評估臟器的正常與否。

解剖所需材料

剪刀	有齒鑷子	橡膠手套
塑膠袋	加蓋罐子	耐水性筆
刀子	砧板	淡水
手術刀柄	骨鋸	10%福馬林
手術刀片	標籤	鋁箔紙
鉛筆	紙	

其他工具如秤、捲尺、卡尺（尺規）和照相機，也會很有幫助。此外，需要用到多種規格的塑膠袋：大型袋子用於盛裝屍體以便於丟棄，小袋子（封口袋）則可以用來保存個別器官。

福馬林緩衝溶液可用來保存組織，本手冊後段有列出福馬林緩衝溶液的配製方法。在此先提供一個替代配方：以15份的37%甲醛溶液混合85份的海水。請勿直接把臟器浸入37%的甲醛溶液或非中性福馬林。

安全議題

解剖海龜是件艱苦的工作，要留意刀子和尖銳骨頭，並謹守衛生規範。過程中務必穿戴手套且不可飲食。記住，你不知道是否會面臨人畜共通傳染病。

使用福馬林時，**全程皆需穿戴手套**，在通風良好處操作並且在屍體解剖全程結束後洗手。所有裝有福馬林的容器都需清楚標示為「危險液體」。

標示

所有標籤皆需以不褪色墨水（例如：奇異筆）或鉛筆書寫，**避免使用鋼珠筆**。標籤上的資料至少要包括採樣地點、採樣日期和單一不重覆的編號。為避免混淆，日期縮寫的方式也要留意（例如西元2000年3月5日，英文縮寫應該標示為 MAR 5, 2000，而非3/5/00）。

【譯註：中文日期格式多為年/月/日，最好保持標示的一致性，以利資料整理和回溯。】

實驗室檢驗用病材的採集

福馬林固定（2個步驟）

福馬林固定的樣本可供病理醫師在顯微鏡下檢查組織切片（鏡檢）並進行疾病診斷：

1) 確保罐子內有足量的福馬林能用來固定組織，福馬林和組織的比例最少要2份的福馬林比1份的組織（圖1）。同一隻個體的組織可以放置於同一個罐子內，並於罐子上標記清楚。

2) 確認每塊組織的尺寸，不可大於0.5公分（1/4英吋），才能使其充分固定。如果有發現病灶，病灶處旁邊的正常組織要一同取下（圖2），因為許多疾病的診斷，都要針對正常組織和異常組織間的「病變帶」進行鏡檢。組織固定後，最好要再更換一次福馬林緩衝液（大約是在固定24小時後），這樣固定和染色的效果都會比較好，有助於後續的鏡檢，而用過的福馬林必須妥善丟棄。經福馬林固定過的組織不可冷凍。

冷凍組織（勿放入福馬林緩衝液中）（1個步驟）

冷凍臟器可用來分離微生物和毒物含量分析：

1) 收集足量的組織（20-30 公克或 1/4-1/2 杯）並置放於適合大小的塑膠袋中將其密封，並在袋子上以奇異筆標示清楚。有些病例需先以鋁箔紙將組織包裝好再放入塑膠袋中。解剖時，應儘早收集需要冷凍保存的組織，避免受到腸內容物或塵土等的污染。收集好的組織樣本需放置於冰箱（-20°C，越低溫越好），並在寄送至實驗室的過程中保持冷凍狀態。



圖1. 福馬林和組織罐。(福馬林:組織=至少2:1)

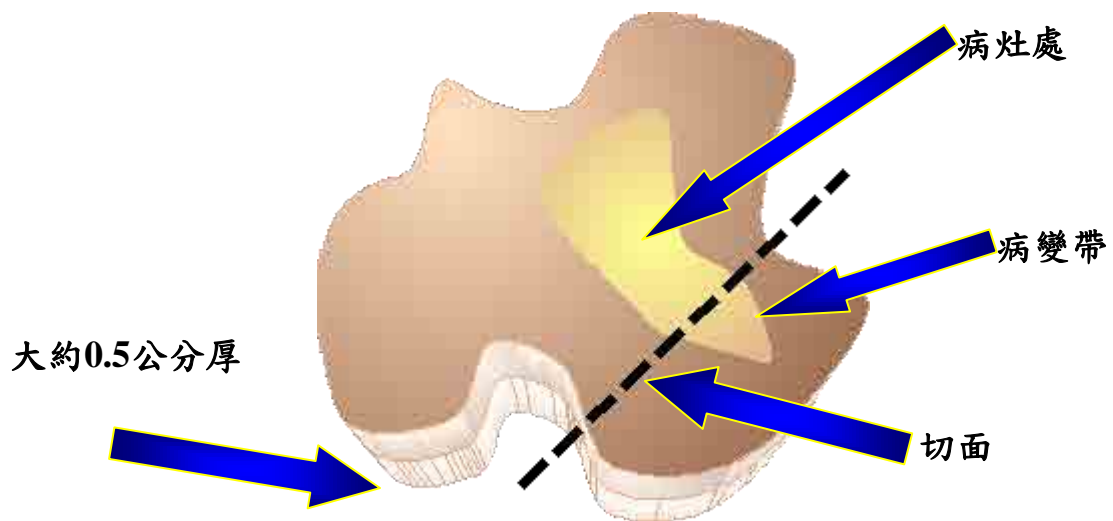


圖 2

手冊的使用說明

本手冊接下來將利用夏威夷的綠蠟龜當作「模特兒」，一步步地教你如何解剖海龜。手冊中提及的器官，除了綠蠟龜有，其他品種的海龜也都有。然而，器官的尺寸和型態在各品種間或許會有差異，但手冊中的照片仍能做為判斷何謂正常器官的依據。

本手冊由一系列的照片穿插正文而成，其中還包括兩個小插圖－剪刀和眼鏡，導引您貫穿全文。插圖功能如下：



剪刀：表示該段落是在敘述解剖屍體的方式，以“**粗體字**”標示。



眼鏡：有眼鏡插圖在前面的段落，主要是描述臟器和臟器的外觀，常見的異常狀況會以“*斜體字*”標示，請利用這些段落當作區別異常臟器的參考。除此之外，最好是一邊解剖一邊收集各個臟器的組織，第 23 頁附有需保存臟器清單，列出解剖完成後應該已經收集好且置於福馬林緩衝液中的所有臟器，而屍體解剖的空白表格在第 24 頁。

注意：本手冊假設你解剖的海龜為剛死亡（亦即你目擊海龜的死亡或是死亡時間在 12-24 小時內）。有些臟器的外觀和診斷價值會隨著腐敗程度的增加而有劇烈的變化，屍體腐敗地越嚴重，實驗診斷的價值就越低。

最後，記得將你看到的任何細節都記錄下來，細節永遠不嫌多！

外部檢查



檢查海龜的外觀，從頭部到尾部徹底找尋任何異常處或是傷口，並將異常處拍照記錄下來。你也可以用照片辨認海龜的身份並存檔記錄。進行屍體檢查時，依照下列項目檢查：



-腹甲、背甲和表皮：盾片是否有剝落？是否有舊傷口和新傷口？是否有藤壺（數量？）、吸蟲（數量？）、藻類（覆蓋百分比？）或其他的附生物在背甲/腹甲上？表皮上是否有異常增生？

-身體狀況：狀況良好的海龜通常腹甲較飽滿；若是極度瘦弱的海龜，腹甲則會往內凹陷。



綠蠟龜身體狀況的範例



- 測量（見第10頁）
- 泄殖腔：是否有突出物伸出泄殖腔？
- 鼻孔：是否有任何液體滲出？（如血液或黏液？）
- 口：口腔黏膜應該是平滑均勻的，若有紅斑或黃褐色的突起就是異常。須留意口腔中是否有潰瘍、切創傷、菌斑、增生、鈎子、魚線、出血、斑點或腫塊。此外，需留意口腔內有無藻類，若有，則採集部分樣本，以裝有福馬林緩衝液的小瓶子獨立保存。
- 眼：眼睛是否塌陷、混濁或流淚？是否有異常增生疣長在眼眶周圍？
- 鰭狀肢：表皮是否有異常增生疣？鰭狀肢是否完整？是否有魚線纏繞或魚鈎埋刺在鰭狀肢內？
- 任何其他異常：腫塊、突起或是不尋常處有滲出物？
- 留意背甲內側的體脂肪含量。健康的海龜會有大量棕綠色的脂肪（下圖左），然而狀況不好的海龜脂肪量很少，看起來水水的、顏色較深且有突出的肋骨（下圖右，箭頭處）。



測量海龜

為了能精確地測量海龜，你需要準備一個捲尺和一個卡尺，而且所有的計量單位都是公分。我們能從海龜身上測得許多數值，下方圖例為必須測量的數值。

卡尺：

背甲直線長 (SCL)

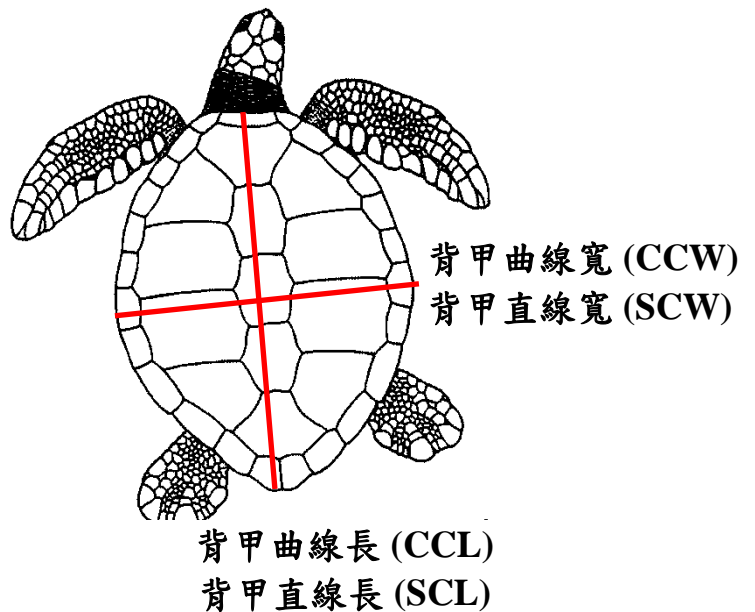
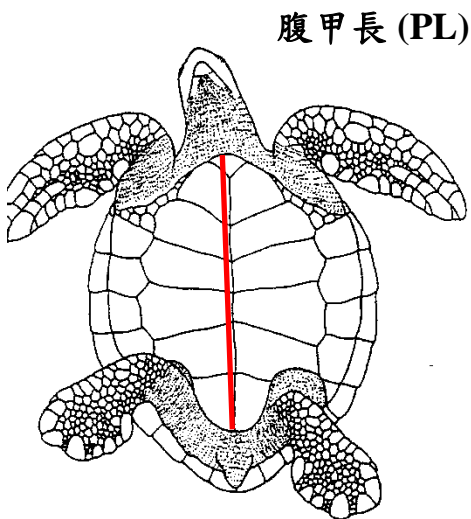
背甲直線寬 (SCW)

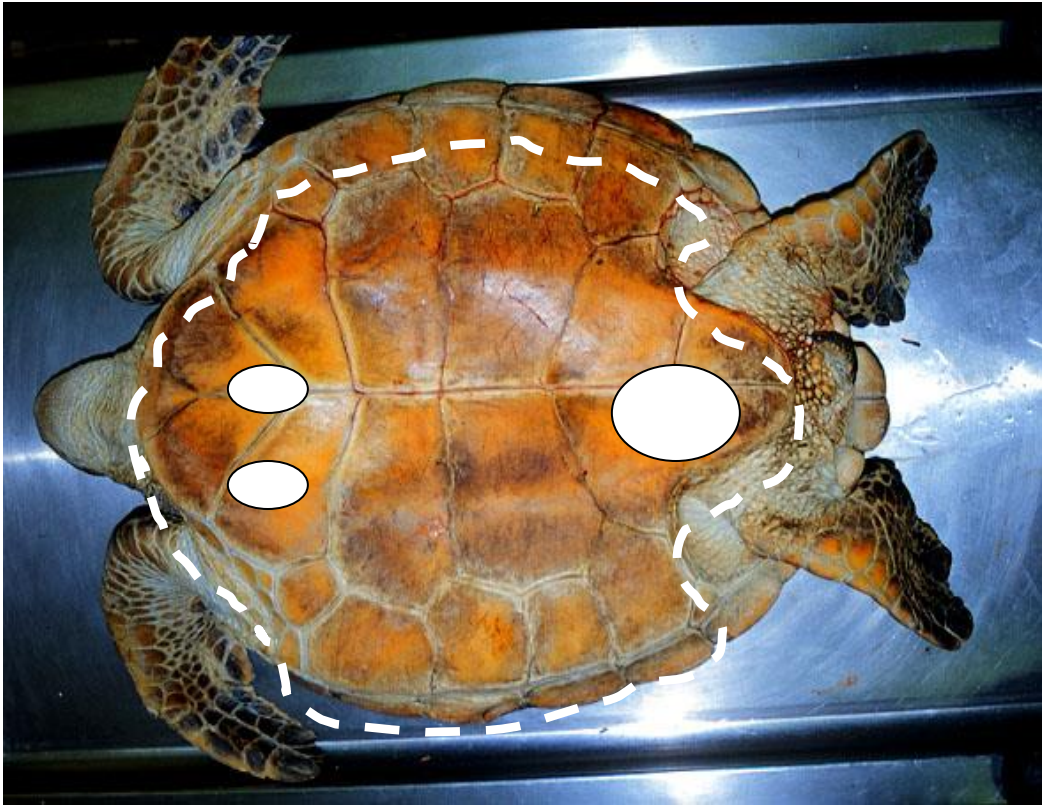
腹甲長 (PL)

捲尺：

背甲曲線長 (CCL)

背甲曲線寬 (CCW)



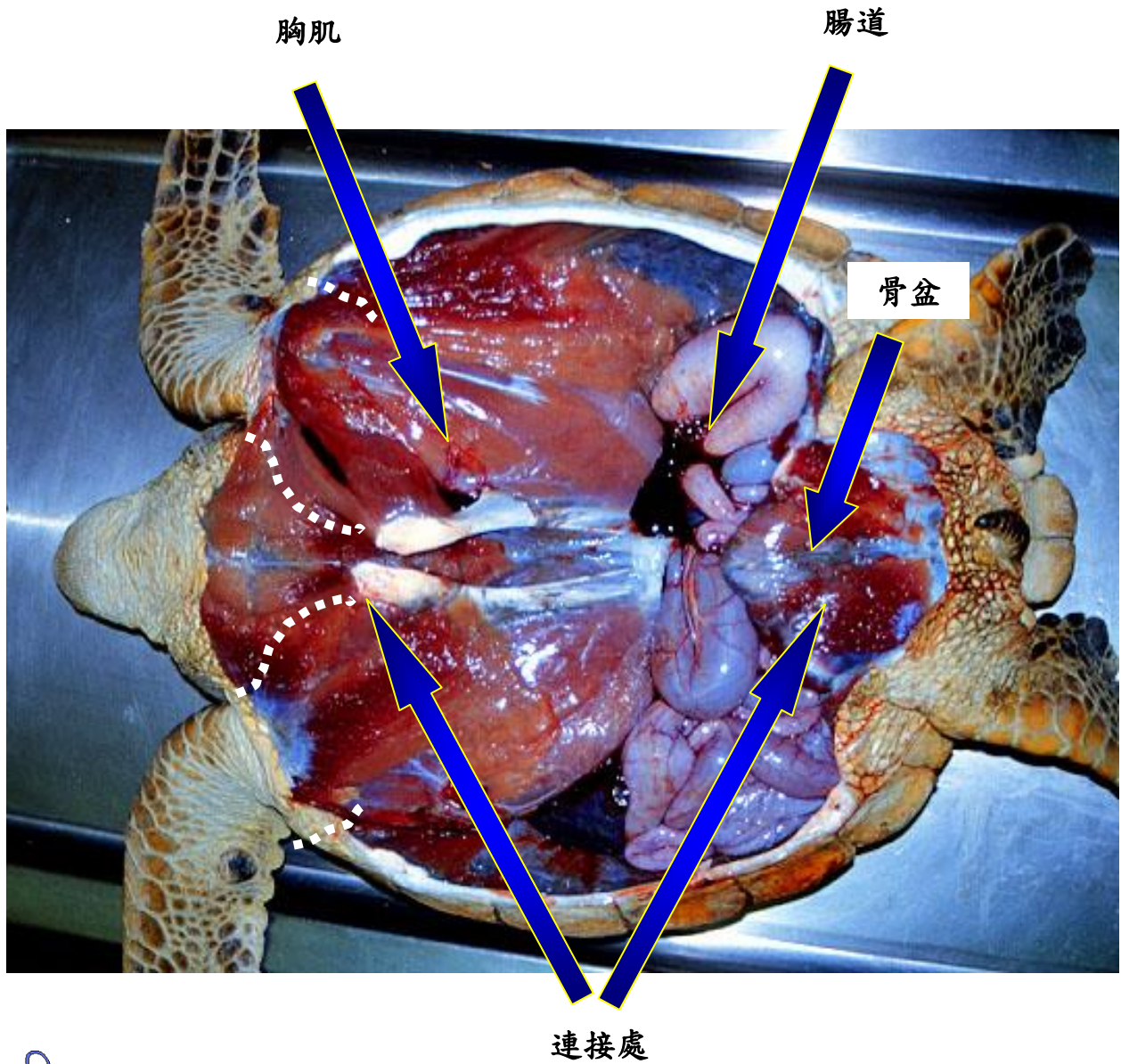


開始解剖前，先將海龜的背甲朝下放置，用銳利的刀子或手術刀沿虛線切開（如照片所示）。如果你下刀的位置正好是在背甲和腹甲之間，就可以很輕易地用刀子切開，因為這個部分只有軟骨，雖然有時成龜會有硬骨。將接合的骨骼和肌肉的連接處切開後，就可以將腹甲整個拉開來。

白色圓圈區域指出鎖骨（前面）和骨盆骨（後面）與腹甲的連接處，可沿著腹甲內側用刀子將連接處的韌帶和軟骨分開。



如果是極瘦弱的海龜，如匕首形狀的骨頭可能會向外突出而刺穿腹甲。



當腹甲移除後，你將會看到胸肌和腸道。牠的胸肌（海龜的動力引擎）佔據體腔的比例很大，藍色箭頭所示包括鎖骨及骨盆和腹腔的連接處。

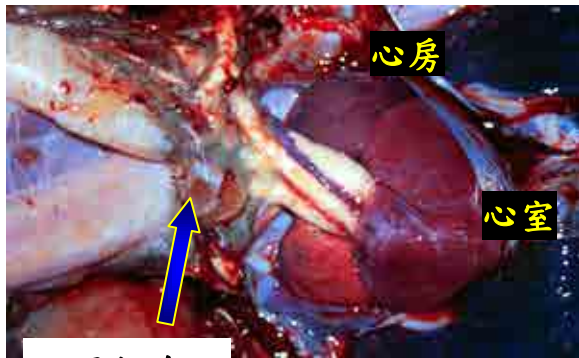


沿著前肢基部切開周圍肌肉（如第 12 頁的白色虛線），並以旋轉的方式將前肢和背甲的連結處分開，就可以將胸肌和整個前肢移除。接下來映入眼簾的就是即將出場的器官。



腸道：應該具有平滑表面並呈現均勻的黃褐色。大部分綠蠵龜的腸道內都富含藻類或海草，如果沒有食物或是量很少，都需要特別註記。

心臟：跟人類不同，海龜的心臟有3個心腔（1個心室和2個心房）。從心臟原



甲狀腺

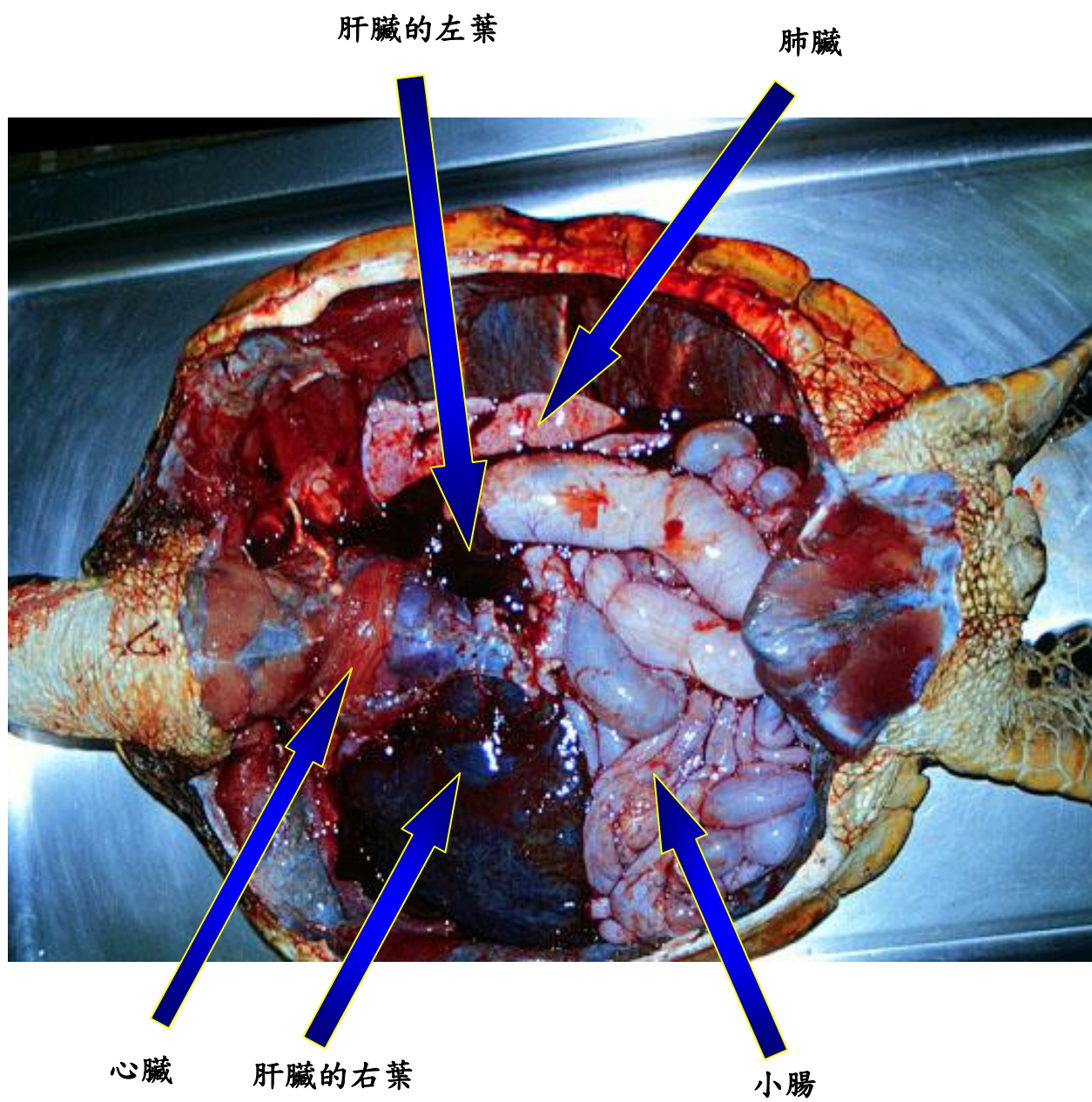
始位置即可見到白色的動脈從心室引出（左圖）。如果你仔細留意，可以在心臟旁邊找到呈透明球狀的甲狀腺。正常來說，心臟的質地結實，呈現均勻的暗粉紅色，其外面和內部的表面都相當平滑。

異常：腫瘤、心肌上的蒼白斑點、心臟的外部或內部有如砂紙般的粗糙表面、心臟上堆積有凝膠狀（半固體）的脂肪。



肝臟：這個器官應該是結實、表面平滑且邊緣飽滿，呈現均勻的暗紫褐色。跟人類一樣，海龜肝臟旁邊有個富含膽汁的膽囊。肝臟切面的堅硬度和質地應該為均勻一致的。

異常：結節、腫瘤、表面粗糙、乾燥、大區域的褪色或蒼白的小斑點。





將心臟和肝臟移除後，沿著頸部腹面表皮的中線切開，就可以看到食道和呼吸道（氣管）。一旦你進行到此，你手邊的海龜看起來如同下一頁的照片。



氣管：應為黃褐色，切開後為平滑的內腔。氣管分叉為二個支氣管。

異常：管腔內有氣泡、血液或食物，表面粗糙或是氣管開口（聲門）有腫瘤。



食道：位於氣管之下的軟管狀器官，管腔黏膜處有許多大型棘刺（如左圖），這在海龜身上是很正常的。相反的，胃部黏膜的表面無論是外側或內側都是平滑的，而且呈現黃褐色。

異常：魚鈎或是魚線埋入黏膜中。



嗉囊：在下頁的照片中可見到食道是如何潛藏在支氣管底下，並形成嗉囊的。嗉囊是食物進入胃部之前的暫存區，為一袋狀構造。目前僅在夏威夷和澳洲的綠蠛龜身上發現此構造。正常來說，它應該充滿藻類而且黏膜呈黃褐色。

異常：如砂紙般粗糙的黏膜、是否有魚鈎或是魚線陷入黏膜中。

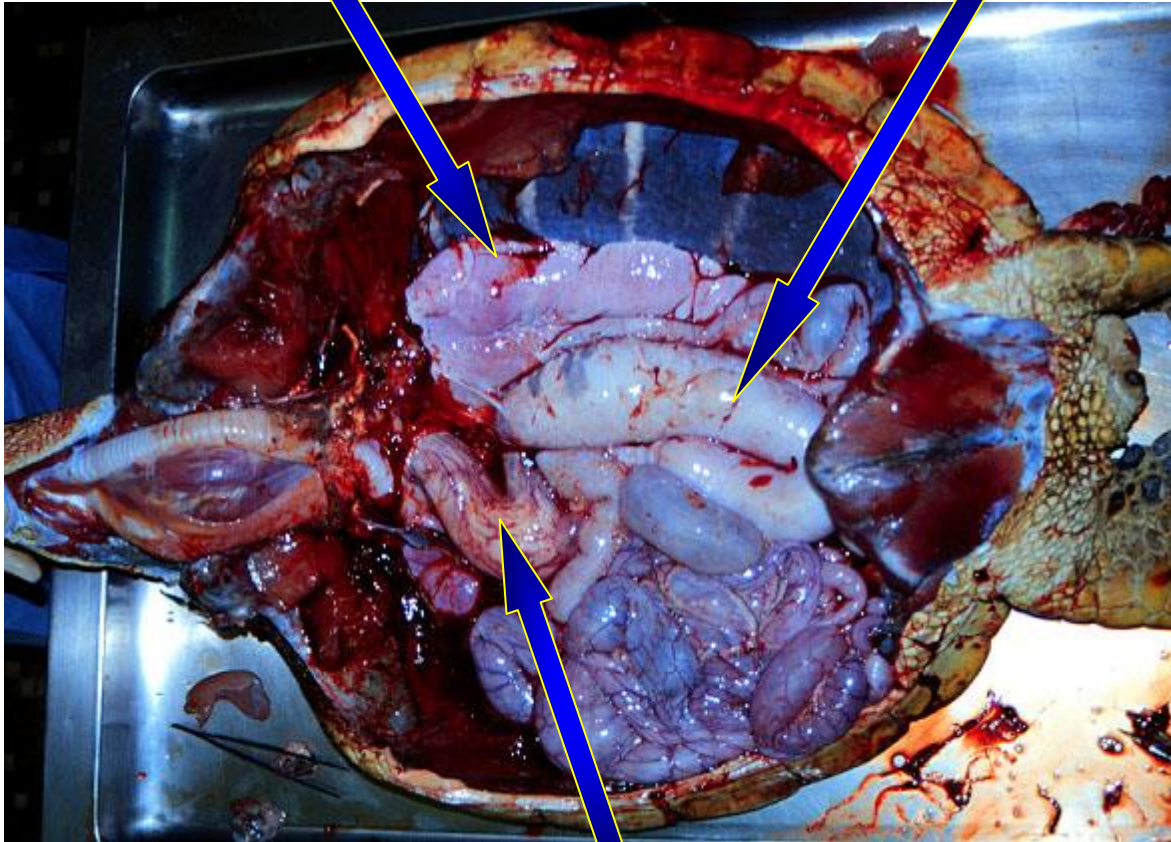
此時是收集胃內容物（可供攝食習慣研究）的好時機！



肺臟和大腸：此時可見到這兩個器官。通常，腸道內富有許多已浸潤的植物（就草食性的綠蠛龜而言）。

肺臟

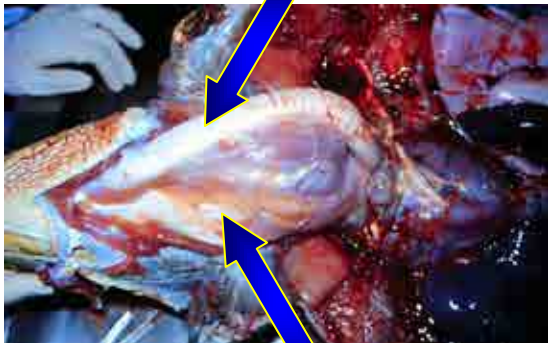
大腸



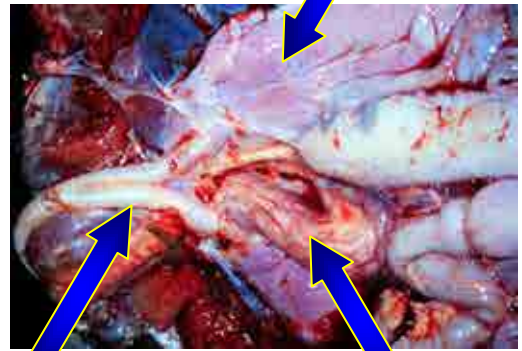
嗉囊

氣管

肺



食道



支氣管

嗉囊



胃腸道：從口到泄殖腔，包含完整的胃腸消化道。

可以見到下列的器官：

舌骨結構—如同男性的喉結，底下（背面）則是聲帶，開口於氣管。

食道：如前面所述。

嗉囊：如前面所述。

胃部：正常來說，黏膜表面為平滑的。



小腸：注意，此照片中的小腸已被切開且內容物已清空，所以它們看起來比之前照片中的小腸還來得小。小腸黏膜的外觀應該有如「蜂巢」。



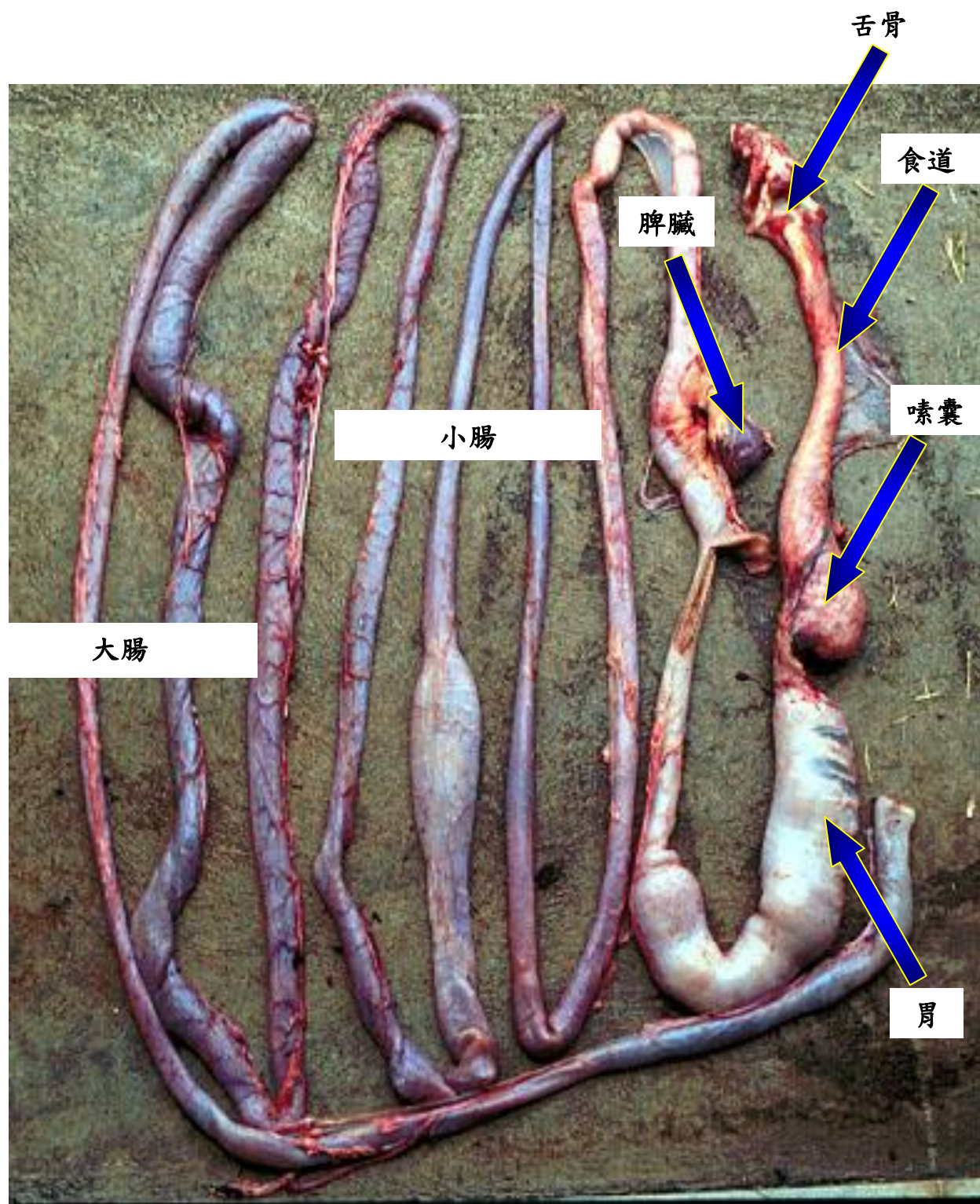
大腸：注意，此處的內容物已被清空。大腸黏膜應是平滑且呈黃褐色。

胃腸道異常：魚鈎、魚線、或其他外物，黏膜出血、如砂紙般粗糙的黏膜表面或寄生蟲。



脾臟：這個球形的器官是海龜的免疫系統之一，通常是結實、平滑、呈現粉紅棕色。它位於小腸靠近胃部出口處，和胰臟緊密相連。

異常：腫瘤、蒼白區域、暗斑、如砂紙般粗糙的表面。



大腸

小腸

脾臟

舌骨

食道

嗉囊

胃



當你將胃腸道移除後，剩下的器官將如下頁照片所示：



肺臟：質地如海綿，其表面及切面應該都是平滑的，呈現均勻粉紅色。

異常：腫瘤、結節、大區域的褪色、質地硬實、大量泡沫狀的血液從切面的小氣管滲出。



後大動脈：相當於人類的主動脈，不同的是海龜有兩條。通常為平滑且顏色呈現均勻的黃褐色至白色。

異常：結節、內腔表面如砂紙般粗糙。



膀胱：負責儲存尿液，為一個具有厚壁的囊袋，從側面可見其位於骨盆下和大腸上方一些。膀胱可能含有澄清黃色的尿液，有時也會有白色斑點狀的黏液分佈其中。膀胱的黏膜具有皺摺，可能具有較深的色素沈澱。

異常：腔內有寄生蟲。

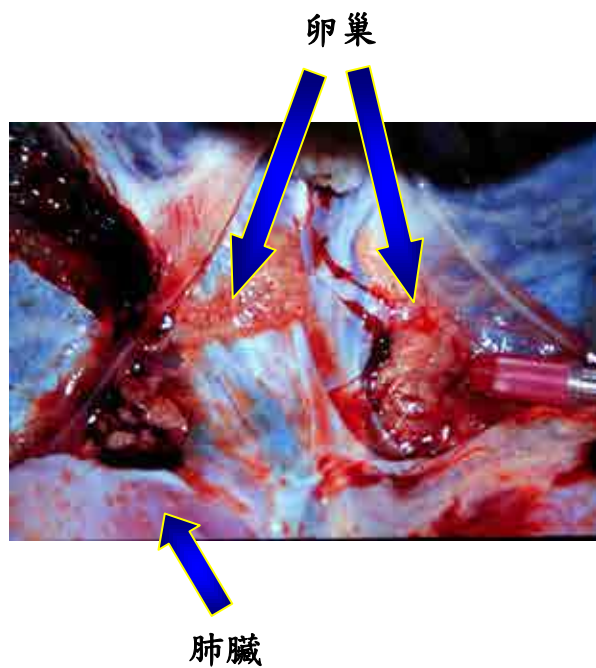
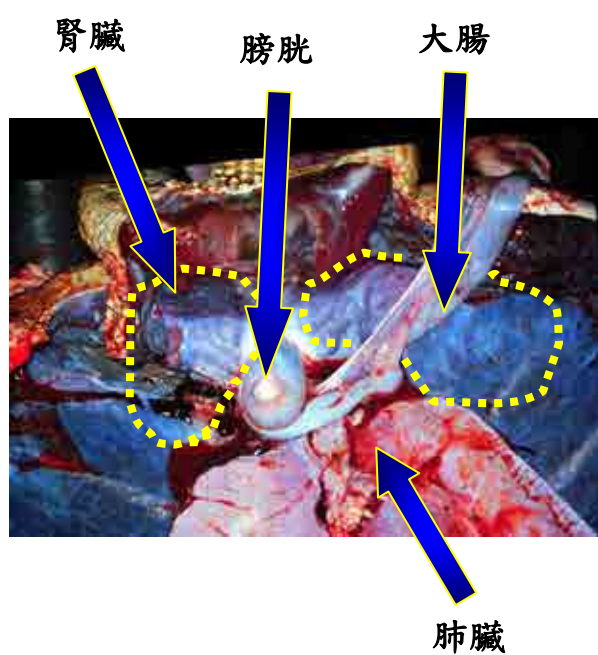
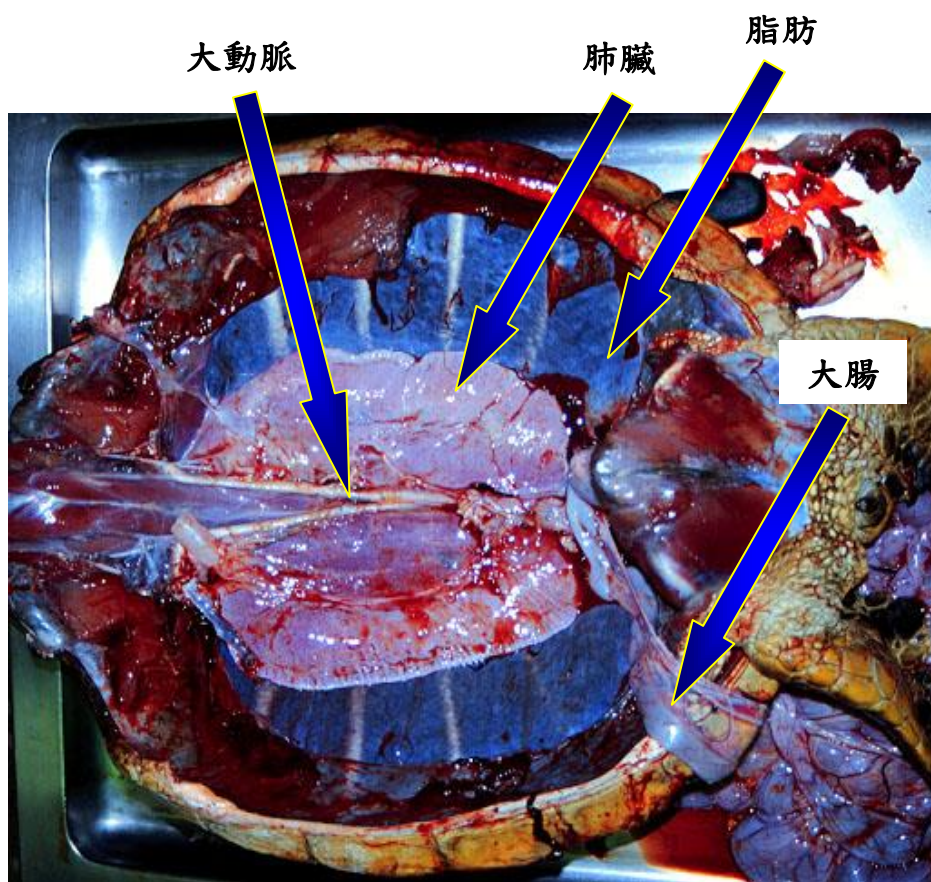


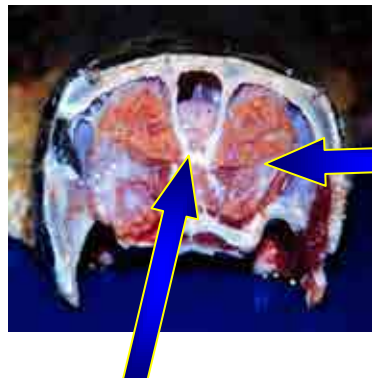
腎臟：它們藏在背甲底下，剛好在肺臟之下，骨盆上方一些（見照片中的黃色虛線）。表面有如結節般粗糙，質地結實且呈現均勻的棕色。

異常：大顆的蒼白球形硬實腫瘤。



性腺：位於腎臟的正上方。雄性為黃褐色的平滑腺體，雌性的性腺看起來像是小串的葡萄，成熟的個體很容易辨認，未成熟的個體則較難區分。





鹽腺

腦



屍體解剖的最後一個部分為將腦和鹽腺取下。為了完成這個步驟，必須沿圖片中的虛線將頭骨鋸開，之後你就能看到如上方照片中的器官構造。你可以利用剪刀和鑷子將腦取下。



腦：這個器官應該為結實且呈現均勻的黃褐色。你會發現與頭部相比，腦的尺寸小了許多。



鹽腺：調節滲透壓的重要器官。結實成葉狀，顏色為粉紅色至淡棕色。

異常：蒼白斑點、砂礫狀的質地。

完成屍體解剖後的確認事項

- 1) 所有的樣本和組織罐都要用屬於該動物個體的特定號碼標示清楚，並加註採樣日期。需保存的臟器清單可參閱第 23 頁。
- 2) 解剖記錄表的內容已記載完整（表格可見第 24 頁）。
- 3) 用過的手套和其他所有物品都要妥善丟棄，任何尖銳的器械，如手術刀片和針頭，都要放置於可密封、不易穿刺的堅固容器（如塑膠罐）內。
- 4) 所有的福馬林溶液都要存放於密封容器中，並於瓶身標示【警告：甲醛溶液：使用時需穿戴手套】，使用後妥善處理。

10% 福馬林溶液的兩種配方

配方 1

使用刻度量筒和秤，依照以下比例配製：

Na ₂ HPO ₄ (Sodium phosphate dibasic) ，磷酸氫二鈉	6.5 g
NaH ₂ PO ₄ · H ₂ O (Sodium phosphate monobasic) ，水合磷酸氫鈉	4.0 g
Fresh water ，淡水	900 ml
37% formaldehyde ，37% 甲醛	100 ml

配方 2

如果你手邊沒有秤或是測量儀器：

37% formaldehyde ，37% 甲醛	150 ml or 15 份
Seawater ，海水	850 ml or 85 份

配置福馬林溶液時，務必要配戴手套並在通風良好處操作

需保存於福馬林溶液中的臟器清單

(細體數字表示內文中提及該器官的頁數；粗體數字表示含有該器官的照片頁數)

器官	頁數
氣管	15, 16
食道	15, 16, 17, 18
肌肉	12
肝臟	13, 14
心臟	13, 14
甲狀腺	13
嚔囊	15, 16, 17, 18
脾臟/胰臟	17, 18
胃	17, 18
小腸	17, 18
大腸	15, 16, 17, 18, 20
肺臟	15, 16, 17, 18, 20
腎臟/膀胱	19, 20
性腺	19, 20
腦/鹽腺	21

解剖紀錄表 (所有單位均採公制)

種類 _____ 標號# _____ 樣本取得日期 _____ 解剖日期 _____
(mm/dd/yy) (mm/dd/yy)

樣本取得地點 _____

過往資料 _____ 性別 (公/母/未知) 年齡 _____

重量 _____ (公斤) 背甲直線長(SCL) _____ 背甲曲線長(CCL) _____ 腹甲長(PL) _____

背甲直線寬(SCW) _____ 背甲曲線寬(CCW) _____

(圈選出最合適的狀態) 或加註任何你認為必要的發現

身體狀態： (良好，瘦弱，極差)

死後變化： (剛死、~死亡1天、超過2天)

體表檢查： (表皮、背甲、眼睛、鼻孔、泄殖腔)

肌肉骨骼系統： (胸肌萎縮的程度：無、適度、嚴重；脂肪：結實、鬆軟、膠狀；體腔：大量的液體、少量液體、無)

肝臟： (表面：平滑、粗糙、顆粒、皺摺；質地：結實、纖維化；顏色：均勻/斑駁、紅色、棕色、紫色、黃褐色、黃色)

心臟： (表面：平滑、粗糙、顆粒、皺摺；質地：結實、纖維化；顏色：均勻/斑駁、紅色、棕色、紫色、黃褐色、黃色)

肺臟： (表面：平滑、粗糙、顆粒、皺摺；質地：結實、纖維化、海綿狀；顏色：均勻/斑駁、粉紅色、黃褐色、黃色、灰色、紅色、棕色)。氣管：(內腔：平滑、粗糙；顏色：均勻/斑駁、黃褐色、白色、紅色、棕色、綠色、粉紅色)。

脾臟： (表面：平滑、粗糙、顆粒、皺摺；質地：結實、柔軟；顏色：均勻/斑駁、棕色、黃褐色、紅色、黑色、黃色)。

腎臟： (表面：平滑、粗糙；質地：結實、柔軟；顏色：均勻/斑駁、棕色、黃褐色、紅色、黑色、黃色)

性腺：(表面：平滑、粗糙；質地：結實、纖維化；顏色：均勻/斑駁、紅色、黑色、棕色、紫色、黃褐色、黃色)

甲狀腺：(表面：平滑、粗糙；質地：結實、纖維化；顏色：半透明/斑駁、橘色、紅色、黃褐色、黃色)

口腔：(黏膜：平滑、粗糙、顆粒、凹痕；顏色：均勻/斑駁、粉紅色、黃褐色、黃色、灰色、紅色、棕色) 內容物？

食道：(黏膜：平滑、粗糙；顏色：均勻/斑駁、黃褐色、白色、紅色、粉紅色) 內容物？

嚔囊：(黏膜：平滑、粗糙；顏色：均勻/斑駁、黃褐色、紅色、黃色、黑色、棕色) 內容物？

胃：(黏膜：平滑、粗糙；顏色：均勻/斑駁、黃褐色、紅色、黃色、黑色、棕色) 內容物？

小腸：(黏膜：平滑、粗糙；顏色：均勻/斑駁、黃褐色、紅色、黃色、黑色、棕色) 內容物？

大腸：(黏膜：平滑、粗糙；顏色：均勻/斑駁、黃褐色、紅色、黃色、黑色、棕色) 內容物？

膀胱：(黏膜：平滑、粗糙；顏色：均勻/斑駁、黃褐色、紅色、黃色、黑色、棕色) 內容物？

腦：(表面：平滑、粗糙；質地：結實、纖維化；顏色：均勻/斑駁、黃褐色、紅色)

鹽腺：(表面：平滑、粗糙；質地：結實、纖維化；顏色：均勻/斑駁、棕色、粉紅色、黃褐色、橘色)

收集的樣本

福馬林： _____

冷凍： _____

其他： _____



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海龟解剖手册

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前言

这本手册是专门为海龟解剖生手或是解剖经验较少的生物学者与科学家设计的，它能协助你辨识海龟的器官并采集适合的检体，以供病理学和相关的实验室检验。若野生动物专科医生无法到场协助采样时，这本手册将会是你的最佳帮手！

为何要解剖呢？

解剖是评估动物死因的基本工具之一，彻底检查尸体的外部和内部，寻找与死因有关的任何线索（病灶），包括仔细检查病灶或异常处，并采集病材、标记和保存组织样本，才能算是一个好的解剖。正确地保存组织样本有利于野生动物疾病专科医师进行后续评估，以了解野生动物致死的可能原因。

解剖工作做得越好，正确判定死因的机会越高，所以须尽可能地选择最新鲜的尸体，在解剖前避免尸体的冷冻和解冻，因为这会影响组织切片在显微镜底下的观察结果，使判读效果打折。进行解剖时，要仔细观察尸体状况并详细记录下你的观察结果和发现，可能的话，你也可以替有趣的发现拍摄一些特写近照，并放大尺度从腹部和背部将整体一并拍摄下来。

一般而言，要先将脏器的异常处指认出来，像是异常的形状、颜色、硬度、数量和大小。例如，正常的绿蠍龟（*Chelonia mydas*）肝脏为边缘圆滑、组织结实，并呈现均匀的暗紫褐色。而异常的肝脏可能会显现不正常的颜色（斑点或污点）、硬度（太软或太硬）、大小（过大或过小）或形状（凸起、肿块或疤痕）。显然，必须先知道「正常」的脏器看起来是如何，才能够指认出脏器的异常处。最好的学习方式是透过解剖经验的累积，并参考本手册中的照片，这些都有助于初学者评估脏器的正常与否。

解剖所需材料

剪刀	有齿镊子	橡胶手套
塑料袋	加盖罐子	耐水性笔
刀子	砧板	淡水
手术刀柄	骨锯	10%福尔马林
手术刀片	标签	铝箔纸
铅笔	纸	

其他工具如秤、卷尺、卡尺（标尺）和照相机，也会很有帮助。此外，需要用到多种规格的塑料袋：大型袋子用于盛装尸体以便于丢弃，小袋子（封口袋）则可以用来保存个别器官。

福尔马林缓冲溶液可用来保存组织，本手册后段有列出福尔马林缓冲溶液的配制方法。在此先提供一个替代配方：以15份的37%甲醛溶液混合85份的海水。请勿直接把脏器浸入37%的甲醛溶液或非中性福尔马林。

安全议题

解剖海龟是件艰苦的工作，要留意刀子和尖锐骨头，并谨守卫生规范。过程中务必穿戴手套且不可饮食。记住，你不知道是否会面临人畜共通传染病。

使用福尔马林时，**全程皆需穿戴手套**，在通风良好处操作并且在尸体解剖全程结束后洗手。所有装有福尔马林的容器都需清楚标示为「危险液体」。

标示

所有标签皆需以不褪色墨水（例如：奇异笔）或铅笔书写，**避免使用钢珠笔**。卷标上的数据至少要包括采样地点、采样日期和单一不重复的编号。为避免混淆，日期缩写的方式也要留意（例如公元2000年3月5日，英文缩写应该标示为 MAR 5, 2000，而非3/5/00）。

【译注：中文日期格式多为年/月/日，最好保持标示的一致性，以利资料整理和回溯。】

实验室检验用病材的采集

福尔马林固定（2个步骤）

福尔马林固定的样本可供病理医师在显微镜下检查组织切片（镜检）并进行疾病诊断：

1) 确保罐子内有足量的福尔马林能用来固定组织，福尔马林和组织的比例最少要2份的福尔马林比1份的组织（图1）。同一只个体的组织可以放置于同一个罐子内，并于罐子上标记清楚。

2) 确认每块组织的尺寸，不可大于0.5公分（1/4英吋），才能使其充分固定。如果有发现病灶，病灶处旁边的正常组织要一同取下（图2），因为许多疾病的诊断，都要针对正常组织和异常组织间的「病变带」进行镜检。组织固定后，最好要再更换一次福尔马林缓冲液（大约是在固定24小时后），这样固定和染色的效果都会比较好，有助于后续的镜检，而用过的福尔马林必须妥善丢弃。经福尔马林固定过的组织不可冷冻。

冷冻组织（勿放入福尔马林缓冲液中）（1个步骤）

冷冻脏器可用来分离微生物和毒物含量分析：

1) 收集足量的组织（20-30 公克或 1/4-1/2 杯）并置放于适合大小的塑料袋中将其密封，并在袋子上以奇异笔标示清楚。有些病例需先以铝箔纸将组织包装好再放入塑料袋中。解剖时，应尽早收集需要冷冻保存的组织，避免受到肠内容物或尘土等的污染。收集好的组织样本需放置于冰箱（-20℃，越低温越好），并在寄送至实验室的过程中保持冷冻状态。

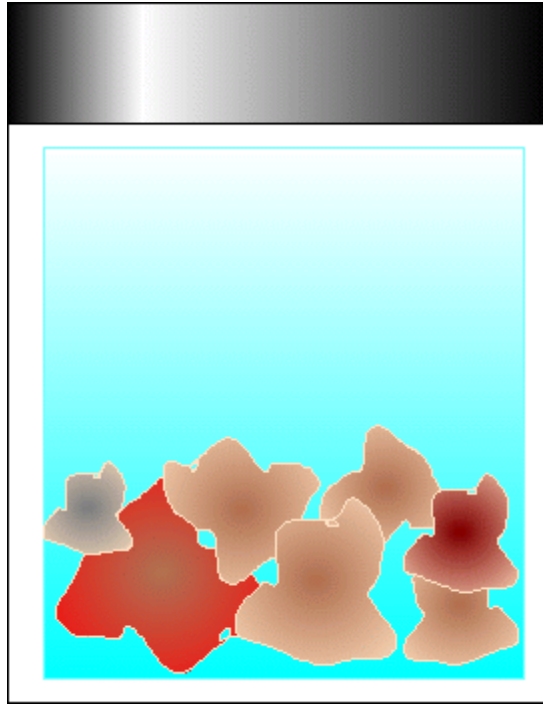


图1. 福尔马林和组织罐。
(福尔马林:组织=至少2:1)

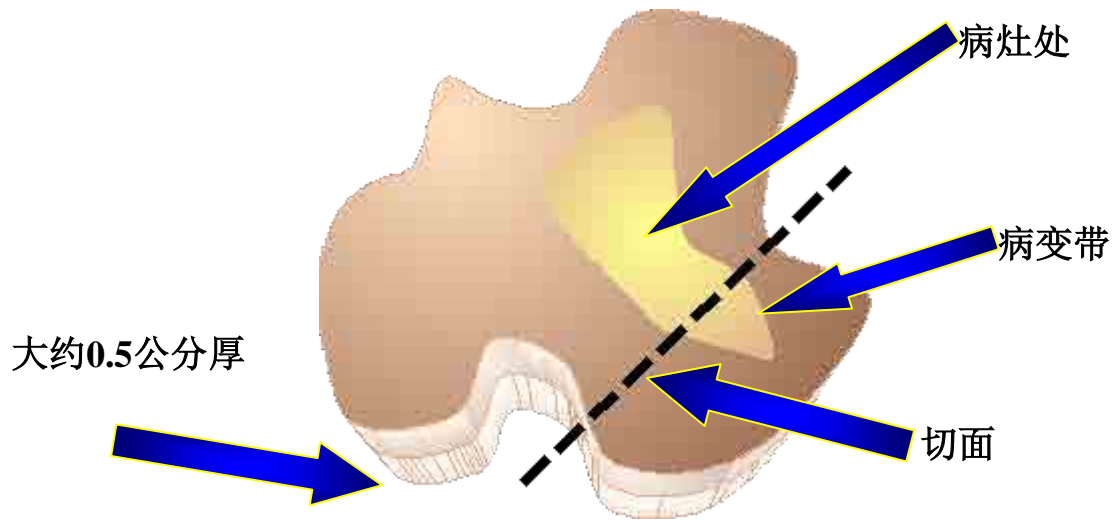


图 2

手册的使用说明

本手册接下来将利用夏威夷的绿海龟当作「模特儿」，一步步地教你如何解剖海龟。手册中提及的器官，除了绿海龟有，其他品种的海龟也都有。然而，器官的尺寸和型态在各品种间或许会有差异，但手册中的照片仍能做为判断何谓正常器官的依据。

本手册由一系列的照片穿插正文而成，其中还包括两个小插图—剪刀和眼镜，导引您贯穿全文。插图功能如下：



剪刀：表示该段落是在叙述解剖尸体的方式，以“**粗体字**”标示。



眼镜：有眼镜插图在前面的段落，主要是描述脏器和脏器的外观，常见的异常状况会以“*斜体字*”标示，请利用这些段落当作区别异常脏器的参考。除此之外，最好是一边解剖一边收集各个脏器的组织，第 23 页附有需保存脏器清单，列出解剖完成后应该已经收集好且置于福尔马林缓冲液中的所有脏器，而尸体解剖的空白表格在第 24 页。

注意：本手册假设你解剖的海龟为刚死亡（亦即你目击海龟的死亡或是死亡时间在 12-24 小时内）。有些脏器的外观和诊断价值会随着腐败程度的增加而有剧烈的变化，尸体腐败地越严重，实验诊断的价值就越低。

最后，记得将你看到的任何细节都记录下来，细节永远不嫌多！

外部检查



检查海龟的外观，从头部到尾部彻底找寻任何异常处或是伤口，并将异常处拍照记录下来。你也可以用照片辨认海龟的身份并存盘记录。进行尸体检查时，依照下列项目检查：



-腹甲、背甲和表皮：盾片是否有剥落？是否有旧伤口和新伤口？是否有藤壶（数量？）、吸虫（数量？）、藻类（覆盖百分比？）或其他的附生物在背甲/腹甲上？表皮上是否有异常增生？

-身体状况：状况良好的海龟通常腹甲较饱满；若是极度瘦弱的海龟，腹甲则会往内凹陷。



绿海龟身体状况的范例



- 测量（见第10页）
- 泄殖腔：是否有突出物伸出泄殖腔？
- 鼻孔：是否有任何液体渗出？（如血液或黏液？）
- 口：口腔黏膜应该是平滑均匀的，若有红斑或黄褐色的突起就是异常。须留意口腔中是否有溃疡、切创伤、菌斑、增生、钩子、鱼线、出血、斑点或肿块。此外，需留意口腔内有无藻类，若有，则采集部分样本，以装有福尔马林缓冲液的小瓶子独立保存。
- 眼：眼睛是否塌陷、混浊或流泪？是否有异常增生疣长在眼眶周围？
- 鳍状肢：表皮是否有异常增生疣？鳍状肢是否完整？是否有鱼线缠绕或鱼钩埋刺在鳍状肢内？
- 任何其他异常：肿块、突起或是不寻常处有渗出物？
- 留意背甲内侧的体脂肪含量。健康的海龟会有大量棕绿色的脂肪（下图左），然而状况不好的海龟脂肪量很少，看起来水水的、颜色较深且有突出的肋骨（下图右，箭头处）。



测量海龟

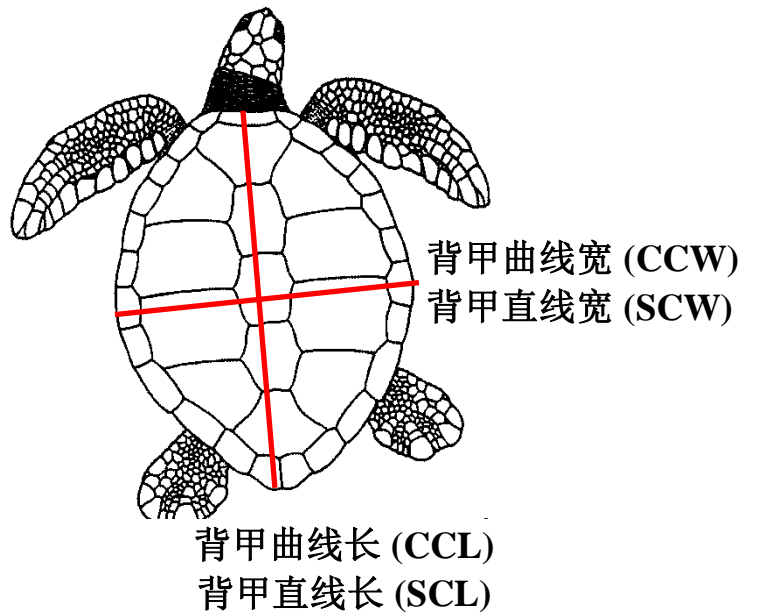
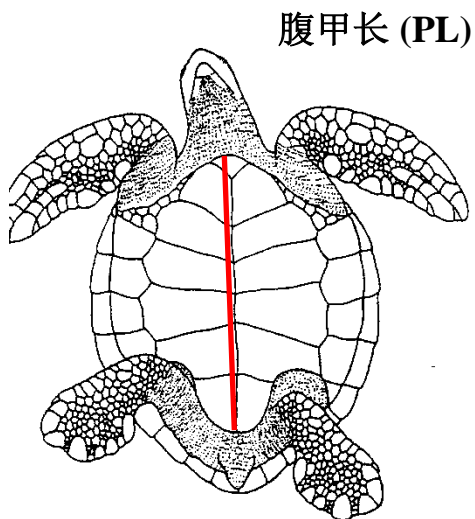
为了能精确地测量海龟，你需要准备一个卷尺和一个卡尺，而且所有的计量单位都是公分。我们能从海龟身上测得许多数值，下方图例为必须测量的数值。

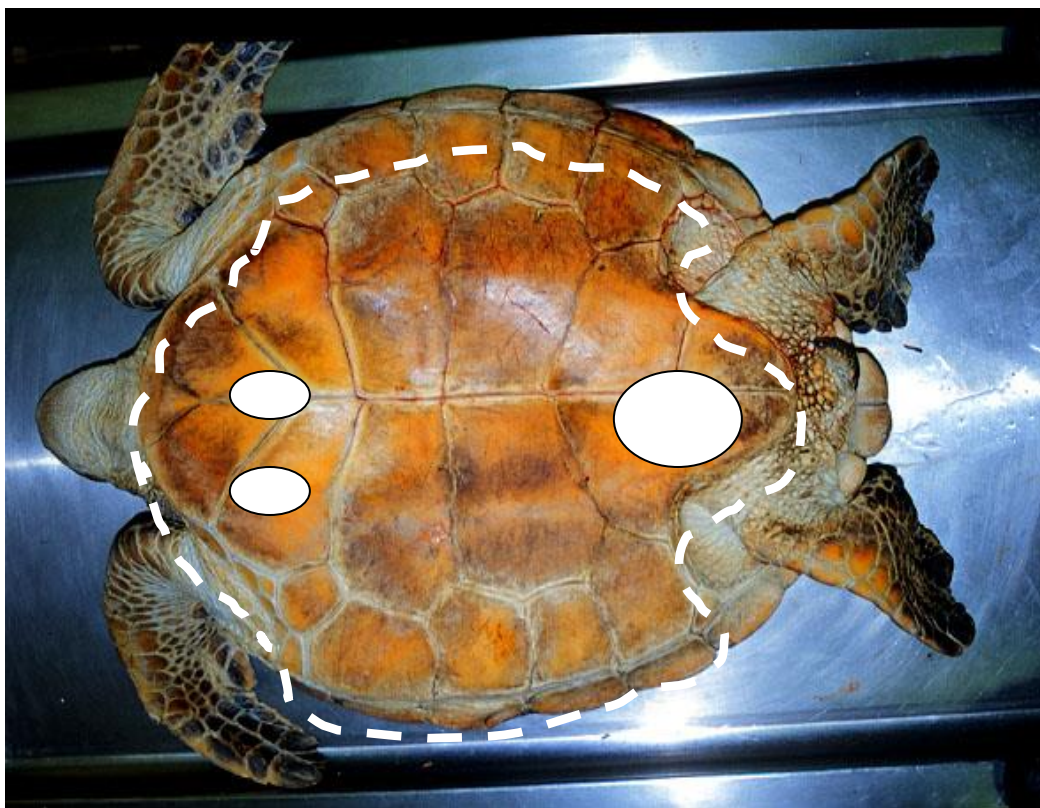
卡尺：

背甲直线长 (SCL)
背甲直线宽 (SCW)
腹甲长 (PL)

卷尺：

背甲曲线长 (CCL)
背甲曲线宽 (CCW)



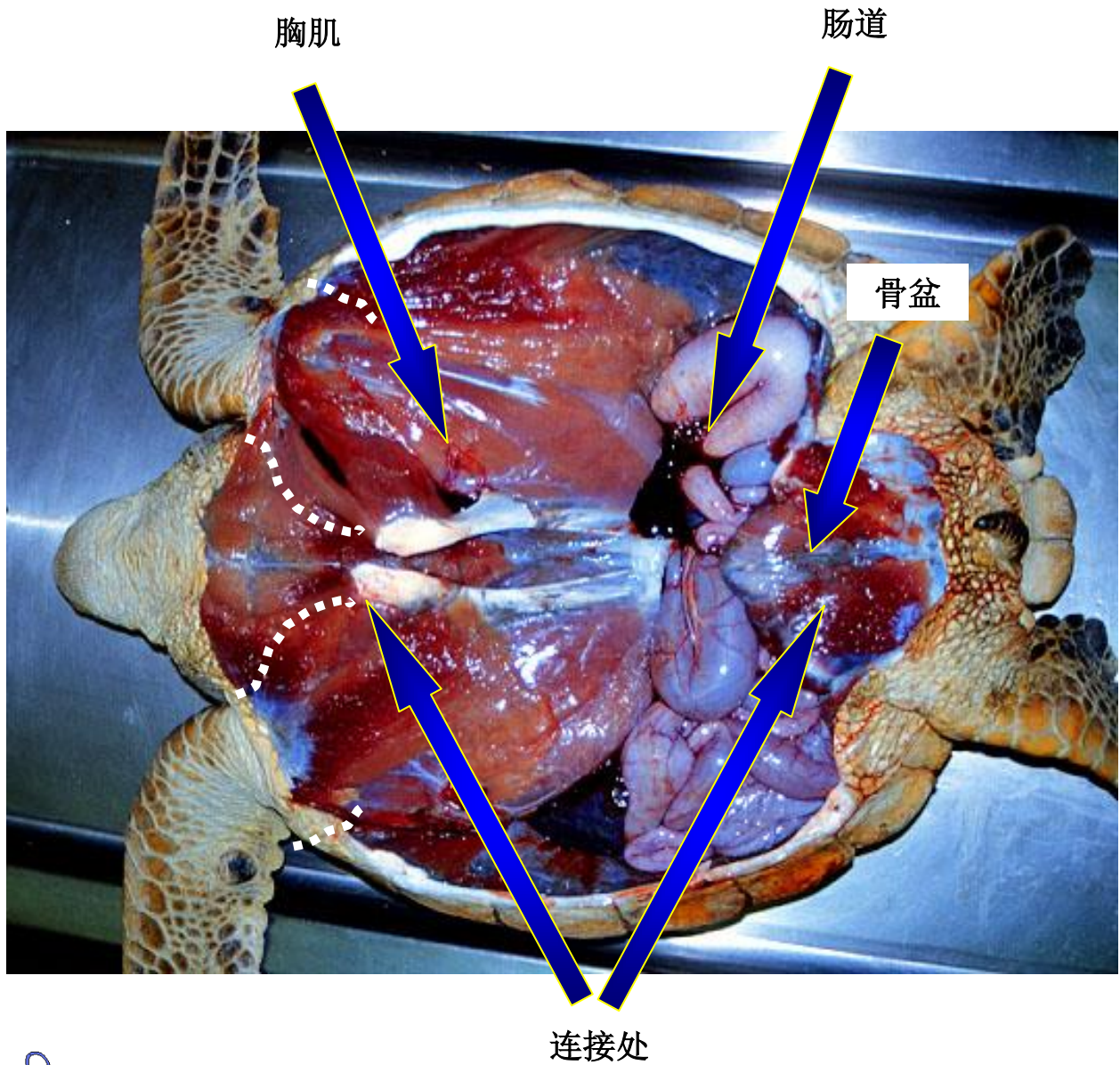


开始解剖前，先将海龟的背甲朝下放置，用锐利的刀子或手术刀沿虚线切开（如照片所示）。如果你下刀的位置正好是在背甲和腹甲之间，就可以很轻易地用刀子切开，因为这个部分只有软骨，虽然有时成龟会有硬骨。将接合的骨骼和肌肉的连接处切开后，就可以将腹甲整个拉开来。

白色圆圈区域指出锁骨（前面）和骨盆骨（后面）与腹甲的连接处，可沿着腹甲内侧用刀子将连接处的韧带和软骨分开。



如果是极瘦弱的海龟，如匕首形状的骨头可能会向外突出而刺穿腹甲。



当腹甲移除后，你将会看到胸肌和肠道。牠的胸肌（海龟的动力引擎）占据体腔的比例很大，蓝色箭头所示包括锁骨及骨盆和腹腔的连接处。

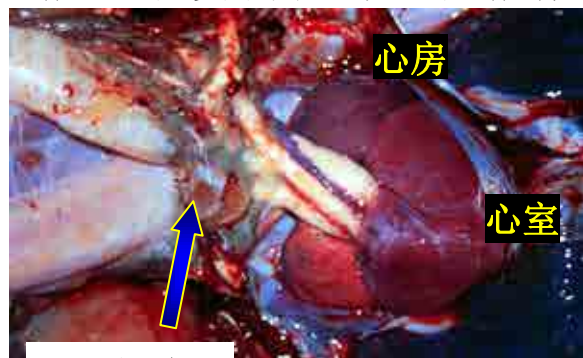


沿着前肢基部切开周围肌肉（如第 12 页的白色虚线），并以旋转的方式将前肢和背甲的连结处分开，就可以将胸肌和整个前肢移除。接下来映入眼帘的就是即将出场的器官。



肠道：应该具有平滑表面并呈现均匀的黄褐色。大部分绿蠓龟的肠道内都富含藻类或海草，如果没有食物或是量很少，都需要特别注记。

心脏：跟人类不同，海龟的心脏有3个心腔（1个心室和2个心房）。从心脏原始位置即可见到白色的动脉从心室引出



（左图）。如果你仔细留意，可以在心脏旁边找到呈透明球状的甲状腺。正常来说，心脏的质地结实，呈现均匀的暗粉红色，其外面和内部的表面都相当平滑。

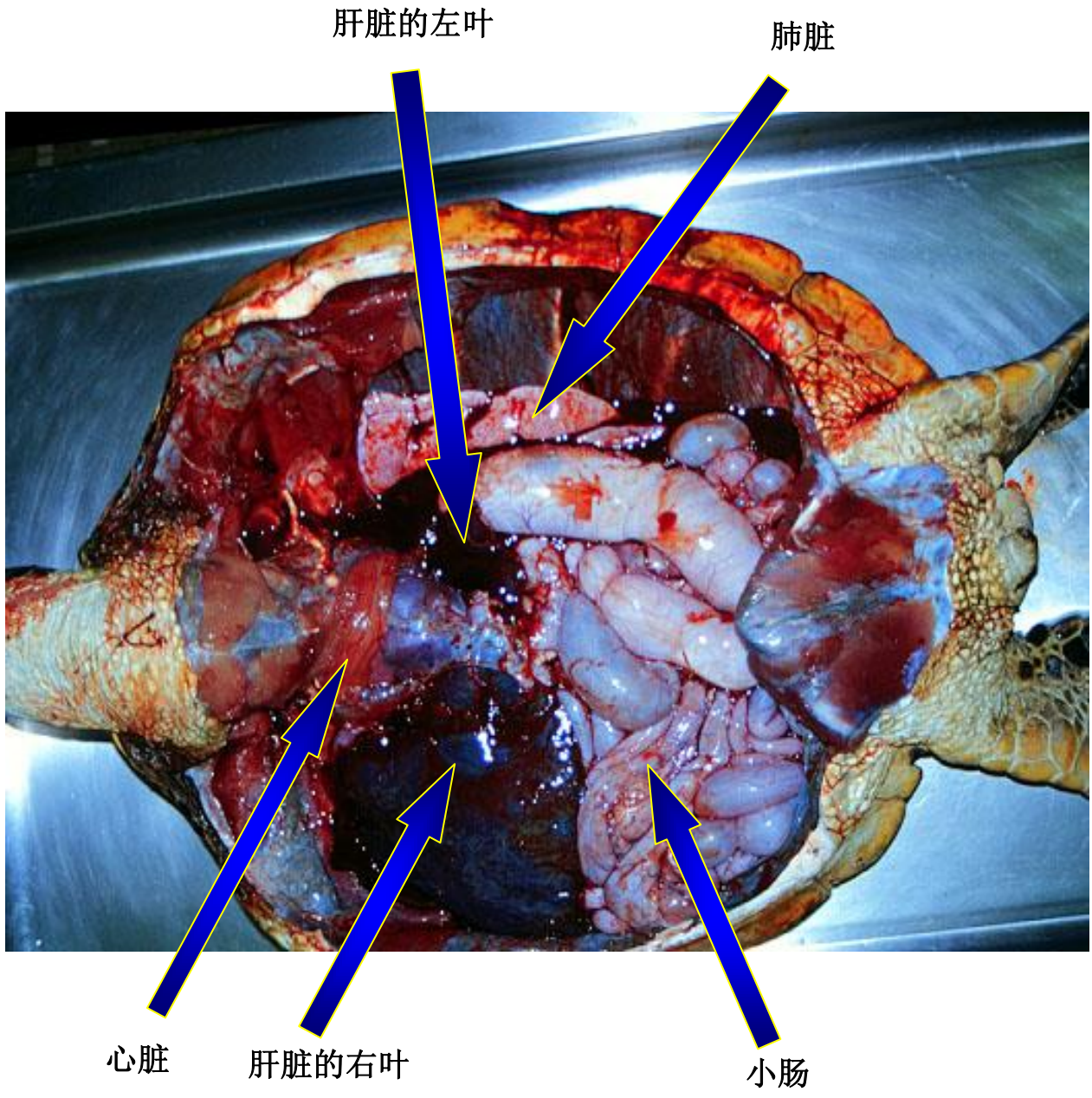
甲状腺

异常：肿瘤、心肌上的苍白斑点、心脏的外部或内部有如砂纸般的粗糙表面、心脏上堆积有凝胶状（半固体）的脂肪。



肝脏：这个器官应该是结实、表面平滑且边缘饱满，呈现均匀的暗紫褐色。跟人类一样，海龟肝脏旁边有个富含胆汁的胆囊。肝脏切面的坚硬度和质地应该为均匀一致的。

异常：结节、肿瘤、表面粗糙、干燥、大区域的褪色或苍白的小斑点。





将心脏和肝脏移除后，沿着颈部腹面表皮的中线切开，就可以看到食道和呼吸道（气管）。一旦你进行到此，你手边的海龟看起来如同下一页的照片。



气管：应为黄褐色，切开后为平滑的内腔。气管分叉为二个支气管。

异常：管腔内有气泡、血液或食物，表面粗糙或是气管开口（声门）有肿瘤。



食道：位于气管之下的软管状器官，管腔黏膜处有许多大型棘刺（如左图），这在海龟身上是很正常的。相反的，胃部黏膜的表面无论是外侧或内侧都是平滑的，而且呈现黄褐色。



异常：鱼钩或是鱼线埋入黏膜中。



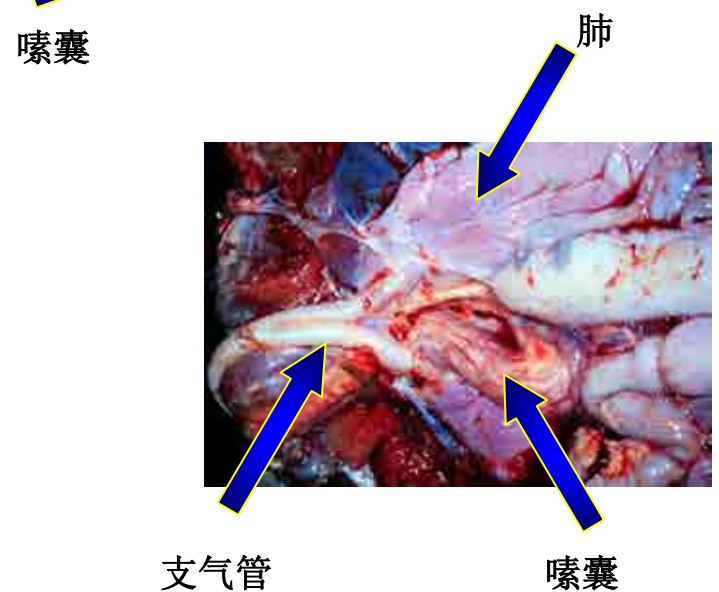
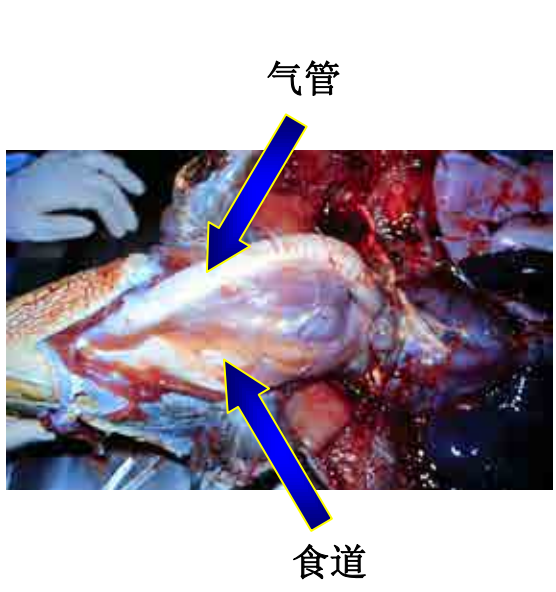
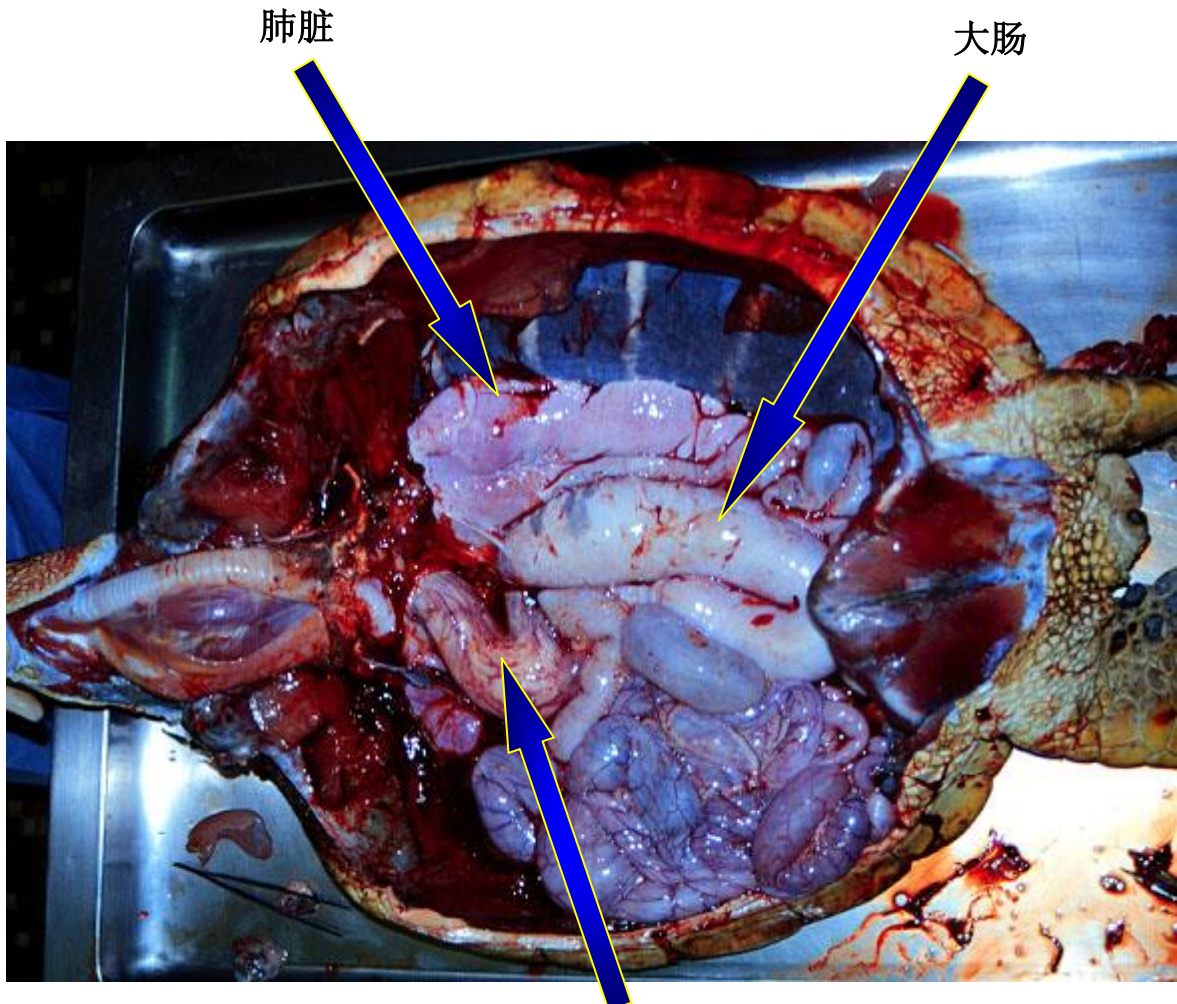
嗉囊：在下页的照片中可见到食道是如何潜藏在支气管底下，并形成嗉囊的。嗉囊是食物进入胃部之前的暂存区，为一袋状构造。目前仅在夏威夷和澳洲的绿海龟身上发现此构造。正常来说，它应该充满藻类而且黏膜呈黄褐色。

异常：如砂纸般粗糙的黏膜、是否有鱼钩或是鱼线陷入黏膜中。

此时是收集胃内容物（可供摄食习惯研究）的好时机！



肺脏和大肠：此时可见到这两个器官。通常，肠道内富有许多已浸润的植物（就草食性的绿蠵龟而言）。





胃肠道：从口到泄殖腔，包含完整的胃肠消化道。
可以见到下列的器官：

舌骨结构—如同男性的喉结，底下（背面）则是声带，开口于气管。

食道：如前面所述。

嗦囊：如前面所述。

胃部：正常来说，黏膜表面为平滑的。



小肠：注意，此照片中的小肠已被切开且内容物已清空，所以它们看起来比之前照片中的小肠还来得小。小肠黏膜的外观应该有如「蜂巢」。



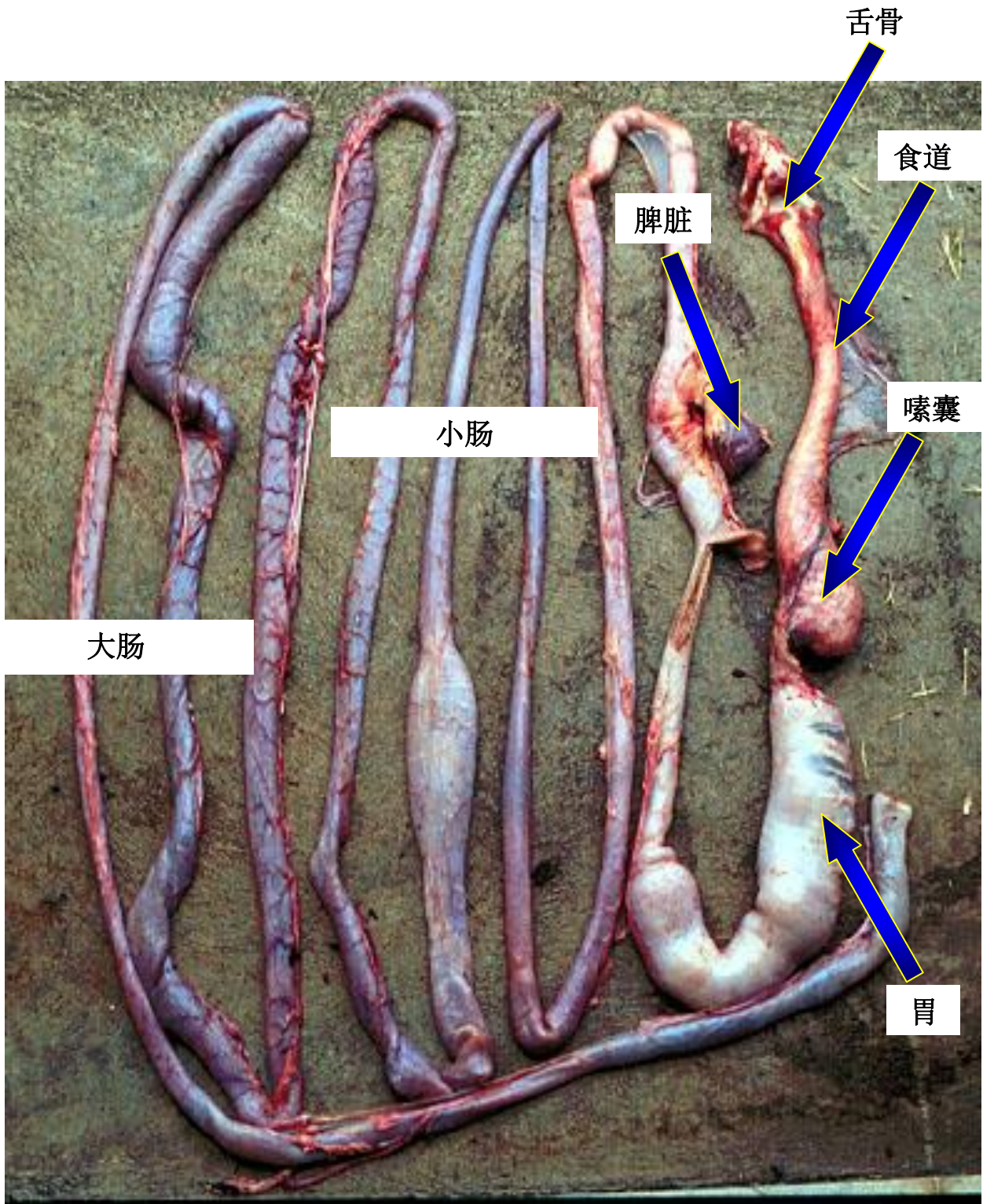
大肠：注意，此处的内容物已被清空。大肠黏膜应是平滑且呈黄褐色。

胃肠道异常：鱼钩、鱼线、或其他外物，黏膜出血、如砂纸般粗糙的黏膜表面或寄生虫。



脾脏：这个球形的器官是海龟的免疫系统之一，通常是结实、平滑、呈现粉红棕色。它位于小肠靠近胃部出口处，和胰脏紧密相连。

异常：肿瘤、苍白区域、暗斑、如砂纸般粗糙的表面。



大肠

小肠

脾脏

舌骨

食道

嗉囊

胃



当你将胃肠道移除后，剩下的器官将如下页照片所示：



肺脏：质地如海绵，其表面及切面应该都是平滑的，呈现均匀粉红色。

异常：肿瘤、结节、大区域的褪色、质地硬实、大量泡沫状的血液从切面的小气管渗出。



后大动脉：相当于人类的主动脉，不同的是海龟有两条。通常为平滑且颜色呈现均匀的黄褐色至白色。

异常：结节、内腔表面如砂纸般粗糙。



膀胱：负责储存尿液，为一个具有厚壁的囊袋，从侧面可见其位于骨盆下和大肠上方一些。膀胱可能含有澄清黄色的尿液，有时也会有白色斑点状的黏液分布其中。膀胱的黏膜具有皱折，可能具有较深的色素沉淀。

异常：腔内有寄生虫。

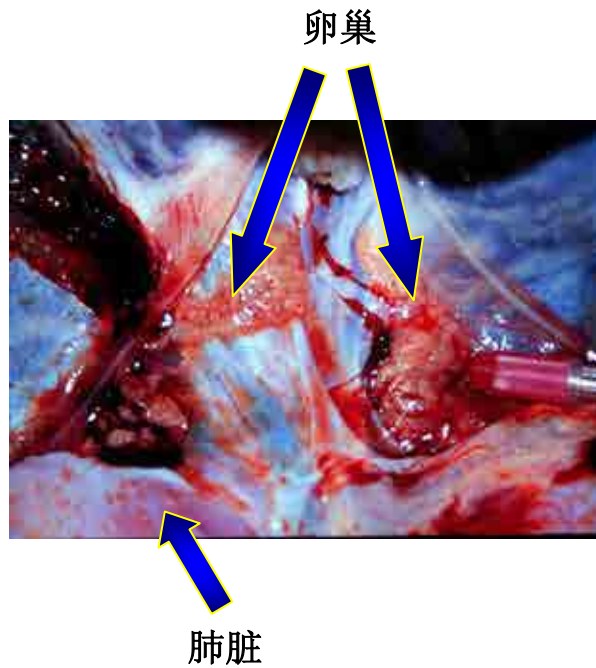
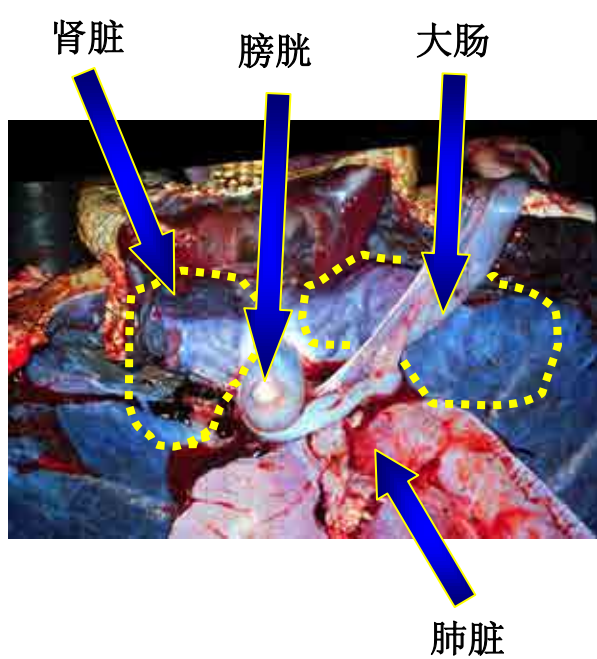
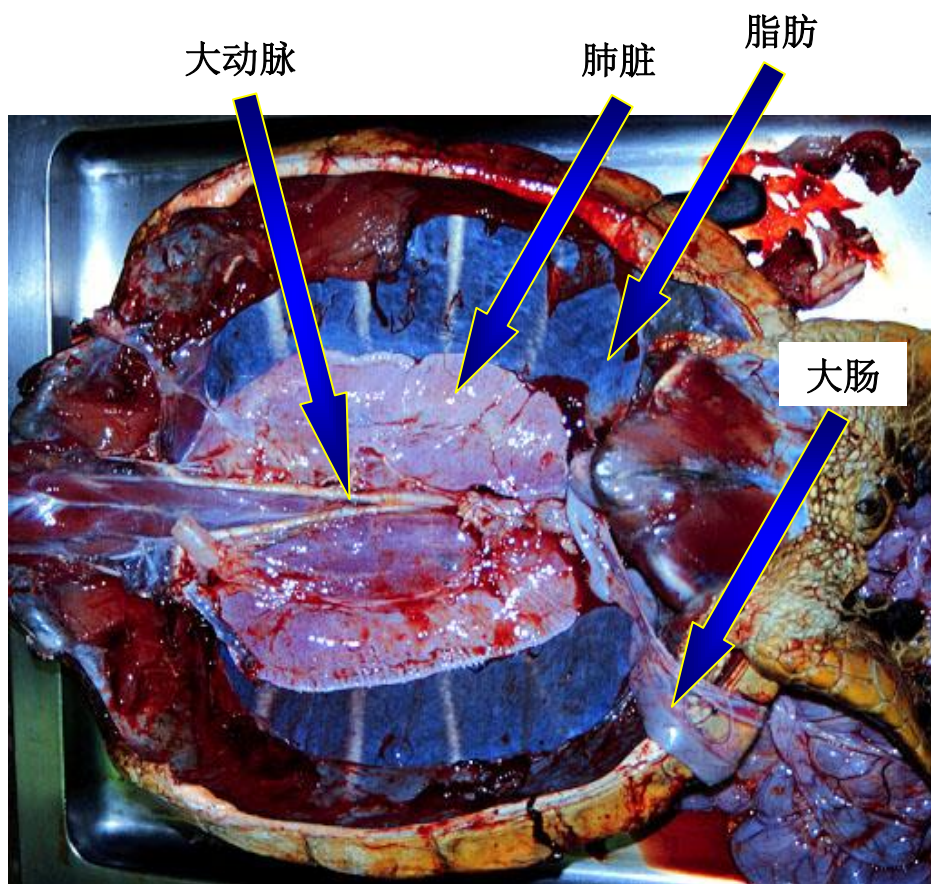


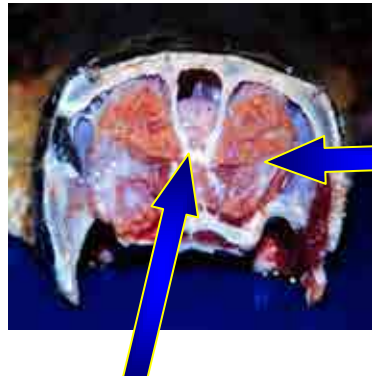
肾脏：它们藏在背甲底下，刚好在肺脏之下，骨盆上方一些（见照片中的黄色虚线）。表面有如结节般粗糙，质地结实且呈现均匀的棕色。

异常：大颗的苍白球形硬实肿瘤。



性腺：位于肾脏的正上方。雄性为黄褐色的平滑腺体，雌性的性腺看起来像是小串的葡萄，成熟的个体很容易辨认，未成熟的个体则较难区分。





盐腺

脑



尸体解剖的最后一个部分为将脑和盐腺取下。为了完成这个步骤，必须沿图片中的虚线将头骨锯开，之后你就能看到如上方照片中的器官构造。你可以利用剪刀和镊子将脑取下。



脑：这个器官应该为结实且呈现均匀的黄褐色。你会发现与头部相比，脑的尺寸小了许多。



盐腺：调节渗透压的重要器官。结实成叶状，颜色为粉红色至淡棕色。

异常：苍白斑点、砂砾状的质地。

完成尸体解剖后的确认事项

- 1) 所有的样本和组织罐都要用属于该动物个体的特定号码标示清楚，并加注采样日期。需保存的脏器清单可参阅第 23 页。
- 2) 解剖记录表的内容已记载完整（表格可见第 24 页）。
- 3) 用过的手套和其他所有物品都要妥善丢弃，任何尖锐的器械，如手术刀片和针头，都要放置于可密封、不易穿刺的坚固容器（如塑料罐）内。
- 4) 所有的福尔马林溶液都要存放于密封容器中，并于瓶身标示【警告：甲醛溶液：使用时需穿戴手套】，使用后妥善处理。

10% 福尔马林溶液的两种配方

配方 1

使用刻度量筒和秤，依照以下比例配制：

Na ₂ HPO ₄ (Sodium phosphate dibasic)，磷酸氢二钠	6.5 g
NaH ₂ PO ₄ ·H ₂ O (Sodium phosphate monobasic)，水合磷酸氢钠	4.0 g
Fresh water, 淡水	900 ml
37% formaldehyde, 37%甲醛	100 ml

配方 2

如果你手边没有秤或是测量仪器：

37% formaldehyde, 37%甲醛	150 ml or 15 份
Seawater, 海水	850 ml or 85 份

配置福尔马林溶液时，务必要配戴手套并在通风良好处操作

需保存于福尔马林溶液中的脏器清单

(细体数字表示内文中提及该器官的页数；粗体数字表示含有该器官的照片页数)

器官	页数
气管	15, 16
食道	15, 16, 17, 18
肌肉	12
肝脏	13, 14
心脏	13, 14
甲状腺	13
嗦囊	15, 16, 17, 18
脾脏/胰脏	17, 18
胃	17, 18
小肠	17, 18
大肠	15, 16, 17, 18, 20
肺脏	15, 16, 17, 18, 20
肾脏/膀胱	19, 20
性腺	19, 20
脑/盐腺	21

解剖纪录表

(所有单位均采公制)

种类 _____ 标号# _____ 样本取得日期 _____ 解剖日期 _____
 (mm/dd/yy) (mm/dd/yy)

样本取得地点 _____

过往资料 _____ 性别(公/母/未知) 年龄 _____

重量 _____(公斤) 背甲直线长(SCL) _____ 背甲曲线长(CCL) _____ 腹甲长(PL) _____

背甲直线宽(SCW) _____ 背甲曲线宽(CCW) _____

(圈选出最合适的状态) 或加注任何你认为必要的发现

身体状态: (良好, 瘦弱, 极差)

死后变化: (刚死、~死亡1天、超过2天)

体表检查: (表皮、背甲、眼睛、鼻孔、泄殖腔)

肌肉骨骼系统: (胸肌萎缩的程度: 无、适度、严重; 脂肪: 结实、松软、胶状; 体腔: 大量的液体、少量液体、无)

肝脏: (表面: 平滑、粗糙、颗粒、皱折; 质地: 结实、纤维化; 颜色: 均匀/斑驳、红色、棕色、紫色、黄褐色、黄色)

心脏: (表面: 平滑、粗糙、颗粒、皱折; 质地: 结实、纤维化; 颜色: 均匀/斑驳、红色、棕色、紫色、黄褐色、黄色)

肺脏: (表面: 平滑、粗糙、颗粒、皱折; 质地: 结实、纤维化、海绵状; 颜色: 均匀/斑驳、粉红色、黄褐色、黄色、灰色、红色、棕色)。 **气管:** (内腔: 平滑、粗糙; 颜色: 均匀/斑驳、黄褐色、白色、红色、棕色、绿色、粉红色)。

脾脏: (表面: 平滑、粗糙、颗粒、皱折; 质地: 结实、柔软; 颜色: 均匀/斑驳、棕色、黄褐色、红色、黑色、黄色)。

肾脏: (表面: 平滑、粗糙; 质地: 结实、柔软; 颜色: 均匀/斑驳、棕色、黄褐色、红色、黑色、黄色)

性腺: (表面: 平滑、粗糙; 质地: 结实、纤维化; 颜色: 均匀/斑驳、红色、黑色、棕色、紫色、黄褐色、黄色)

甲状腺: (表面: 平滑、粗糙; 质地: 结实、纤维化; 颜色: 半透明/斑驳、橘色、红色、黄褐色、黄色)

口腔: (黏膜: 平滑、粗糙、颗粒、凹痕; 颜色: 均匀/斑驳、粉红色、黄褐色、黄色、灰色、红色、棕色) 内容物?

食道: (黏膜: 平滑、粗糙; 颜色: 均匀/斑驳、黄褐色、白色、红色、粉红色) 内容物?

喉囊: (黏膜: 平滑、粗糙; 颜色: 均匀/斑驳、黄褐色、红色、黄色、黑色、棕色) 内容物?

胃: (黏膜: 平滑、粗糙; 颜色: 均匀/斑驳、黄褐色、红色、黄色、黑色、棕色) 内容物?

小肠: (黏膜: 平滑、粗糙; 颜色: 均匀/斑驳、黄褐色、红色、黄色、黑色、棕色) 内容物?

大肠: (黏膜: 平滑、粗糙; 颜色: 均匀/斑驳、黄褐色、红色、黄色、黑色、棕色) 内容物?

膀胱: (黏膜: 平滑、粗糙; 颜色: 均匀/斑驳、黄褐色、红色、黄色、黑色、棕色) 内容物?

脑: (表面: 平滑、粗糙; 质地: 结实、纤维化; 颜色: 均匀/斑驳、黄褐色、红色)

盐腺: (表面: 平滑、粗糙; 质地: 结实、纤维化; 颜色: 均匀/斑驳、棕色、粉红色、黄褐色、橘色)

收集的样本

福尔马林: _____

冷冻: _____

其他: _____



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