Regular Article

Asking the PRIME questions for grossing: Teaching a framework for grossing and constructing gross descriptions using the PRIME model[☆]

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A B S T R A C T

Grossing is essential to the practice of anatomic pathology. The importance of this skill cannot be understated, but it simultaneously can be enigmatic for novice pathology residents. Successful grossing asks questions to yield the most accurate answers which facilitate a complete report and diagnosis for patient care. To provide a unified framework of approach to grossing specimens, we devised the PRIME (P = process/picture, R = relationships, I = internal, M = margins, E = external) model for grossing. The PRIME model was introduced to anatomic pathology trainees (n = 21) at two academic hospitals through an interactive workshop featuring multiple exercises: (1) scoring provided inadequate gross descriptions of common, familiar objects (fruit) for content quality before and after introduction of the PRIME model, (2) building a gross description as a group with a representative fruit specimen using PRIME, (3) videos of grossing specimens which the participants used to practice constructing their own gross description using PRIME, and (4) analysis of an example surgical specimen's gross description using PRIME. Pre- and post-workshop questionnaires assessed the trainees' experience with grossing before residency, their confidence to write a gross description, and their opinions of the PRIME model. The assessment of fruit gross descriptions before and after the introduction of PRIME was significant (p < 0.05), as well as the participants' confidence level to write an accurate gross description using PRIME. The PRIME model and workshop help to fill a void in pathology education and erode perceived barriers to confident grossing by providing a framework of the key concepts behind grossing specimens, no matter the complexity.

Keywords: Anatomic, Education, Grossing, Model, Pathology, Prosection, Resident, Trainee

Introduction

Grossing (or surgical prosection) is essential to surgical pathology. Before tissue becomes a slide, it must first be assessed grossly, prepared, and described accordingly. The importance of this skill cannot be understated, but it simultaneously can be enigmatic for beginners. A thorough gross assessment not only creates the tissue sampling plan for histologic examination but is critical to the accurate pathologic diagnosis and staging.[1] Successful grossing answers clinical questions to provide the most complete diagnosis for patients. To that effect, we devised the PRIME (P = process/picture, R = relationships, I = internal, M = margins, E = external) model for grossing, as described in detail in the Materials and Methods section of this manuscript below (Table 1).

For first-year pathology residents, the gross room can be intimidating, especially given the wide gamut of conceptual pathology content covered in medical school curricula.[2–4] Pathology residents can show a steep learning curve given the variable pre-residency exposure to pathology.

Pathology medical education tends to concentrate on histopathology and gross pathology, and how to gross may not be a component of a new resident's prior pathology experience.[5,6] In this respect, different methods have been explored by pathology residency programs regarding onboarding their trainees to the grossing process.

One strategy employed to guide and teach pathology trainees is the use of templates (synoptic reports, grossing templates, report templates, etc). In the case of surgical pathology reports, there is data supporting their use, which certainly has a place and can aid in completing a report; however, studies of template use in other specialties show that errors are still possible.[7,8] While standardized templates to guide grossing can be an asset in certain scenarios, templates will be less useful when the specimens deviate from a "typical" resection anatomy (resections that include multiple organs with adhesions, altered anatomy due to prior surgical intervention, unexpected margins, etc). Furthermore, following templates too rigidly can lead to over-submission of tissue blocks for histologic analysis that may not significantly contribute to the final diagnosis.[9] While there are

Table 1
Summary of the PRIME model for grossing mnemonic and key concepts of each letter.

P	R	I	M	E
Process/Picture	Relationships	Internal	Margins	External
• Most important: What is the overall big picture here? Why was this procedure performed, and what is the clinical scenario? This frames our goal. • Walk the reader through your findings by outlining the process that you used. What did you ink? What did you cut or open? What planes of transection did you cut along? What axis did you cut along? • Take pictures • Can a reader draw a picture based on the gross description?	• What are the relationships to the various structures? • If there is a lesion, where is it located with respect to margins, surrounding tissue, layers, or regions of the tissue? What part of the tissue does it involve? What are the structures present, and do they make sense? Is the anatomy altered?	• Describe the tissue on cut section • If the specimen is opened, what were the findings?	• What needed to be transected to remove this tissue or organ from the patient? • How have these areas of transection been delineated? Were they left open, stapled, clipped, cauterized?	• The anatomy, what organs or tissue are present here? • What are the dimensions? • How would you describe the external aspect of the specimen? • What is the orientation of the specimen? • Are lymph nodes present or palpable?

initiatives to improve grossing techniques and standardizations (typically in an organ-specific fashion), an initiative to create a more generalized approach to grossing and formulation of gross descriptions is not represented in pathology education literature.[10,11] Organ-specific grossing instructions are important for extracting clinically relevant information from a specimen, but this does not support an understanding of how to approach grossing and answer clinical questions regarding specimens that are not textbook.

In reviewing the literature, some programs have utilized video instructional guides on how to gross specimens.[12] In one residency program, a tiered system of responsibility and workload had been created based on measuring the approximate time required to gross a specimen to account for the technical aspects of grossing and other components, such as navigating the gross room technology and software.[13] Other programs offer an intensive "boot camp".[6,14] In order to reinvigorate interest and demonstrate the importance of grossing and accompanying gross descriptions, institutions have created conferences to highlight gross findings, correlated with their surgical microscopic counterparts.[15,16] These sessions function to emphasize the gross findings and "bridge the gap" between the physically disparate gross and microscopic (sign-out) rooms.

Teaching gross pathology and the proper recognition of gross findings is exciting and challenging. There are helpful resources, such as books (Manual of Surgical Pathology by Susan C. Lester MD PhD) and videos (free instructional videos hosted on institutional YouTube pages such as Weill Cornell Medicine and PathCast), that are commonly used references for grossing. Additionally, each organ system has well-established criteria for tumor assessment, and this information can be accessed in College of American Pathologists (CAP) protocols,[17] the guidelines of pathologic staging. While these checklists and grossing manuals are invaluable educational tools, a significant but overlooked aspect of the gross assessment is the implementation of a strategic approach to reviewing a specimen and describing the findings. Regardless of prior experiences and knowledge, we describe a method that provides a unified framework to approach specimen; the PRIME model for grossing provides a generalized approach to surgical prosection that can be applied to all specimens without reliance on organ-specific grossing templates, offering the key concepts of the clinical questions to be answered by a specimen. In order to investigate the utility of PRIME, we hosted workshops, which included multiple activities (described below) built around the PRIME model. During our workshops, we aimed to assess the effectiveness of PRIME by allowing residents to evaluate the quality of gross descriptions and gain an appreciation for the art of grossing.

Materials and Methods

The PRIME model

Our PRIME model for grossing offers a conceptual framework for how to approach a specimen and a heightened appreciation for the importance of gross evaluation which are summarized in Table 1 and detailed below. This model is useful for constructing the gross description. It is important to note that:

- While the components create the acronym PRIME, it is not necessary to follow the exact sequence of the letters in the acronym when evaluating a specimen.
- The elements of PRIME are used in union with each other and complement each other. (see Margin section below)
- From the first receipt of the specimen to the final parts of the grossing evaluation and tissue submission, the resident can go through the PRIME sequence multiple times during different aspects of the grossing.
- PRIME can also be used as a tool to evaluate the completeness of a gross description.
- When used in conjunction with organ-specific grossing reference materials, PRIME maintains the holistic perspective when

approaching a specimen for a comprehensive examination and gross description.

P = process or picture; the big picture

The "P" serves as a reminder to ask: what is the big picture? Why was the procedure performed? What is the clinical scenario? The first step to grossing is verifying the patient specimen by matching the requisition with the patient by accession number, patient name, specimen designation, medical record number, or other unique identifiers. This is critical to providing high-quality clinical care and ensuring the patient's clinical and surgical history matches the specimen. The clinical history frames our goal to provide answers to clinical questions and appropriately diagnose and stage the patient. Another aspect of "picture" is gross photography, and the resident is encouraged to take photographs (if possible). The "P" also stands for "process." It reminds the resident to carefully articulate the steps used in the gross assessment. This is reflected in the gross description by describing the process used in prepping, opening, and cutting the specimen and the findings at each step. Lastly, can the reader draw a picture based on the gross description provided? This is an incredibly helpful way to illustrate how effectively the gross description communicates the gross findings. The "P" component of PRIME is a thread that runs throughout the entire gross assessment and the accompanying description: consistently documenting the process and keeping the clinical picture at the center of grossing.

For example, a total colectomy specimen is received with a clinical history of a large, obstructing colorectal mass. Upon examination of the colon, a mass is not identified. This is an example of how the "P" (big picture) should always be kept at the forefront of grossing. While the patient *does* have an obstructing colorectal mass, it is located within the distal rectum, which was not included in this specimen. The colectomy was performed due to sequelae of colon obstruction; a more proximal colonic perforation was identified. Reviewing the clinical history and available medical records is important for all specimens. Some specimens may require further communication with other clinicians and surgeons for proper gross evaluation.

R = relationships

The "R" component is the relationships of the structures and findings. If there is a lesion, where is it in respect to the margins, surrounding tissue, or layers of tissue? This also is asking the resident to evaluate all the relationships seen grossly. What types of tissues or organs are present? Are these relationships in the expected anatomic locations, or have relationships been altered or created by adhesions, anastomoses, fistulas, etc.? Identify and describe all the relationships.

For example, the gross description for an esophagogastrectomy specimen indicates that there is an ulcerated lesion involving the gastroesophageal junction. In this example, the gastroesophageal junction is a necessary landmark to note, but what are the other possible scenarios here that may affect staging? An ulcerated lesion involving the gastroesophageal junction is staged differently from an ulcerated gastric cardia tumor extending to involve the gastroesophageal junction (i.e. staging as esophageal versus gastric primary). Reporting relationships is critical in grossing, and this includes not only the lesion epicenter but also the surrounding involved structures.

I = internal; the tissue appearance on cut surface or once it is opened

The "I" component represents the internal findings. Once the specimen has been opened, bivalved, or sectioned, what are its characteristics? What is present within the specimen, on the cut surface, or in the lumen? This is a detailed evaluation of what is present once the specimen has been altered by the resident.

For example, a hysterectomy specimen is bivalved through the endocervical canal and endometrial cavity. The contents are crucial to understanding the specimen or considering a differential for the complimentary histologic morphology. What does the endometrial cavity contain? Furthermore, upon serial sectioning, how does the cut surface appear grossly? Staging a carcinoma relies on the depth of invasion which, to be sampled accurately, needs to be measured grossly for the most representative section of the deepest point of invasion into the myometrium.

M = margins

The "M" is the tissue margins transected by the surgeon. This component complements and is likely performed in conjunction with the "R" (relationships) and "E" (external, see below) elements of PRIME. Some follow-up questions here include: how have the surgical margins been altered (stapled, open, clipped, cauterized, inked, etc)? How do these margins of resection appear (grossly normal or involved by the lesion or pathologic process)? While some specimens have more predictable margins (e.g. ileocectomy), other specimens may be more complex as seen below. How should the margins be submitted for histology to achieve the most useful information for the patient (en face or perpendicular)?

For example, sarcoma resection specimens can be quite complex, as in a deep tissue resection, such as a myxofibrosarcoma arising in the thigh with invasion into adjacent structures. The specimen may be oriented by the surgeon with multiple margins. The specimen may contain skin; the surface of the skin is not a margin, but the skin perimeter and surrounding soft tissue are margins. Muscle, bone, vasculature, and tendons may also be present which can pose a challenge when approaching cases of this nature. The margins need to be carefully documented, correlated to the orientation, described grossly, and appropriately inked before cutting into the specimen. All margins must be sampled for histology to provide appropriate follow-up care (including potential re-resections if margins are positive). An alternative scenario would be an excision specimen that is received un-oriented by the surgeon. Would this specimen benefit from orientation? The surgeon should be contacted for proper orientation prior to cutting and grossing the specimen.

E = external; initial evaluation of the specimen as received

The anatomy is a key aspect of the "E". This is likely the first step of the PRIME model that a resident will take in the assessment. This includes tissue type, organs, and orientation, as well as verifying the correct specimen and patient identity. Is the specimen oriented by the surgeon, or is the specimen naturally oriented (such as ileocecectomy, as the ileum represents proximal, and cecum is distal)? Correlate all the observations with the information provided in the surgical pathology documentation. What is your anatomic assessment? If the specimen requisition indicates that it is a left (or right)-sided portion of an organ, does that align with the anatomy that is present? It is important to verify and to reconcile any potential discrepancies at this stage. Critical here is a thorough examination of the external surface. Palpating and assessing the specimen for potential lymph nodes, tumor deposits/implants, or disruptions of tissue layers is important at this stage as this information is likely difficult to recapitulate after the specimen is sectioned. Take time to carefully evaluate before inking and cutting.

For example, for a sigmoidectomy specimen, the gross description includes tan-pink mucosa with normal colonic folds and the absence of masses, lesions, and diverticula. Upon histologic examination, the colonic tissue shows no significant pathologic change. Is the final diagnosis a normal colon? In this case, the pathology lies in the findings on the external examination: the colon was markedly dilated. The final diagnosis then acknowledges the abnormal gross findings ("markedly dilated sigmoid colon") and the corresponding clinical history of sigmoid volvulus.

The PRIME model is cyclical, acknowledging the dynamic nature of the gross assessment and creating a gross description. There are multiple

stages beginning with the receipt and initial evaluation of the specimen, proceeding to sectioning, and so on, and PRIME is useful for taking stock of the specimen at these various stages.

The PRIME workshop

The PRIME model was introduced to PGY-1 residents during their orientation block in a two-part interactive workshop. These workshops were conducted at three different intervals and cohorts of trainees: Session 1, University of Pennsylvania trainees in July of 2021 (n = 8); Session 2, University of Pennsylvania trainees in July of 2022 (n = 8); and Session 3, Temple University Hospital trainees in September of 2022 (n = 5) (n = 21 in total: PGY-1, n = 19; PGY-2, n = 1, a transferred resident with little surgical pathology experience; student fellow/MS3, n = 1). At the Hospital of the University of Pennsylvania, the workshop was held in person, using Microsoft PowerPoint and a whiteboard for drawing and note-taking. The Temple University Hospital workshop was done completely virtually using Microsoft Teams. The workshops were created and lead by a surgical pathology faculty member and a senior resident.

The workshop was divided into two 60-min sessions, detailed below, given over two days consisting of three major activities: (1) scoring provided inadequate gross descriptions of common, familiar objects (fruit) for content quality before and after the introduction of the PRIME model, (2) building a gross description as a group with a representative fruit specimen using PRIME, (3) videos of grossing specimens which the participants used to practice constructing their own gross description using PRIME, and (4) analysis of an example surgical specimen's gross description using PRIME.

Day #1

Pre-workshop questionnaire

Before the first session, a pre-workshop questionnaire was conducted relating to previous exposure to grossing and gross descriptions, confidence to build a gross description, challenges with grossing, and upcoming opportunities in the grossing room (Table 2).

Workshop exercise (1): working with deficient gross descriptions of fruit to understand and utilize the PRIME model

In this activity, three inadequate gross descriptions of three different fruits (Table 3: G1, G2, and G3) were read at three separate intervals, and trainees were asked to score their opinion of the quality of each gross description at these three separate scoring intervals. The scoring ranged from 1 to 10 (with 10 = outstanding). A fruit was used in place of traditional surgical pathology specimens so the participants could focus on using the gross description provided to conceptualize familiar entities and not be distracted by anatomy. The gross descriptions offered were written with an "intended diagnosis" (cherry, avocado, cantaloupe), which superficially appeared adequate but overall lacked key discerning details to distinguish it from similar fruits (color, cut surface, size, etc.; see Table 3). Here, the PRIME model is meant to help residents identify the information missing in these gross descriptions. Table 3 summarizes the deficiencies of these gross descriptions and areas for improvement when analyzing the content with PRIME. Scoring of the gross descriptions occurred at the following intervals:

- Scoring interval 1: At the onset of the workshop, before PRIME was introduced, participants were asked to read the gross descriptions and rate the quality of each.
- Scoring interval 2: After introducing and discussing PRIME, the gross descriptions were asked to be reread, keeping the concept of PRIME in mind, and scored individually by the participants.
- Scoring interval 3: After residents participated in an interactive activity in which they drew the specimen based on the gross descriptions (part of the P in PRIME). As a group, after attempting to

draw the specimens, the participants discussed what they each thought the specimens should be (apple versus cherry, etc.), now realizing that a diagnosis could not be made as they each had different interpretations of what fruit gross descriptions represented. They rated the gross descriptions a final time.

After the activity, the group offered various potential diagnoses (fruits) based on the provided gross descriptions, and identifying areas for improvement in these gross descriptions were discussed.

Workshop exercise (2): creating a collaborative group gross description

In this next activity, images of a jalapeño in various stages of evaluation and sectioning were shown to the group. Using a chart labeled with the components of the PRIME model, the group collaborated on filling in the chart to describe the jalapeño. Once the chart was complete, the group collaborated to create a cohesive gross description based on the collective gross findings. This exercise further emphasized the PRIME model and helped create a foundation for constructing gross descriptions. The jalapeño was intentionally sectioned to mimic the grossing of a benign appendix, including amputating the proximal appendiceal margin (en face), bisecting the appendiceal tip, and serial sectioning.

Homework

At the closure of the first day of activities, the participants were given short videos of unknown specimens being grossed to watch and construct a gross description of their own for analysis on day two of the workshop (detailed below).

PRIME Workshop Day #2

Based on the principles reviewed in Day #1, PRIME Workshop Day #2 transitioned the focus to the application of the PRIME model to human anatomy and gross specimens.

Workshop exercise (3): Creating individual gross descriptions from gross specimen videos

At the conclusion of Day #1, trainees were given workshop "homework": two brief videos (approximately 2 min in duration) showing the gross assessment of two specimens. The specimen videos were an ileocecectomy resected for ischemia and a partial nephrectomy resected for a lesion. This identifying information was not detailed to the participants to encourage them to use their own visual assessment to describe the findings, rather than rely on the anatomic site. There was no expectation for the trainees to know what the specimens were. The videos showcased the elements needed for PRIME, including external views, internal aspects via opening or sectioning, methods of sectioning, etc., and a ruler was included in the frame for scale and approximation of measurements. The residents were asked to write a gross description for these specimens using PRIME before Day #2 and anonymously submit the descriptions for review and feedback by the group and session leaders (faculty member and senior resident). The descriptions may not have included terms such as "colon" or "terminal ileum" but instead described "tubular organ" or "hollow organ", and this was acceptable for the exercise's purposes. The trainees were offered the opportunity to deanonymize their gross descriptions to walk the group through their thought process and how they used PRIME to construct their gross description and many residents chose to do so. As workshop mentors, the faculty member and senior resident leading the session emphasized the importance of creating a safe space for sharing, identifying strengths and opportunities for improvement, and learning from each other.

Workshop exercise (4): small bowel lesion—Can you diagnose it based on the written gross description?

Before beginning the exercise, the group briefly reviewed the patterns of tumor staging (T staging) in the luminal gastrointestinal tract.[17] Then, a gross description of a small bowel resection with a lesion was

Table 2
The pre- and post-PRIME workshop questionnaires completed by participants and the corresponding responses.

Pre-PRIME Workshop Questionnaire				
Question Number		Question	Number of Responses	Average Response
Q1-Q8		Describe your experiences with grossing and/or gross descriptions (check all that apply):		
	Q1	No prior experience with grossing and/or gross descriptions.	3	
	Q2	Very minimal prior exposure to grossing and/or gross descriptions.	6	
	Q3	Have read gross descriptions while reviewing slides from the case.	4	
	Q4	Have written gross descriptions.	2	
	Q5	Have observed grossing and observed dictation of gross descriptions.	4	
	Q6	Have reviewed educational materials describing how to formulate a gross description.	1	
	Q7	Have attended lectures, seminars, sessions, etc. regarding how to construct a gross description.	1	
	Q8	Have received some other type of formal guidance or instruction on constructing a gross description (other: ___)	1	
Q9		On a scale of 1–5 (1 = not comfortable, 5 = very comfortable), today, how confident do you feel in being able to construct a gross description?		2.6
Q10-Q11		Short answer, free response questions:		
	Q10	List any aspects of constructing a gross description that you feel are most challenging for you at this time: ___	See below	
	Q11	What do you look forward to regarding your upcoming opportunities for grossing and constructing gross descriptions?	See below	

Post-PRIME Workshop Questionnaire				
Question Number		Question		
Q12-Q16		On a scale of 1–5 (1 = not comfortable or strongly disagree, 5 = very comfortable or strongly agree), today (post-workshop):		
	Q12	How confident do you feel in being able to construct a gross description?		3.9
	Q13	I enjoyed the PRIME workshop.		5.0
	Q14	The workshop accomplished the following objective: provide a framework for constructing gross descriptions.		4.9
	Q15	I feel more confident in constructing a gross description based on what I learned from the workshop.		4.8
	Q16	The workshop fostered team-building within the group.		4.8
Q17-Q19		Short answer, free response questions:		
	Q17	What have you learned from this workshop?	See below	
	Q18	What were the strengths of this workshop?	See below	
	Q19	What are areas for improvement in the workshop?	See below	

Short Answer Question Comments

Q10	Q11	Q17	Q18	Q19
• Achieving complete descriptions • Terminology, anatomy • Describing what I see • Technical, accepted terms for descriptors • Organization, forgetting things • Thinking of descriptive words • "Blanking" on describing, forgetting to describe something crucial/essential • The external findings and their orientation • Texture description	• Learning and understanding how to describe anatomy better • Improving understanding of anatomy • Having a better understanding of anatomy and understanding the patient's history through their pathology • Learning and improving, advancing to interesting/complex cases • Practice • To make a gross description that my attending and any pathologist feels very useful and drawing them closer to the diagnosis before reviewing the slides • A good description that can help attending pathologists understand the specimen accurately	• How much there is to learn and practice • How to write gross description • How to formulate a gross description • Elements of a good gross description • Framework for approaching gross description • PRIME components, to give me something to describe when I blank • Using a systemic approach • Step-by-step construction of gross description, importance of gross description in patient care	• Teamwork, lots of practice • Fun, low stress, educational • Interactive, educational • Fun, constructive, interactive • Practice and teamwork • Informal, started with fruit (familiar), easy mnemonic • Actively engaging the participants, reinforcing their tiny efforts in trying to provide gross description during the workshop, and fruit descriptions at the beginning helped to make everyone curious and interested to participate • Explaining constructive ways how to build a gross description step by step; nice exercise on trying to draw a picture based on the gross description, it makes you understand what exactly is missing in the description and it can be applied in the real life	• Example of good gross description for the fruits

reviewed in the group. It provided nearly all necessary information for the final diagnosis except the key relationships and external findings: from where the lesion appeared to be arising and the suspicious gross finding of serosal retraction/puckering. As a group, using the PRIME model, the description was carefully evaluated for content. This included creating a group drawing of the specimen from the description provided. The following questions were posed: What is the pathologic T stage, and what is differential diagnosis? After reviewing the group's drawing in conjunction with the gross description analysis, the specimen's gross photos were revealed to the group for comparison

Table 3
Deficient gross descriptions of familiar objects (fruit) provided to residents for scoring and analysis before and after the utilization of the PRIME model. The intended diagnosis is not conveyed by the gross descriptions provided and, through the utilization of PRIME, conclusions can be made regarding the information missing and overlapping characteristics of other fruits.

Gross Description (G)	Deficient description provided	Intended Diagnosis	Utilization of PRIME	Conclusions of Gross Description
G1	The specimen is received after being picked from a tree and is designated as "fruit 1." The outer surface of the fruit is red, and its shape is round to slightly ovoid. At the most proximal end is a tan-brown and firm to slightly flexible stem. The specimen is opened to reveal at least one small firm brown pit. The specimen is serially sliced and submitted in cassettes 1A-1C.	Cherry	P (Process/Picture) ●How was the specimen sectioned? ●How was the specimen submitted? Reps, entirely? R (Relationships) ●Where is the stem (superior aspect of the specimen)? Where are the pits/seeds? I (Internal) ●Color of the flesh ●Ambiguous number of pits/seeds ●Location of the pit (centrally located, multiple aggregated in the center) M (Margins) ●If the stem is the margin, how was it submitted? What cassette? E (External) ●Size ●Stem (dimensions, color) ●What is the quality of outer surface: smooth, shiny? Roughened? Mottled?	●Cherries, plum, apples, peaches are red and contain pits or hard cores ●No size is given ●Ambiguous number of pits/seeds ●No mention of cut surface ●No mention of whether representatively or entirely submitted ●No mention of margins
G2	The specimen is received following purchase from a grocery store shelf and is designated as "green object number 1." The specimen measures 6.5 x 4.2×3.1 cm in overall dimension and is oval-shaped. The outer surface consists of a tan to green skin. The specimen is serially sectioned to reveal a slightly firm to fleshy and soft interior with no discolorations grossly identified. Representative sections are submitted in cassettes 1A-1F.	Avocado	P (Process/Picture) ●How was the specimen sectioned? R (Relationships) ●Where is the stem (superior aspect of the specimen)? I (Internal) ●Color of the flesh ●No mention of pit(s)/seed(s) M (Margins) ●What is the margin (i.e. stem)? E (External) ●What is the quality of outer surface: smooth, shiny? Roughened? Thickened? Mottled?	●Pears and avocados have similar sizes ●Outer surface can apply to both pears and avocados ●The interior color should be defined in the gross ●Pits/seeds or stems (margins) are not recorded
G3	The specimen is received following purchase from a farmer's market and is designated as "melon." The melon measures 10.5 x 7.5×6.4 cm in overall dimension and is uniformly round. The outer shell is tan and textured with no defects or lesions identified. The specimen is serially sectioned to reveal a firm to fleshy interior with scattered small seeds. Representative sections are submitted in cassettes 1A-1J.	Cantaloupe	P (Process/Picture) ●How was the specimen sectioned? R (Relationships) ●Is there a stem or multiple structures involved? I (Internal) ●Color of the flesh ●Ambiguous number of pits/seeds ●Location of the pit (centrally located, multiple aggregated in the center) M (Margins) ●Is there a margin? Where was the fruit cut from? E (External) ●Why is the size a range here if it is uniformly round? ●What is the quality of outer surface: smooth, shiny? Roughened? Mottled?	●Watermelon, honeydew, and cantaloupe have similar sizes ●Outer surface is not completely described ●Color of cut surface not described ●Shape, color, size, and distribution of seeds is not recorded

which showed that the lesion was a subepithelial lesion that was suspicious for serosal involvement. While the technical grossing was adequate and the gross description was thorough, using the PRIME model, the group identified certain key elements that would have allowed to better answer the aforementioned questions, which would focus on a subepithelial/submucosal differential (neuroendocrine tumor) rather than a mucosal differential (erosion, ulcer, adenoma).

At the conclusion of the activities on Day #2, a post-workshop questionnaire was administered to the participants (Table 2).

Results

The scores of the gross descriptions of various fruit at the three different scoring intervals were assessed using a paired t-test. For all gross description scores, there was a statistically significant difference

($p < 0.05$, n = 21) in the paired scores between all scoring intervals: scoring interval 1 (before the introduction of PRIME), scoring interval 2, (after introducing PRIME) and scoring interval 3 (after the interactive drawing activity) (Fig. 1).

Table 2 displays the number of responses among trainees in the pre-workshop questionnaire, primarily addressing their exposure to grossing and gross descriptions. Most respondents express no prior experience with grossing (Q1; n = 3 of 21), very minimal exposure (Q2; n = 6 of 21), have read gross descriptions (Q3; n = 4 of 21), and having written a gross description (Q4; n = 2). Several residents have observed grossing or dictation of grossing (Q5; n = 4). Very few residents have reviewed educational material on how to formulate a gross description (Q6; n = 1), attended lectures regarding building a gross description (Q7; n = 1), or received some type of formal guidance regarding gross descriptions (Q8; n = 1). When asking the residents how comfortable they feel in being able to construct a gross description (Q9) on a scale of 1–5 (5 = very comfortable), the average score was 2.6 (n = 21).

There were two short answer questions in the pre-questionnaire which asked the residents to identify the challenges they perceive in construction a gross description (Q10) and what they look forward to in upcoming opportunities regarding the grossing experience. The responses are located at the bottom of Table 2.

In the post-questionnaire (Table 2), the residents were once again asked to rate (on a scale of 1–5, 5 = very comfortable) how comfortable they feel in being able to construct a gross description after the workshop activities and working with the PRIME model (Q12) which they now rate at 3.9 (n = 21) which is statistically significant compared to the corresponding pre-workshop question (Q9, $p < 0.05$, n = 21).

The average responses to the post-questionnaire questions pertaining to the enjoyment of the workshop (Q13), the workshop being able to provide a framework for constructing a gross (Q14), feeling more confident to construct a gross description based on the information provided from the workshop (Q15), and the workshop's ability to foster teambuilding (Q16) were high, averaging greater than 4.8 to all questions (Table 2).

The short answer questions asking the participants what they learned during the workshop (Q17), what the strengths of the workshop were (Q18), and what areas of improvement they would recommend (Q19) are detailed with responses in Table 2.

Discussion

Grossing is one of the most challenging experiences in pathology residency. In our experience, frequently asked questions by candidates during residency program interviews are focused on grossing training and educational support. The PRIME model and corresponding workshop create a foundation for grossing, aid in building gross descriptions, and help take the mystery out of grossing by providing a framework that complements other organ-specific resources.

In one study, approximately 50% of pathology residents do not feel that their training programs adequately prepared them for gross examination of specimens, rating the histologic quality of their education higher. Simultaneously, in the same study, respondents noted that increased grossing was less satisfactory to the workplace environment.[18] This dichotomy suggests that there are elements of the gross examination and section submission process that are not learned from simply high volume or usage of templated gross descriptions with section submission keys. This is where PRIME takes its place in the educational space as it offers a model to approach a specimen from a holistic standpoint, especially as most of the participants had little, if any, experience grossing.

One of the goals of the PRIME workshop is to engage trainees in a collaborative environment to help strengthen grossing practice early in training. Rather than a template-based approach to grossing, PRIME offers a framework to attach further knowledge and education onto early in

the grossing experience. As demonstrated in Fig. 1, the PRIME workshop was successful in helping trainees understand key aspects of a gross description, even before starting a surgical pathology rotation. The deficient gross descriptions of fruit provided to them by the moderators of the workshop (Table 3) were initially perceived as quite adequate by the residents, but, after the introduction of the PRIME model in the workshop, there was a statistically significant drop in the scoring of each of the fruit gross descriptions. In other words, the trainees' appraisal of the gross descriptions fell once the PRIME model helped them analyze these gross descriptions and realize that they were not as clear as originally perceived before the workshop began. Furthermore, once the residents were asked to draw the fruit from the gross descriptions (part of the P in PRIME), they realized they were unable to completely do so as measurements, cut surface description, or margins, etc. were not given in the gross description. This aspect of gross description analysis through PRIME was a goal of the workshop. PRIME can be used as a tool to help residents reassess their own gross descriptions as they compose them to ensure that their descriptions contain all the elements required to be interpreted in the report as intended and representative of the specimen.

Furthermore, the responses received in the pre- and post-workshop questionnaire express wide approval of the exercise with participants rating their confidence to construct a gross description higher after the introduction of the PRIME model for grossing (Table 2). Perhaps PRIME, by offering a strategy on how to approach specimens as a whole, can demystify grossing and provide a tool to trainees when they are confronted with an unusual or new type of specimen. Particularly, the participants praised the structure of the workshop and its interactive nature.

The comments on the pre-workshop questionnaire indicated that trainees are looking for help in beginning the process of learning how to gross, particularly with terminology, organization of a description, and practice. There is excitement among trainees for this type of interactive instruction to complement the traditional didactics in the beginning of training of residency, hinting at a desire for other forms of learning.[19] The trainees are seeking structure from the onset of their residency, as opposed to on-the-job training which residency programs of all specialties have traditionally embraced.

The PRIME workshop, at its core, also provided new residents the opportunity to foster camaraderie amongst their new peers. The workshop was collaborative, interactive, and well received by the participants. In the post-workshop questionnaire comments, participants recounted
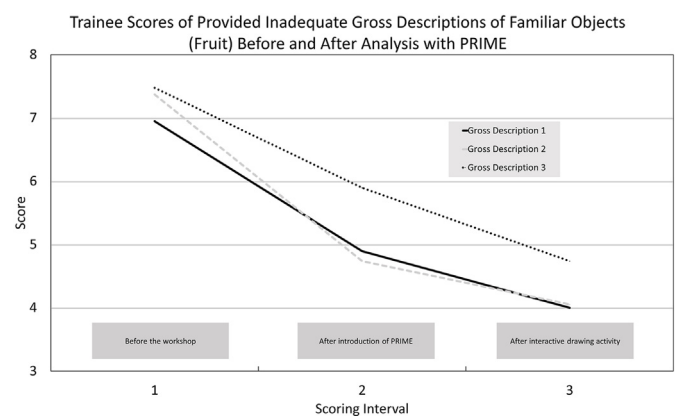

Fig. 1. Scores (0–10, 10 = outstanding) of inadequate gross descriptions of familiar objects (fruit) at three different scoring intervals: (1) before the introduction of PRIME at the beginning of the workshop, (2) after PRIME is discussed, and (3) after an interactive session in which participants attempt to the draw the object based on the provided deficient gross description (the P of PRIME).

that teamwork and team-building were some of their favorite elements of the workshop. It cannot be overstated how important the healthcare team is when handling, processing, and diagnosing specimens. The comments made by participants on the post-workshop questionnaire indicated that they felt more confident to build a gross description and appreciated being able to practice gross description writing. Notably, beginning the session with fruit (familiar objects) and translating the descriptive approach to anatomical specimens was helpful. The participants were able to hear from their colleagues and work together to build the gross descriptions. The easy-to-follow acronym PRIME was also praised for its ability to address all facets of the specimen. An additional important component of this workshop was the facilitation of a comfortable learning environment. When reviewing gross descriptions, emphasizing the successes and strengths of the gross descriptions written by the participants also contributed to the positive learning environment and instilling foundational skills in giving and receiving feedback.

There is insufficient literature published regarding the education of and how to approach grossing as a beginner. The PRIME model and workshop help to fill a void in pathology education. Our study, though multiple cohorts of residents were involved, is limited by its small sample size, and it is difficult to make definitive conclusions based on our data. To that effect, in addition to continual incorporation of PRIME during resident orientation, we plan to investigate how PRIME can further impact grossing experiences beyond the workshop, and moving forward, examine how trainees incorporate this model into their daily grossing experiences in more robust and objective ways. Consistent implementation of PRIME during initial training may shape perceptions and guide learners when grossing and formulating the accompanying description. Furthermore, from a trainee perspective, it may increase confidence in embarking on grossing education and approaching all specimens, and perhaps help them build more complete and thorough gross descriptions.

Ethics approval

This quality improvement study was approved through the departmental institutional review board.

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Disclosures

The authors have no conflicts of interest to disclose.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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